AIR AND RAIL COSTS IN THE CONTEXT OF THE FULL-COST INVESTIGATION OF TRANSPORTATION

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1 INTRODUCTION

This paper presents interim results concerning the costs of the air and rail transportation networks in Canada in the context of the Full-Cost Investigation (FCI) being undertaken by Transport Canada, Economic Analysis Directorate, and steered by a federal-provincial Task Force. While social externalities are within the context of the FCI, they are not covered within this specific paper. The paper will first highlight some of the key methodological issues surrounding the calculation of the network costs. This will be followed by a presentation of a selection of the interim results. The base year of the FCI project is 2000, however, interim results from 2000 to 2002 are presented in this paper. The paper covers costs at the national level, whereas average and marginal costs on specific routes are also being calculated with the FCI project.[2]

2 OVERVIEW OF METHODOLOGY

Transportation costs are broken into two different categories, operating and capital costs. The former includes expenditures during the year on consumption items such as fuel, labour and marketing. Capital costs are calculated in order to estimate the value of capital resources consumed during the year,

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[1] Views expressed in this paper benefited from numerous exchanges between the author and the Transport Canada FCI team and the provincial FCI Task Force members. However, these views do not necessarily reflect those of either Transport Canada or the FCI Task Force.

[2] A more detailed analysis of issues and estimates can be obtained from the FCI website at http://www.tc.gc.ca/pol/en/aca/fci/menu.htm.

consisting of depreciation (loss in value of the asset during the year) and the opportunity cost of invested capital. The method employed in order to calculate annual depreciation costs and the asset base for the purpose of the opportunity cost of capital calculation was the perpetual inventory method (PIM). A detailed explanation of the PIM methodology is not within the scope of this paper[3], however, some of the primary inputs into the PIM for FCI estimates are detailed below.

2.1 Asset Categories and Asset Lives

The capital expenditure data was derived from company annual reports, Statistics Canada surveys and public accounts. The number of categories possible was limited by the detail that was available. Asset lives were determined through analysis of annual reports, consultation with stakeholders or Statistics Canada estimates. Several asset categories and their assets lives are presented in table 1.

Table 1 – Asset lives and categories

Asset Category	Asset Life
Buildings	40 to 50 years
Structures, runways	20 to 40 years
Equipment, baggage systems	10 to 20 years
Computer, vehicles and other	3 to 10 years
Nav Canada equipment	12 years
Air carrier assets	20 years
Rail carrier rolling stock	30 years
Rail carrier plant assets	50 years

2.2 Depreciation Method

For annual reports prepared according to Generally Accepted Account Principles (GAAP), straight-line depreciation is usually employed. On the other-hand, depreciation for taxation

[3] For a detailed discussion regarding the measurement of capital, see OECD manual, "Measuring Capital: Measurement of Capital Stocks, Consumption of Fixed Capital and Capital Services," 2001.

purposes is usually accelerated while delayed depreciation methods are also used in some cases. The choice of a depreciation method ought to depend on the nature of the asset and factors such as the degree of physical wear and technological obsolescence. In the FCI project, most of the data being used is at an aggregate level where there is a mix of older and newer assets, causing differences between the various methods to be of less significance. For example, newer assets will have higher calculated annual depreciation costs under an accelerated method, but older assets will exhibit lower depreciation costs using the same method and account for a smaller portion of the capital stock. Furthermore, the inclusion of the opportunity cost of capital in capital costs serves to further minimize the difference between the two (higher opportunity costs of capital will occur using the slower methods of depreciation, since the cost of capital is calculated on the net asset base).

After various sensitivities were tested using FCI data, it was determined that the different depreciation rates do not cause significant differences in terms of overall capital costs. By virtue of the fact that it is simple to calculate and easily-understood, straight-line depreciation was chosen as the primary method of depreciation.

2.3 Price Indexes

The choice of price indexes is an important factor in the conversion from historical to current values. Specific indexes were chosen for each category of assets. For the most part, indexes were based on data from the Statistics Canada Capital Stock division. The choice of indexes for asset categories that were particularly unique and/or experienced rapid increases in the quality of service was problematic. For example, no specific index was available for Nav Canada technological equipment. As a substitute, a telecommunications index was applied. Due to technological obsolescence (and a general decrease in the costs of producing this type of equipment), this index has exhibited rapid decline. Furthermore, the general quality of service of this type of equipment has increased rapidly, while price indexes attempt to hold the quality of service constant. The end result is a significantly lower value of navigations assets at current prices than at historical prices, the opposite result of most other categories of assets.

Other price indexes used normally did not deviate radically from broad producer-price indexes.

2.4 The Opportunity Cost of Capital

An opportunity cost of capital rate is applied to the asset base (current value, net of depreciation) as part of capital costs. On the recommendation of external expertise, a base rate of 7.3 per cent in real, before-tax terms is utilized.[4] However, a sensitivity range from 6 to 8.6 per cent is applied in order to reflect the possibility of a variation in systematic risk among transportation investments. The base rate represents a social opportunity cost of capital, which is essentially a weighted average of the return on private investment, foreign borrowing and foregone personal consumption.

The social opportunity cost rate is applied to all invested capital, without making an assessment of sunk or redundant assets. For example, it is possible that some assets, when valued in terms of the discounted present-value of future returns, would be determined to have a value less than as determined by the PIM. For this reason, capital costs in the FCI can be considered as an upper-value on the possible range. Furthermore, some commercialized entities incur interest charges for the portion of capital that is financed by debt. Because the opportunity cost rate is applied to all capital, the opportunity cost of capital is used in place of, rather than in addition to existing interest charges.

The opportunity cost of land is particularly problematic, as land itself has no original cost and therefore cannot be assessed a value within the PIM without an assessment of the market value of land at some point in time. That the value of land itself is affected by

[4] Brean, Burgess, Hirshhorn, Schulman, “Treatment of Private and Public Charges for Capital in a “Full-Cost Accounting” of Transportation,” 2005.

capital investment on and around it, including the presence of transportation investments, adds another layer of complexity. It is for this reason that land used by transportation capital is being assessed independent market values within the FCI and a sensitivity range from zero to the full opportunity cost of capital is being applied. In the context of this paper, the opportunity cost of capital is applied to the current value of land using the same range as technical capital, for a simplification of results. The interim values of land have been calculated by employing existing current market value assessments or assessments done in the past and adjusted with land price indexes in order to reflect current values.

2.5 Cost Allocation

Due to the fact that parts of the transportation infrastructure as well as other transportation assets are used by more than one mode, or sub-groups within modes, methods to allocate these common and joint costs must be determined.[5] In addition, operating costs such as marketing and overhead may have to be allocated as well. Within aviation, infrastructure such as airport and navigations assets, as well as aircraft capital and associated costs must be allocated between passenger, freight and general aviation activities. In the rail mode, track is shared by both freight and passenger trains, though freight and passenger carriers are independent from one another.

There are many possibilities regarding the allocation of capital and overhead costs. For the most part, these methods fall under the category of allocation by activity (such as tonne-kilometers or gross tonnage), allocation in proportion to incremental or marginal costs or allocation based on Ramsey-style techniques (where capital and overhead is allocated in inverse proportions to the price-elasticity of demand of users). In addition to considering the methodological merits of each, data limitations must be considered. For example,

[5] This issue is covered in a more detailed fashion in the related CTRF paper, Jacques, "Addressing Allocation Issues in the Full-Cost Investigation of Transportation," 2006.

most commercial organizations would employ an activity-based costing system where discrete internal activities are identified and causality (links to the production of goods or services) is determined for each one, thereby reducing the amount of joint and common costs that need to be allocated in an arbitrary fashion. However, data is not always available publicly at such a disaggregated level as to allow for this to be done externally. Moreover, since the user pay principle is not applied to all transportation costs, the FCI has to define cost allocation for many cost elements.

The final allocation method for the FCI project has yet to be determined. Interim allocation methods are briefly discussed here.

2.5.1 Aviation Cost Interim Allocation

In the interim, a working assumption has been that aviation infrastructure and capital has been invested primarily for the purpose of passenger transportation, while cargo and general aviation are marginal activities. For this reason, a higher proportion of capital costs are allocated to passenger traffic, both on the infrastructure and aircraft capital sides. When it comes to carrying cargo on passenger aircraft, carriers would be concerned with charging at least their marginal costs while attempting to recoup capital and overhead costs from passenger transportation, the primary activity. This may in fact produce a somewhat similar result as a Ramsey-style method, though we are not attempting to distinguish between users within each category (such as business and leisure) which air carriers normally do.

The result of this assumption is that air cargo activity recovers its costs, while all economic surplus or loss is attributed to passenger transportation. This allows for a simple allocation of costs to air cargo based upon revenues derived from that activity. The residual is allocated to passenger traffic. In terms of air infrastructure costs, a similar approach is used for general aviation. However, because all of the direct revenues from general aviation is not readily available, a somewhat arbitrary percentage of revenues and costs has been allocated (in equal amounts), based on approaches used in past studies.[6] This approach in particular may be revised, as there exists considerable criticism of airport charges for general aviation activity and the lack of cost-recovery from that segment. Nevertheless, it still remains small relative to the overall size of the market.

2.5.2 Rail Cost Interim Allocation

The main allocation issue in terms of rail costs at the national level exists between shared freight and passenger infrastructure. Since the bulk of passenger traffic (which in this case could often be considered as 'fringe' traffic) is provided by stand-alone carriers the possibility of economic surpluses or losses is considered in that segment (whereas in air cargo it was assumed that carriers recover costs in their cargo operations). In cases where VIA Rail makes payments to Class I freight carriers for track access, the costs of this track access to the Class I carriers is assumed to be equal to those payments. In cases where carriers do provide some passenger services directly, network cost allocations are done on the basis of revenue. However, these costs represent a very small proportion of the total.

The calculation of commuter rail costs has not been covered in this paper, and is currently being covered in a separate urban transit category within the FCI. In those cases, many of the same allocation issues apply.

2.6 Other Issues in Aviation

Most large airports are now run by local authorities on long-term leases from the federal government. As a result, several airports make lease payments for the operating rights. If lease payments are considered in the operating costs of these airport authorities, the federal government must be considered as a supplier of aviation infrastructure services with lease payments as the revenues and the opportunity cost and depreciation on transferred airport assets as

[6] See "Directions: The Final Report of the Royal Commission on National Passenger Transportation," 1992.

costs. However, since the lease payments on the cost side of the local authorities are netted out by the revenue side of the government, including the opportunity cost of transferred assets directly in the costs of the local authorities in place of the lease payments would result in the same calculated surplus and prevent double-counting of revenues. It is in this way that the air infrastructure costs and revenues are usually presented.

This issue is somewhat similar to the situation between air carriers and airports, where some revenues for one are costs for another. When presented distinctly, no adjustments are made. However, when presenting the overall aviation picture, adjustments are made in order to ensure that only revenues derived from consumers are included, in order to prevent double-counting of revenues.

The calculation of the value of aircraft owned and operated by air carriers presents some measurement difficulty. A significant portion of carrier fleets are leased rather than owned, making it difficult to estimate capital expenditures on an annual basis. Furthermore, some leased aircraft may be reported as owned in carrier annual reports, due to rules regarding the accounting for long-term capital leases.

It is possible to estimate the value of leased aircraft by obtaining lease payment schedules (generally available in aggregate amounts in notes to financial statements) and discounting to a present value. Aircraft lease expense would then be replaced by depreciation on this capitalized value along with the opportunity cost of capital. However, due to the cumbersome nature of the process and the lack of detailed data in some cases, it was assumed that lease payments themselves were combined charges for depreciation and the opportunity cost of capital and were therefore added to overall capital costs. This method still poses a problem, due to the fact that some air carriers have obtained more favourable lease terms for different reasons ranging from either a difficult financial situation to more favourable market conditions at the time of the negotiations of their lease, meaning capital costs will decline but the actual number of aircraft may not (it can be argued that this is simply reflecting a decline in the market value of assets, though in that case the associated capital loss or depreciation will not appear in our accounts).

In terms of scope, the FCI project is concerned only with transportation activity within Canada. Relatively to the rail mode, aviation is somewhat unique in that it is difficult to limit and define the activity in such a rigid manner. For this reason, the aviation data has been limited to Canadian carriers, including their international operations, while foreign carriers providing international service to Canada have been excluded. In some regards this is similar to assuming that the Canadian carriers' share of the Canadian-international market is roughly equal to that of competing foreign carriers. A similar limitation has been set on air navigations providers (Nav Canada has been included in its entirety, despite the fact that Nav Canada provides services to foreign carriers as well as to carriers that just use (fly over) the Canadian air space while Canadian carriers receive services from foreign navigations providers for the same reasons).

2.7 Other Issues in Rail

Data sources are strong in terms of the Class I carriers. These carriers compose the bulk of the rail network and activity in Canada. However, there exists over forty regional and shortline carriers in Canada, the data for which is not always as robust. Furthermore, the degree of interlining between these and the large carriers adds another level of complexity. Capital stock data is not always entirely reliable for these carriers, as assets have been in many cases acquired from Class I carriers. This presents some difficulty when attempting to measure the value of the stock with a model such as the PIM.

While the valuation of land presents uncertainties for the aviation mode as well, potential problems are more acute within rail. Naturally, the area of land occupied by rail infrastructure is more dispersed than in the case of aviation assets. Furthermore, the fact that the land occupied is in smaller parcels may have a bearing on its value, though carriers have retired segments of lines in the past and generated revenues through the sale of the land. That much of the land has been occupied by the rail network since the 19th century and prior to significant development in many cases may also be a relevant issue in terms of land valuation. Moreover, much of this land was granted to the carriers meaning that no value would appear in their financial accounts, rendering the price-index approach for land value estimation entirely inadequate. In the interim, land value estimates have been made using the price-index approach for those values of land that have appeared in carrier financial accounts at acquisition prices.[7] A land value study covering all modes is currently underway for the purpose of addressing this issue in a rigorous manner for all modes.

3 Interim Results[8]: Aviation

Table 2 presents the estimated net current value of aviation assets. The cost of leased aircraft is represented by the annual lease payments, rather than distinct depreciation and cost of capital figures. However, in order to provide a more accurate indication of the total value of air carrier assets, a rough estimation of the value of leased aircraft is included.[9]

[7] A land value study covering all modes is currently underway for the purpose of addressing this issue in a rigorous manner for all modes.
[8] More detailed results are available on the FCI website.
[9] The value is derived by calculating the present value of lease payments assuming flat payment amounts over a 20 year period and a discount rate of 7.3 per cent.

Table 2 – Net Current Value of Aviation Assets

In $000	2000	2001	2002
Airport Assets	7,017,242	7,632,834	8,591,672
Air Navigation Assets	922,660	860,722	860,410
Total Infrastructure	7,939,903	8,493,556	9,452,081
Air Carrier Assets	9,361,652	7,778,305	6,262,310
Leased Aircraft	13,523,099	13,337,575	11,835,881
Total Assets	30,824,653	29,609,436	27,550,273

The estimated value of total assets declined over the 2000 to 2002 period due in large part to the decline in aircraft lease payments resulting from more favourable lease terms, as well as a shift towards more leased aircraft and aircraft retirements. The asset value estimate allows for the calculation of the annual depreciation and cost of capital. These are added to annual operating costs in order to arrive at an estimate of total costs. The estimates are presented in table 3.

Table 3 – Total Aviation Costs

In $000	2000	2001	2002
Operating expenses	12,605,226	12,591,034	12,374,598
Depreciation	1,513,417	1,526,911	1,371,807
Cost of capital - 6%	1,042,006	980,153	946,704
Cost of capital - 8.6%	1,493,542	1,404,885	1,356,943
Aircraft rentals	1,306,400	1,288,478	1,143,406
Total costs - 6%	16,467,050	16,386,575	15,836,516
Total costs - 8.6%	16,918,586	16,811,307	16,246,755

Total costs declined over the period, due mainly to the contraction in the value of the invested capital over the period. These costs are subtracted from total revenues in order to calculate the total economic surplus for each year. Table 4 presents the estimates.

Table 4 – Total Aviation Economic Surplus

In $000	2000	2001	2002
Total revenues	15,806,388	14,897,083	14,882,192
Total costs 6%	16,467,050	16,386,575	15,836,516
Total costs 8.6%	16,918,586	16,811,307	16,246,755
Economic surplus 6%	-660,662	-1,489,492	-954,324
Economic surplus 8.6%	-1,112,198	-1,914,225	-1,364,563

Regardless of the year or cost of capital rate applied, there is an estimated economic loss. Not surprisingly, the loss is largest in 2001. Tables 5 and 6 provide some perspective regarding infrastructure fees and total costs on a per passenger basis.

Table 5 – Infrastructure Fees per Enplaned Passenger

	2000	2001	2002
Total Passengers	42,207,010	39,274,429	37,264,354
Aeronautical fees ($)	14.14	16.10	17.71
AIF ($)	3.80	6.17	8.30
Navigation fees ($)	21.70	23.05	23.69
Total ($)	39.64	45.32	49.71

Table 6 – Average Costs per Passenger-Kilometer

In cents	2000	2001	2002
Costs per pkm 6%	14.48	14.81	15.38
Costs per pkm 8.6%	14.91	15.22	15.81

Infrastructure fees per enplaned passenger increased over the period, mainly due to the introduction of Airport Improvement Fees at several airports during that time. Note that while the fees are presented on a per-enplaned passenger basis here, this does not infer that fees are actually charged in this manner. For example, navigation fees to domestic flights are generally much lower. However, this figure attempts to approximate the average fee for all included flights, which also consists of international flights by domestic carriers. The fees charged for these international flights would generally be higher. Average costs in table 6 do not make a scalar adjustment in order to take into account the effect on unit costs of increased stage lengths, which normal exhibit an inverse relationship.

4 INTERIM RESULTS: RAIL

The preliminary net current value estimates of the rail infrastructure and carrier estimates is provided in table 7.

Table 7 – Net Current Value of Rail Assets

In $000	2000	2001	2002
Equipment	3,875,902	3,906,315	3,777,563
Road & Structures	20,747,882	21,282,032	21,043,901
Land	2,293,546	2,315,609	2,458,092
Total Assets	26,917,330	27,503,956	27,279,557

The value of the total capital stock is estimated to be relatively stable over the three-year period. Land value estimates are presented independently in order to provide an idea of its relative importance. The cost of capital and depreciation is calculated and added to operating costs for total cost estimates. Subtracting from total revenues provides an estimate for the annual economic loss.

Table 8 – Total Rail Economic Surplus

In $000	2000	2001	2002
Total revenues	7,772,294	7,860,268	7,918,044
Total costs 6%	6,949,284	7,040,681	6,830,240
Total costs 8.6%	7,638,768	7,741,020	7,526,685
Economic surplus 6%	823,009	819,587	1,087,804
Economic surplus 8.6%	133,526	119,248	391,359

In all three years using either cost of capital estimate, there is an estimate economic surplus. In order to put the total costs into an activity context, average costs per tonne-kilometer and passenger-kilometer are calculated for freight and passenger activity.

Table 9 – Average Freight Costs per Tonne-Kilometer

In cents	2000	2001	2002
Costs per tonne-km 6%	1.85	1.88	1.84
Costs per tonne-km 8.6%	2.04	2.07	2.03

Table 10 – Average Passenger Costs per Passenger-Kilometer

In cents	2000	2001	2002
Costs per pkm 6%	24.93	25.79	26.33
Costs per pkm 8.6%	26.32	27.49	28.09

Freight unit costs were stable over the period, while passenger unit costs increased. Relative to air passenger unit costs, rail costs on a pkm basis are approximately 80 per cent higher.

5 CONCLUSION

The figures presented in this paper are preliminary and continue to be refined as the FCI project continues. Social costs will also be developed in order to present a more complete picture of total costs. Finally, full average and marginal costs will be estimated on specific routes for each of the modes.

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