ELEMENTS FOR DESIGNING A MODAL SHIFT PROGRAM FOR CANADA

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Introduction

A freight modal shift program is one that provides incentives to shippers to move their goods by an alternative mode of transportation. This incentive is usually a financial reward for switching the shipping method of choice from truck to rail or marine, and is provided on the grounds that this shift would generate social benefits that offset the cost of the incentives provided.

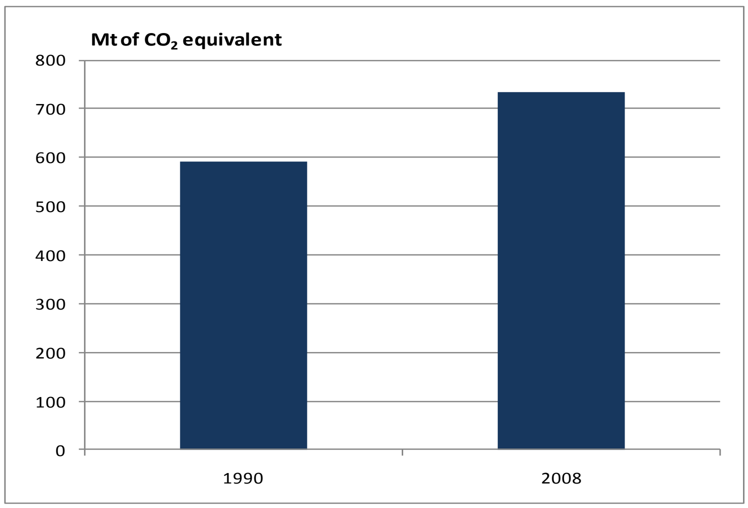
This paper focuses specifically on truck-to-rail modal shift. First, we briefly illustrate the need for such programs in Canada. We then proceed to describe a few existing modal shift programs, namely the Alberta Freight Modal Shift Protocol, the United Kingdom Modal Shift Revenue Support program and provide a detailed overview of the European Union Marco Polo Programme. Then, using recent data from Transport Canada's Full Cost Investigation, we attempt to estimate the environmental, social and economic advantages of shifting freight from truck to rail. Finally, we employ these estimates to construct a framework for a national modal shift program in Canada with an example describing how such a program would work in practice.

The Need for Modal Shift

In 2008, the freight transportation sector accounted for 8% of Canada's total greenhouse gas emissions. Yet, while total GHG emissions have increased by 24% since 1990 (see Figure 1), freight transportation was responsible for 13% of this increase. GHG emissions attributable to freight transportation have increased 45%

from 1990 to 2008, far outpacing emissions growth in most other sectors (1). As such, any effort to reduce our national GHG emissions must incorporate strategies to reduce emissions from the freight transportation sector.

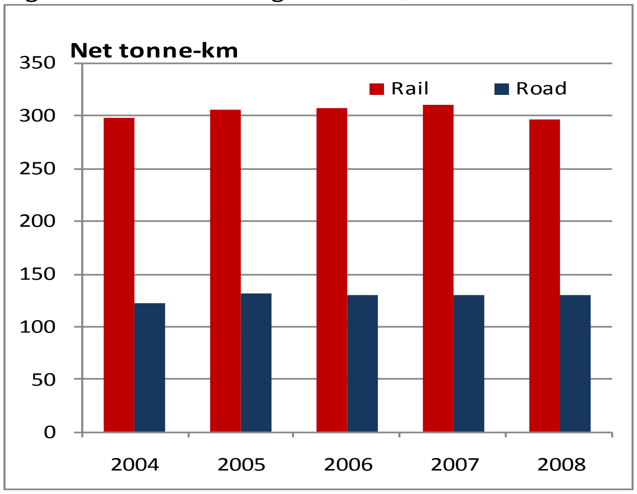
Figure 1: Total GHG Emissions, 1990 and 2008



Source: Environment Canada, *National Inventory Report 1990–2008: Greenhouse Gas Sources and Sinks in Canada*

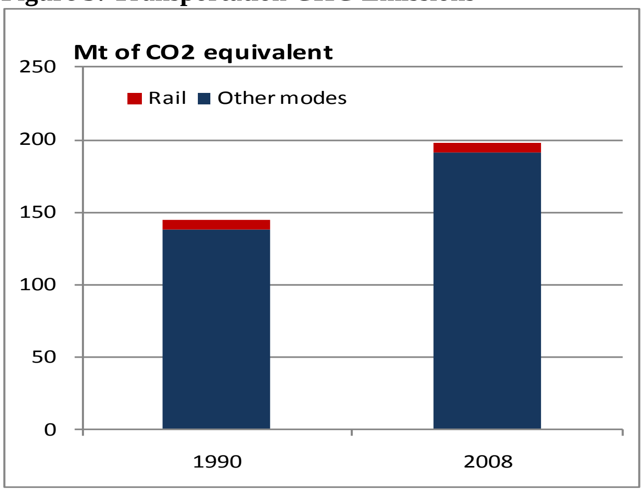
The idea behind modal shift as a policy tool to reduce GHG emissions is based on the fact that railways are more fuel-efficient than trucks on a tonne-km basis. While the rail sector ships roughly 70% of all surface domestic freight (measured in net tonne-kilometres), it emits only 3% of the corresponding GHG emissions derived from transportation activities, thus having a clear advantage in this area (2)

Figure 2: Domestic Freight Carried, 2004–2008



Source: North American Transportation Statistics Database

Figure 3: Transportation GHG Emissions



Source: Environment Canada, *National Inventory Report 1990–2008: Greenhouse Gas Sources and Sinks in Canada*

Yet combating climate change is not the only rationale for modal shift. Shifting some of the freight transportation off the road can also reduce criteria air contaminant (CAC) pollution, noise and congestion on highways and lead to an increase in traffic accidents resulting in injury or death.

Additionally, truck use contributes to the deterioration of our public highway and road system. Heavier vehicles require exponentially higher pavement costs. A study conducted in the United States found that one heavy truck (five or more axles) has the same impact on pavement costs as 90 passenger cars (3). This leads to higher pavement maintenance costs for the various levels of government.

Despite these facts, Canada still treats road transportation as a public good. Under such a policy, charges per a given user do not properly account for the proportion of costs incurred by this user. This fact is well-documented by the 2001 report of the Canadian Transportation Act Review Panel, "Vision and Balance".

This is problematic for two reasons. The first is that, it leads to an inefficient and inequitable allocation of costs and resources. The second is that user charges do not recover the full costs of road transportation. In fact, a 2005 report by Transport Canada estimates that the Canadian federal, provincial, and municipal governments only recovered between 67 to 91 per cent of the overall costs of road transportation (4).

Modal Shift Programs

The Government of Alberta was the first government in Canada to introduce a freight modal shift program. Companies that ship freight within or through the province are eligible for carbon offset credits for all their truck to rail modal shift actions taken on or after January 1st, 2002. Following the Alberta "Modal Freight Shift Protocol", companies can calculate the GHG emission reductions that their modal shift induced and apply for carbon offset credits. This program is especially appealing to companies that ship heavy freight over long distances, notably across the province, as the longer distance increases the GHG emission reductions resulting in higher incentives to switch.

The United Kingdom also has its own program known as the Modal Shift Revenue Support (MSRS), implemented in England, Wales and Scotland. The present version, running from April 2010 to March 31st 2015, offers grants to companies that shift from truck to rail or marine.

The largest and most comprehensive program in the world is known as "Marco Polo" and we discuss it more thoroughly in the following section.

Marco Polo Programme

The *Marco Polo Programme* (MPP) is the European Union's modal shift program. Designed to reduce congestion and contribute to an efficient and sustainable transportation system, the program has offered funding for projects that shift freight transportation away from the roads. The first MPP was launched in 2003 and ran till 2006. Owing to its great success, a second ongoing *Marco Polo II* was launched in 2008 and runs till 2013. *Marco Polo II* expands the program to countries neighbouring the European Union and benefits from a larger budget of €450 million, more than four times that of the first program.

To qualify for funding under the MPP, the applicant must demonstrate that a project shifts an average of at least 60 million tonne-km of freight per year and produces net benefits to society. Social benefits taken into account are noise, pollutants and climate costs as well as accidents, infrastructure and congestion. An action produces social benefits if it results in net savings in social costs. In other words, as some modes of transportation generate larger social costs per tonne-km, benefits can be produced by shifting to a less costly mode, and the net benefit is computed as the difference between the two costs. The social cost figures used are based on an internal European Commission paper and are summarized as follows:

Table 1: Costs per tonne-km by Mode of Transport

Mode of Transportation	Costs per tonne-km (€)
Road	0.035
Rail	0.015
Net Social Benefit	**0.020**

While applicants may not profit from their project, they must prove that it will be viable after the grant. Funding can cover up to 35% of the costs of the project. Since the inception of the MPP, it has annually funded an average of twenty projects.

In one successful application, for example, SA des Eaux Minerales d'Evian and their partners Danone Waters Deutschland received a grant of €560,000 for a project to switch to rail for the shipment of bottled water from the spring in Volvic to the German distribution center in Hockenheim, where it is then distributed by trucks. As a result, a distance of 700 km, or 70% of the average distance from Volvic to final destinations in Germany is now transported by rail. As a result, 341 million tonne-km are expected to be shifted off the road over the next three years, resulting in environmental benefits of €6.9 million. Furthermore, the company estimates that this shift takes the equivalent of 10,000 trucks off the road every year.

Developing a National Canadian Modal Shift Program

If Canada were to introduce its own national freight modal shift program, it is important that it have social cost estimates that are consistent with Canadian economic and social costs. Transport Canada launched a multi-year *Full Cost Investigation* (FCI) in 2004 and released a report detailing the financial and social costs of transportation in Canada by mode, type of cost, and purpose of use. In the next section, we attempt to use the results of this report to compare rail to truck efficiency and use the net social benefits of rail as a basis to construct a Canadian national freight modal shift program.

Socio-Economic Benefits of Rail

1. **Air Pollution**

The FCI monetizes pollution costs based on the impact of CAC emissions on human health costs, changes in agricultural productivity and visibility impacts. Transportation emissions were based on *Environment Canada*'s Criteria Air Contaminant Emission Inventory and pollutants included those that reduce air quality directly or through the secondary formation of particulate matter (PM) and ozone.

Adjusting the FCI findings to 2010 price levels, the air pollution costs of carrying one million tonne-kilometres by truck is approximately $6,000, compared with only $1,635 by rail.

2. **Greenhouse Gas Emissions**

Setting a price for greenhouse gas emissions is challenging due to the fact that there is no Canadian market for GHG emissions and no broad consensus as to what the price of carbon should be. Yet, there is little doubt that emitting GHGs imposes a cost on society. The FCI uses middle estimates of the 2006 unit price of carbon on the *European Carbon* Exchange. This, however, does not resolve all problems associated with carbon pricing as the price of carbon on the European Carbon Exchange is very volatile as is the exchange rate between the Euro and the Canadian Dollar. Thus all estimates are to be considered with caution.

Recently, likely due to the global recession, the price of carbon has been significantly lower than 2006 and ranged between 8 € to 16 € per tonne of CO_2 equivalent in 2009, well below the range of 15 € and 30 € per tonne used in the FCI. However, given the constant volatility of prices and the fact that there are many planned initiatives to increase future prices (5), we use the same figures used in the FCI report assuming no change in prices.

Under these assumptions, the GHG costs of carrying one million tonne-km by truck is estimated at $5,560 but only $559 if rail is used instead.

3. Accidents

FCI estimates for accident-related costs are intended to cover costs such as ambulance transportation, first aid, and hospitalization. The most significant part of accident costs, however, is the "Value of Statistical Life" (VSL), which is the cost attributed to the loss of human life. The FCI uses the willingness-to-pay method and estimates VSL within a range of approximately 3 to 5 million Canadian dollars.

Rail transportation can lead to significant accident cost savings, being approximately seven times less costly than trucking on a tonne-kilometre basis. Accident costs for transportation by truck are estimated as $7,296 per million tonne-km compared with only $1,097 per million tonne-km for rail transportation.

4. Noise

The FCI estimates noise economic costs for both and road and rail transportation, using engineering models to estimate the quantity of noise and a mix of hedonic models and stated preference studies to estimate its economic damage. However, while it attributes a relatively small cost of $4 per million tonne-km for freight rail, it chooses not to allocate its estimated road noise costs to the "freight" and "passenger" transportation categories, citing problems with the complexity of the task and the lack of sufficient data.

A European study on the external costs of transportation in Europe estimated an average a 3,200 € per million tonne-km for rail transportation compared with a 7,400 € per million tonne -km for trucks (6). These numbers far exceed the Canadian estimates for rail by the FCI. Part of the reason lies in the fact that population density is much higher in Europe, but perhaps a difference in methodology may be the primary reason for the vast difference in estimates. For this paper, we use the FCI estimates of the cost per tonne-km of noise for rail and compute and estimate of the corresponding costs for truck transportation using the same ratio of costs estimated in the European study. As a result, economic damages are estimated at $4 per million tonne-km for rail transportation and $9.25 per million tonne-km for trucks.

It is important to note that Transport Canada believes its estimates for noise damage costs may be too low and acknowledges that more work is needed in this field, especially in terms of reconciling Canadian noise damage cost estimates with those of other countries in the world.

5. Congestion

The FCI does not attempt to compute delay costs for freight transportation. It does however estimate the cost of congestion on passenger car users by calculating the amount of time lost due to congestion, valuing that time by half the average hourly wage. The total estimate of congestion costs is $6.4 billion per year in 2010 dollars.

Although we do not attempt to measure marginal costs of delay attributable to truck transportation, it is worth noting that congestion costs exhibit increased marginal costs due to the fact that, while the presence of few vehicles do not cause any congestion, increasing the number of vehicles after a threshold volume of traffic leads to an exponential growth in congestion. Furthermore, trucks are on average larger than passenger and other vehicles. Thus, the congestion costs of trucks are certainly significant enough to be mentioned and taken into serious consideration. The total amount of time that can be saved due to modal shift is very valuable, as the time saved can be allocated to productive activities.

6. Road Maintenance Cost Savings

The FCI allocates a road infrastructure cost of around $51,726 per million tonne-km for truck transportation. As railways do not contribute to the deterioration of road pavement, this figure is thus considered the net social benefit. However, this estimate is not the *marginal*, but the *average* cost of road maintenance per tonne-km. While we believe the average cost per tonne-km is a good approximation for the marginal cost in all the previous estimates, it is doubtfully the case when it comes to road maintenance costs. The reason is that road maintenance requires high fixed costs. So while the marginal accident cost of an extra tonne-km is roughly the same for both the first and last tonne-km, this is hardly the case for road maintenance costs. As a result, a more accurate estimate is required.

Fortunately, the Ministry of Transportation of Ontario provided the following estimates to CANARAIL, a railway consulting firm. The Average Marginal Equivalent Uniform Annual Cost (EUAC) for a typical two-lane highway:

- 1.60 cents per tonne-km, with 100% empty returns
- 1.59 cents per tonne-km, with 75% empty returns
- 1.58 cents per tonne-km, with 50% empty returns

We believe the estimates above are preferable to the FCI estimates, and we use third and most conservative cost in our freight modal shift sample program.

Table 2 below summarizes the social costs per tonne-km attributable to each mode of transport and the resulting net savings (or social benefits) that can be achieved through modal shift.

Table 2: Estimated Cost per tonne-km, by Mode

	Costs per million tonne-km		
	Truck	Rail	**Net Benefit**
Air Pollution	$5,999	$1,635	$4,365
GHG	$5,560	$559	$5,001
Accidents	$7,296	$1,097	$6,198
Noise	$9	$4	$5
Road Maintenance	$15,800	-	$5,800
TOTAL	$34,664	$3,296	**$31,368**

Modal Shift Program - Illustrative Example

Suppose that Smith & Co. transports 500,000 tonnes of steel from Sault St. Marie (point A) to a town (point C) 30 km away from Sudbury (point B) over a total distance of approximately 300 km. If it decides to shift part of its traffic to rail, it can move the 500,000 tonnes of steel by rail to Sudbury over a distance of 280 km, and then by truck to the final destination town. Therefore, under the modal shift plan, the company would move 500,000 tonnes a total distance of 310 km, 280km of which are by rail. We can estimate the total social benefits of such a shift as follows, where:

- T_B is the total tonne-km shipped by truck before the modal shift
- $T_{A,1}$ is the total tonne-km shipped by rail after the modal shift
- $T_{A,2}$ is the total tonne-km shipped by truck after the modal shift
- T_A is the sum of $T_{A,1}$ and $T_{A,2}$ or the total tonne-km after the modal shift

- C_B is the social cost of the company's shipment before the modal shift
- C_A is the social cost of the company's shipment after the modal shift.

$$T_B = 500{,}000 \times 300 = 150{,}000{,}000 \ tonne\text{-}km$$
$$T_{A,1} = 500{,}000 \times 280 = 140{,}000{,}000 \ tonne\text{-}km$$
$$T_{A,2} = 500{,}000 \times 30 = 15{,}000{,}000 \ tonne\text{-}km$$
$$T_A = 155{,}000{,}000$$
$$C_B = 150{,}000{,}000 \times \$34{,}664 = \$5.1996 \ million$$
$$C_{A,1} = 140{,}000{,}000 \times \$3{,}296 \div 1{,}000{,}000 = \$0.46144 \ million$$
$$C_{A,2} = 15{,}000{,}000 \times 34{,}664 \div 1{,}000{,}000 = \$0.51996 \ million$$
$$C_A = 0.46144 + 0.51996 = \$0.9814 \ million$$
$$C_B - C_A = 5.1996 \ million - 0.9814 \ million = \$4.2182 \ million$$

Therefore, this project would result in approximately $4.2 million in net social benefits.

Now suppose that there are high fixed costs associated with the project. For example, the company may need to spend $3 million to change the packaging of its products before being able to ship them by rail. In order to qualify for a grant, the company must demonstrate that its project is viable once this $3 million is spent. If its project is viable, the company is then eligible for a grant under the modal shift program grant and may receive up to a certain per cent of the total cost. Under the MPP 2, this grant would be up to 35% of the total or $1.05 million. However, should this grant lead to a profit for the company, the grant is reduced to the point where profits are eliminated.

Evaluating Projects

When many projects are applying for a limited pool of funds, projects can be evaluated on the basis of their estimated social efficiency. We can compute a project's social efficiency as the ratio of its social benefits to the size of the grant. Therefore, social efficiency it is the amount of net benefits to society per dollar of grant. Projects with higher ratios would be given priority. For example, in our previous case:

$$\text{Social Efficiency} = \frac{(C_B - C_A)}{\text{Grant}} = \frac{4.2\ million}{1.05\ million} = 4$$

In other words, for each dollar of grant provided, the project returns 4 dollars in benefits to society.

Conclusion

There are significant social gains that can be attained through modal shift. Trucking remains an indispensible method of transportation that will always have a role in Canada's freight transport network. However, a more socially efficient allocation of transportation resources is required to build a sustainable and modern freight transportation system. Though a modal shift program alone is not sufficient to achieve this objective, it is certainly a proven method and a step in the right direction.

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