TREATMENT OF PRIVATE AND PUBLIC CHARGES FOR CAPITAL IN A "FULL-COST ACCOUNTING" OF TRANSPORTATION

Final Report

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1. INTRODUCTION

1.1 Background

The opportunity cost of capital is an important component of the overall cost of transport in Canada. The networks of roads, railways, airports, ports and waterways that stretch across the country constitute a significant component of the nation's overall wealth. To understand the resources consumed by Canada's transportation system and to compare costs among modes, it is necessary to take account of the costs of the substantial capital employed in the transport of people and goods.

The purpose of this report is to develop rates that can be applied to the capital stock data for 2000 being compiled by Transport Canada to produce estimates of the opportunity costs of invested capital. These estimates together with calculated depreciation expenses will provide information on annual costs of transport capital that can be incorporated in the full cost accounts being constructed by Transport Canada.

In both the public and private sectors, the opportunity cost of capital is recognized as an important consideration in investment decisions, but different approaches are adopted in measuring opportunity costs in the two sectors. Moreover, each approach raises conceptual and empirical questions that have been the subject of much discussion and debate. To meet Transport Canada's requirements, there is a need to develop a methodology that takes account of the major issues raised in the literature and that offers a practical approach to establishing rates within a large scale accounting system. As recognized in Transport Canada's background paper on "Methodological Options for Estimation of Infrastructure Capital Costs," there may be gains in precision from methodologies involving asset-specific calculations but these must be balanced against the increased costs and difficulty of implementation.

The selected methodology must also give recognition to Transport Canada's reasons for developing a full cost accounting system. A major purpose is to lay the basis for realization of the vision set out in *Straightahead* of a system in which user pricing "better reflects the full costs of transportation activity" and there is "modal neutrality". This Transport Canada report sets out other objectives, a few of which, such as ensuring reasonable access by Canada's remote communities, will require policymakers to work out the appropriate tradeoffs with the principle of user pay. A starting point for establishing the desired transportation framework, however, is an information system that reveals the true social costs of transport, including the full opportunity costs of the capital employed in public and private sector facilities and vehicles.

1.2 Organization of the Report

We begin our investigation with an examination of the treatment of capital charges in existing cost studies. There is a substantial costing literature devoted to the needs of regulators and this work provides one perspective on the measurement of capital costs. Efforts to measure the full costs of transport activities within jurisdictions have primarily focused on particular modes, most notably roads. The more ambitious task of measuring system-wide transportation costs has not attracted much interest, but there is some potentially instructive work currently underway in the EU. In the next chapter, we review a range of costing studies to determine if this literature sheds any light on the conceptual issues or the practical problems involved in calculating the opportunity costs of capital.

Chapter 3 sets out the framework we adopt for the development of opportunity cost measures. There is an examination of the concept of opportunity cost and of the conceptual and practical problems besetting the measurement of the opportunity costs of capital. The chapter outlines the approach that is seen to be most suitable for the full cost accounting system being developed by Transport Canada and briefly considers the policies that might at some point be implemented to acquaint users with the social opportunity costs of transport capital.

The proposed approach is applied to develop opportunity cost rates in Chapters 4 and 5. The starting point in our proposed approach is to develop an updated measure of Canada's Social Discount Rate (SDR). This requires, among other things, that evidence on the social rate of return to private investment be carefully analyzed and that information be gathered on the extent to which foreigners help meet any increases in Canadian investment funding requirements. Chapter 4 examines the relevant issues to derive a benchmark social opportunity cost of capital measure that corresponds to Canada's current economic structure and circumstances.

Chapter 5 examines how this benchmark measure can be adjusted to develop opportunity cost rates that reflect the risk associated with different types of transport capital. The chapter develops a methodology that can be employed to calculate the risk factors associated with different transport assets and describes a practical approach for incorporating risk considerations into the measure of social opportunity cost. Using the proposed approach, illustrative estimates of the risk-adjusted social opportunity cost of capital rate are made for some major types of transport capital. The report's conclusions are presented in Chapter 6.

2. TREATMENT OF CAPITAL CHARGES IN TRANSPORT AND OTHER COSTING STUDIES

The starting point in our examination of capital charges was to review existing full cost accounting studies in transport and other potentially relevant costing studies and reports. This chapter presents the results of this literature review. The purpose of this chapter is to provide the context for the subsequent analysis. It sets out the alternative approaches that have been used in past studies to estimate capital charges and identifies important methodological issues that researchers have had to address. Some directional signals emerge from this review, but it primarily serves to highlight the choices that must be made and the issues that must be addressed in developing an approach for measuring the opportunity cost of transport capital for use in a full cost accounting system. The questions identified in this chapter will be addressed in Chapter 3 and the answers will be elaborated on in subsequent chapters.

The following sections of this chapter summarize the main findings from an examination of two different literature streams: regulatory and related studies of cost of capital rates; and reports prepared in connection with efforts to develop estimates of costs in particular modes or of system-wide transport costs.

2.1 Regulatory Agency Estimates

One perspective on the opportunity cost of capital is that of agencies involved in regulating firms with significant market power. Regulatory agencies differ in their specific uses of cost of capital rates depending on their legislative mandates. In general, however, regulatory bodies approach the problem of estimating cost of capital rates from a common perspective, namely that of ensuring that investors are appropriately compensated for the use of long lived assets.[1] Regulatory agencies also

[1] For example, "The ACCC is interested in ensuring that the allowed rate of return is not creating an environment where TNSPs have the incentive to undertake inefficient investments. Ultimately in determining a WACC, the ACCC has to strike a balance between a fair rate of return which provides TNSPs sufficient incentives to reinvest while not inducing the TNSPs to overcapitalise their networks."

tend to employ a similar methodology, generally computing some variant of the weighted average cost of capital (WACC) as the measure of the opportunity cost of capital, or what investors could be earning by committing their funds to alternative projects of similar risk. To provide an indication of the methodology and the results, this section briefly summarizes procedures used by Canadian, U.S. and Australian regulators. The section also presents selected results from a recent extensive international comparison of WACC regulatory decisions. Regulatory agencies generally compute nominal rather than real cost of capital rates, and the rates referenced here are nominal rates unless otherwise indicated.

Canadian Transportation Agency (CTA)

The Canadian Transportation Agency (CTA), established in 1996, administers the economic regulatory provisions affecting all modes of transport (air, rail, marine) under federal jurisdiction found in various Acts of Parliament. Along with its roles as economic regulator and aeronautical authority, the Agency works to facilitate transportation for persons with disabilities and serves as a dispute resolution authority over certain transportation (rail, air) rate and service complaints.[2]

Among its tasks, the CTA determines cost of capital rates for regulated railway companies. Much of the information relating to the CTA's determination of the cost of capital is provided on the Agency's website. Presently, the Agency is required to determine annually railway cost of capital rates for two purposes:

(1) as an input into the composite price index calculation that is used to establish the railways' maximum grain revenue entitlement. These rates are determined each year in March for the upcoming crop year.

Australian Competition and Consumer Commission, *Statement of principles for the regulation of electricity transmission revenues – background paper* (8 December 2004), p. 90.

[2] Canadian Transportation Agency, *About the CTA* [www.cta-otc.gc.ca].

(2) as a costing element in the setting of rail interswitching rates. These rates are determined each year in June for the upcoming calendar year.

In addition, railway cost of capital rates are determined on a case-by-case basis as required for regulatory proceedings outside of grain and interswitching rates, such as compensatory rate setting or level of service complaints.

The principles used by the CTA in determining cost of capital rates were established in a 1985 Decision issued by the Railway Transport Committee of the Canadian Transport Commission and a subsequent 1997 Decision issued by the CTA.[3] Basically, the CTA determines cost of capital rates by calculating the weighted average cost of capital (WACC). This is the weighted average of the component costs of debt and common equity, where the weights are equal to the proportions of debt and equity in the firm's capital structure.

According to the Agency, determining the cost of debt is relatively straightforward as this is simply the weighted rates of interest or premia paid by the firm on its various debt instruments. Determining the cost of equity is more complex as it is a projection or informed estimate of a reasonable rate of return on the shareholders' investment. The Agency uses three market driven models to estimate the cost of equity, the Capital Asset Pricing Model (CAPM), Discounted Cash Flow (DCF) model and Equity Risk Premium model, but gives primary weight to the CAPM method.[4] After assessing the results of the three methods, the Agency makes its determination based on informed judgment.

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[3] Canadian Transport Commission, *Decision on the Cost of Capital Methodology in the matter of issues pertaining to the Canadian Transport Commission's Cost of Capital Methodology for Regulated Railways; and in the matter of proposed amendments to the Railway Costing Regulations related to the Cost of Capital* (July 31, 1985), and Canadian Transportation Agency, *Decision No. 125-R-1997 – in the matter of issues pertaining to the Canadian Transportation Agency's cost of capital methodology for regulated railways* (March 6, 1997).

[4] Canadian Transportation Agency, *Decision No. 52-R-2004 – In the matter of issues related to the Canadian Transportation Agency's determination of cost of common equity rates for regulated railway companies* (February 2, 2004), p. 3.

Table 2.1 shows the Agency's recently approved cost of capital rates for Canadian National and Canadian Pacific Railway.

Table 2.1

CTA APPROVED COST OF CAPITAL RATES

(Pre-Tax Weighted Rate)

For Transportation of Western Grain		
Year	**Canadian National**	**Canadian Pacific Railway**
2001-2002	11.45 %	11.37 %
2002-2003	11.37 %	10.957 %
2003-2004	9.96 %	10.09 %
2004-2005	8.79 %	8.50 %
For Regulatory Purposes Other Than Grain and Interswitching Rates		
Year	**Canadian National**	**Canadian Pacific Railway**
2000	11.87 %	11.82 %
2001	11.95 %	11.44 %
2002	9.94 %	10.07 %
2003	9.12 %	8.76 %

Source: Canadian Transportation Agency, *Cost of Capital Rates* [www.cta-otc.gc.ca/rail-ferro/finance/cost_e.html]

A question important to the present study is whether the same cost of capital rate should apply to all transportation services or should allowances be made for the relative risks of different services. In this context it is noteworthy that under the W*estern Grain Transportation Act* (repealed in 1995), the regulator was obliged by statute to adjust the cost of capital rate used for the WGTA for any differential risk of grain traffic as compared to other railway services. It was determined by the Canadian Transport Commission that this differential risk was sufficient to lead to the assignment of a cost of common equity rate under the WGTA that was one percentage point lower than the cost of common equity determined for railway operations as a whole.[5] Following repeal of the WGTA, the Canadian Transportation Agency found that, under the new circumstances prevailing, the grain risk adjustment was not justified and reduced it to zero.[6]

A further question of significance to the present study is whether the same cost of capital rate should apply to publicly provided infrastructure versus private infrastructure, and whether that rate should reflect the rate of return investors expect from employing those same resources in the private sector. The question applies, in particular, to the situation of Canadian National prior to its privatization at the end of 1995. In considering this matter, the Canadian Transport Commission noted that:

> While the Committee recognizes that CN is a Crown corporation, this by itself is not grounds for assuming that its common equity is risk free. Acceptance of this assumption would result in a crown corporation enjoying a significant cost advantage over its privately owned competitors. We are not convinced that the Government intends such a result.[7]

The Committee concluded that:

> In [its] view, the reduction in financial risk to CN Rail, due to avoidance of bankruptcy and guaranteed access to financial markets, has equal weight to the increase in financial risk due to CN Rail's higher debt ratio. Accordingly, the Committee judges that CN Rail and CP Rail have the same level of financial and business risks, and so the same costs of common equity. Thus, for purposes of VIA services under its Operating Agreement with CN Rail, and for the various purposes of the *Railway Act*, the Committee will continue to use a cost

[5] Canadian Transport Commission, *Decision on the Cost of Capital Methodology in the matter of issues pertaining to the Canadian Transport Commission's Cost of Capital Methodology for Regulated Railways; and in the matter of proposed amendments to the Railway Costing Regulations related to the Cost of Capital* (July 31, 1985), p. 115.
[6] Canadian Transportation Agency, *Decision No. 125-R-1997 – in the matter of issues pertaining to the Canadian Transportation Agency's cost of capital methodology for regulated railways* (March 6, 1997), p. 20.
[7] Canadian Transport Commission, *Decision on the Cost of Capital Methodology in the matter of issues pertaining to the Canadian Transport Commission's Cost of Capital Methodology for Regulated Railways; and in the matter of proposed amendments to the Railway Costing Regulations related to the Cost of Capital* (July 31, 1985), p. 118.

> of common equity for CN Rail that is equal to the cost of common equity established for CP Rail."[8]

U.S. Surface Transportation Board (STB)

The Surface Transportation Board (STB) was created in the Interstate Commerce Commission Termination Act of 1995 and is charged with regulating the railroad industry in the U.S. The STB serves as both an adjudicatory and regulatory body, and has jurisdiction over railroad rate and service issues, rail mergers, line sales, line construction and line abandonments. The STB also has jurisdiction over certain trucking company, moving van, shipping company, intercity passenger bus and pipeline matters.[9]

One of the STB's responsibilities is the annual determination of the railroad industry's cost of capital, which is used to assess the adequacy of railroad revenues each year as mandated by Congress. The cost of capital determination may also be used in other regulatory proceedings, for example those involving the prescription of maximum reasonable rate levels, the proposed abandonment of rail lines and the setting of compensation for disputed trackage rights fees.[10]

The STB's determination of the cost of capital is based on a calculation of WACC. Each year, the STB undertakes a proceeding to determine the railroad industry's cost of capital, seeking comment from interested parties on: (1) the railroads' current cost of debt capital; (2) the railroads' current cost of preferred equity capital (if any); (3) the railroads' cost of common equity capital; and (4) the capital structure mix of the industry on a current market value basis. All Class 1 railroads are required to be respondents. The process involves the railroads submitting their evidence to the Association of American Railroads (AAR), which then compiles and submits the information to the STB. The STB's conclusions with respect to the evidence

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[8] Ibid., p. 120.
[9] www.stb.dot.gov
[10] Surface Transportation Board, *Railroad Cost of Capital – 2003*, Decision, Ex Parte No. 558 (Sub-No. 7) (Service Date June 28, 2004), p.1.

submitted are used in its computation of the industry's overall cost of capital for the year.

The industry's cost of capital is determined on the basis of data for a sample of railroads. A railroad is included in the sample if and only if it meets the following criteria:

The company is a Class 1 line haul railroad;

- If the Class 1 railroad is controlled by another company, the controlling company is primarily a railroad company and is not already included in the study frame;
- The company's bonds are rated at least BBB by Standard & Poor's and Baa by Moody's;
- The company's stock is listed on either the New York or the American Stock Exchange;
- The company has paid dividends throughout the year in question.[11]

In determining the cost of common equity, the STB relies on the DCF method. This has been the method used by the STB and Interstate Commerce Commission for many years and is also the method used by the majority of state regulatory agencies.[12]

Recently, the Canadian Transportation Agency undertook a survey examining the practice developed by various regulatory bodies with respect to estimating the cost of common equity and found the STB was the only body to rely solely on DCF. The other agencies whose practice was examined included the Canadian Radio-television and Telecommunications Commission (CRTC), the National Energy Board of Canada (NEB), and the Australian Competition and Consumer Commission (ACCC). In calculating cost of common equity for rate setting purposes, these groups favor forecasting by use of some form of equity risk premium method, either CAPM or

[11] See, e.g., Surface Transportation Board, *Railroad Cost of Capital – 2004*, Decision, Ex Parte No. 558 (Sub-No. 8) (Service Date December 20, 2004).
[12] See Interstate Commerce Commission Reports, *Railroad Cost of Capital – 1981*, Decision, Ex Parte No. 415 (Decided June 11, 1982), pp. 739-744.

ERP, considering the deficiencies of DCF to be sufficient to eliminate its use. The basic implication is that, in relying on DCF rather than CAPM or ERP, U.S. regulatory decisions are not nearly as aligned to changes in the risk free rate as are the decisions of other countries.[13]

Table 2.2 shows the U.S. railroad regulatory cost of capital as determined by the STB in recent years. This measure is somewhat unconventional in that it aggregates the current pre-tax cost of debt with the post-tax cost of common equity.[14] The reason usually given for this practice is that in determining railroad revenue adequacy, the STB compares this cost of capital to a measure of railroad rate of return on investment where the numerator is income after tax but before interest. Table 2.2 also shows a more conventional, all pre-tax cost of capital as calculated by the AAR. This is based on the STB's annual determination and is derived by simply grossing up the STB's cost of equity to a pre-tax basis and aggregating this with the STB's pre-tax cost of debt. In deriving this pre-tax cost of capital, the AAR uses a marginal statutory corporate income tax rate of 37.5%.

The U.S. pre-tax railroad cost of capital as calculated by the AAR in Table 2.2 may be compared to the CTA pre-tax cost of capital rates for the Canadian railways as shown in Table 2.1. As both sets of rates are pre-tax, any differences observed would be due to methodological variations (the STB relying on DCF and the CTA relying mainly on CAPM), to different proportions of debt versus equity in the capital structures of the U.S. and Canadian railways, or to basic market interest rate differentials between Canada and the U.S.[15]

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[13] Canadian Transportation Agency, *Decision No. 52-R-2004 – In the matter of issues related to the Canadian Transportation Agency's determination of cost of common equity rates for regulated railway companies* (February 2, 2004), p. 3. One of the key issues prompting the inquiry leading to this Decision has been Canadian National's contention in recent years that the CTA should be using an average of the CAPM and DCF methods rather than relying mainly on CAPM.
[14] This, however, is the common measure used in Australia where it is referred to as the "vanilla" WACC (See below).
[15] An alternative approach for the purpose of comparing the U.S. railway cost of capital rates to the CTA's pre-tax rates would be to, first, convert the STB's determination to an all post-tax cost of capital, and then do the gross-up based on Canadian tax rates. The U.S. pre-tax cost of capital figures

Table 2.2

U.S. RAILROAD COST OF CAPITAL RATES

Year	Regulatory Cost of Capital as Determined by the STB	Pre-Tax Railroad Cost of Capital
2000	11.0 %	15.5 %
2001	10.2 %	14.6 %
2002	9.8 %	14.1 %
2003	9.4 %	13.8 %
Source: Association of American Railroads, Railroad Facts (2004 Edition), pp. 19 and 63.		

Australian Competition and Consumer Commission

The Australian Competition and Consumer Commission (ACCC) was formed in 1995 to administer the *Trade Practices Act 1974* and the *Prices Surveillance Act 1983*.[16] The ACCC is charged with promoting competition and fair trade in the marketplace, and it also regulates national infrastructure services. The Commission's primary responsibility is to ensure that individuals and businesses comply with the Commonwealth competition, fair trading and consumer protection laws.

The *Trade Practices Act* covers unfair market practices, industry codes, mergers and acquisition, product safety, product labeling, price monitoring and the regulation of industries. The ACCC's regulatory and price monitoring activities cover a number of industries. These include aviation and airports, electricity, natural gas, railways, telecommunications and others.

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calculated in this manner would then indicate the pre-tax rates of return that U.S. railways would need to earn if they were required to pay taxes according to Canadian tax law.

[16] See www.accc.gov.au. Under proposed legislation the *Prices Surveillance Act* is to be replaced with a new Part VIIA in the *Trade Practices Act.*

Similar to the U.S. Surface Transportation Board, the ACCC has traditionally adopted a weighted average cost of capital which is a weighted average of the post-tax return on equity and pre-tax cost of debt. This is referred to as the "vanilla" form of WACC. The vanilla WACC does not include the impact of business income tax. "This rate is appropriate when applying a rate of return to post-tax building block cash flows. It reflects the fact that debt-holders are compensated before the payment of company tax, whereas equity holders receive compensation after company taxes have been paid."[17]

As an indication of the methodology and the ACCC's various final decisions, Table 2.3 shows the decisions reached for WACC in the Australian Rail Track Corporation (ARTC) Access Undertaking and the Sydney Airports Corporation Ltd. (SACL) Aeronautical Pricing Proposal.[18] In these decisions, the focus was the real WACC. (Table 2.3 shows only the Commission's decisions for the parameters. The ARTC and SACL proposed values are not shown.)

[17] Australian Consumer and Competition Commission. *Sydney Airports Corporation Ltd. Aeronautical Pricing Proposal Decision* (May 2001), p. 172.
[18] Following the report in 2002 by the Australian Productivity Commission on price regulation of airport services, the government has largely deregulated airports, replacing price caps with price monitoring. Under this system, operators of Brisbane, Melbourne, Perth and Sydney airports are required to provide estimates of their weighted average cost of capital:

> "The estimates should clearly specify the assumptions made and the formulae used to derive the estimates.
>
> A possible guide to formulating WACC estimates may be found in the Commission's Post-Tax Revenue Model available from the Commission's website at http://www.accc.gov.au. This model is based on the Capital Asset Pricing Model (CAPM) and is used in a number of regulatory contexts. Airport operators may however elect to use alternative approaches.
>
> The Commission recognizes that care must be taken in the practical application of WACC and other estimates. The appropriate measure of capital costs will vary depending upon the use to which the measure is put. For example, the formulation of WACC will vary depending on how the investment base and earnings streams are specified.
>
> Estimates of WACC do not need to be audited."

Australian Competition and Consumer Commission. *Airports Reporting Guideline, Information Requirements under Part 7 of the Airports Act 1996 and Section 95ZF of the Trade Practices Act 1974*, Revised (March 2004), p. 34.

Table 2.3

SAMPLE ACCC DECISIONS FOR WACC PARAMETERS

WACC Parameters	Draft Decision for ARTC Access Undertaking	Decision for SACL Aeronautical Pricing Proposal
Debt, %	60	60
Equity, %	40	40
Real risk free rate	3.02	2.98
Market risk premium, %	6.0	6.0
Equity beta	1.27	1.37
Debt margin, %	1.2	1.0
Vanilla real WACC	**6.70**	**6.80**

Sources: Australian Consumer and Competition Commission. Australian Rail Track Corporation Access Undertaking Draft Decision (November 2001), p. 141, and Sydney Airports Corporation Ltd. Aeronautical Pricing Proposal Decision (May 2001), pp. 199-200.

International Comparison of WACC Decisions

The Network Economics Consulting Group (Australia) recently completed an extensive international comparison of WACC decisions. The countries covered were Australia, the U.K., rest of Europe, New Zealand, the U.S. and Canada. The industries covered were airports, electricity distribution, electricity transmission, gas distribution, gas transmission, rail, telecommunications and water. The comparison of over 100 regulatory decisions made since 1998, pertaining to various network industries, shows the margin of "vanilla" WACC over risk free rates ranging between 2.19%-4.15% for the airport sector and 2.50%-5.47% for the rail sector. If the agencies surveyed had all assumed the same market risk premium of 6%, the margins would range between 2.93%-4.54% for the airport sector, while the range applicable to the rail sector would be unchanged.[19]

[19] Network Economics Consulting Group, *International comparison of WACC decisions*, Submission to the Productivity Commission Review of the Gas Access Regime (September 2003), Table 17, p. 67 and Table 22, p. 77. As the authors note, by focusing on the margin of WACC over the risk free rate, the study abstracts from the effects of exchange rate expectations and country risk premiums which are

Implications

The purpose of the current exercise is to develop opportunity cost of capital measures that can be incorporated in a system that describes the full social costs of transport in Canada. Regulatory agencies measure the opportunity costs of capital from the perspective of the firm, rather from the perspective of society. If the costs of capital to society differ from the costs to the firm, the regulatory approach will not provide an estimate of opportunity costs that satisfies the requirements of a social accounting system.

In addition to providing a model of one approach to measuring opportunity costs, the regulatory literature highlights a number of specific methodological issues that arise in measuring the opportunity costs of capital and that are potentially germane to the current exercise. These include the question of whether and how to adjust opportunity cost of capital measures for risk; whether to adjust for the differences in the costs of capital faced by private and public organizations; and how to treat tax in a measure of the social opportunity cost of capital. These issues will be revisited in the next chapter where we set out the analytical framework to guide our approach.

2.2 Transport Full Cost Accounting Studies

This section examines the cost of capital rates used in studies attempting to measure the full cost of transport activities. Table 4 below summarizes the results for ten studies that have been examined. Following this, four of the more significant studies are described in more detail, with a discussion of their objectives and their treatment of the discount rate.

Transport system studies concerned with full costs can be grouped into two categories: those that rely on an expenditure-based approach to measure capital costs

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reflected in countries' risk free rates. See Network Economics Consulting Group, *Response to ACCC supplementary submission (No. 72) on international WACC decisions*, Prepared for regulated infrastructure forum (March 2004), p. 22.

and those that use an opportunity cost-based approach.[20] The former group, such as the U.S. Federal Highway Administration cost allocation studies[21] and most similar studies done at the state level, use actual or required road agency outlays to measure capital costs. There is general agreement among economists that the proper focus is not on capital expenditures, which may bear little or no relationship to the value of capital employed in a given year, but on opportunity costs.

The more relevant studies in the latter group attempt to measure the opportunity cost of the capital resources employed in the system, usually by applying a discount rate to an estimated value of the capital stock. Alternatively, capital may be amortized at an assumed discount rate, as in the Delucchi et. al. study described below.

Table 4 documents both the discount rates used in the studies examined along with the reasons for the selected rates as given in the studies. Except for Delucchi et. al., the studies provide very little explanation or justification for the discount rates used, and not much could be added to the information in Table 4 to describe either the conceptual basis for the rates or the particular values chosen. However, the results can be seen as falling into a number of groups:

- Two studies (Newbery and the Royal Commission on National Passenger Transportation) adopt general public sector discount rates recommended by governments for project evaluation in their published project appraisal guidelines. One study (Institute for Transport Studies, University of Leeds) goes a step further, using the recommended public sector rate for infrastructure but a lower rate for discounting environmental impacts though no reason is given.

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[20] Hirshhorn, Ronald, *Concepts and Practical Values of Land Costs and Capital Charges for a "Full-Cost Accounting" of Transport Infrastructure in Canada*, prepared for Economic Research Branch, Transport Canada (December 2003), p.2.

[21] U.S. Department of Transportation Federal Highway Administration, *1997 Federal Highway Cost Allocation Study Final Report* (August 1997). This is the most recent version of the study although an Addendum was released in May 2000. [www.fhwa.dot.gov/policy/otps/costallocation.htm]

- Two studies (Boucher and Lall) simply adopt rates directly from previous studies but with no explanation. One of these (Lall) notes that where nominal rates had been used in the earlier work, they were based on prime lending rates.

- One study (Levelton) uses a rate intended to be representative of current long term borrowing rates, while another (Mansour-Moysey and Semmens) uses a rate representative of the return on commercial investments, and a third (Small, Winston and Evans) uses a rate in between the rate of return on bonds and the rate of return on private investments.

- One study (UNITE Project), a multi-country project, uses a rate intended to reflect pure time preference, determined by reviewing rates used in a few existing studies. The chosen rate is the project's default rate. Participating countries may use other rates but only with good reason and only to test sensitivity.

- One study (Delucchi et. al.) applies different weighted rates to the numerous transport system components. These depend on the extent to which transport investment is considered to displace private consumption or private investment, with the particular opportunity cost rates determined from examining existing studies. Also, in discounting health and environmental impacts, the study suggests that the discount rate should probably reflect only pure time preference.

Table 2.4

DISCOUNT RATES USED IN TRANSPORT STUDIES

Study Reviewed	**Discount Rate**		**Reasons as Given in the Studies**
	Low	**High**	
Boucher, Michel (1996)	6% real		6% is assumed to be the opportunity cost of capital.
Delucchi et. al.*	2% real	10% real	2% applies to discounting the effects of global warming; 10% is the upper bound applicable to private investment in roads and non-residential parking. See Table 5 for details.
Institute for Transport Studies, University of Leeds (2001)*	3% real	6% real	The public sector discount rate 6% is applied to the net asset values of both road and rail infrastructure. 3% is used in the assessment of environmental costs.
Lall, Ashish (1990)	6% real		For inflation-adjusted analysis, 6% is adopted from Transport Canada's 1982 study on transport costs and revenues. For book value analysis, the prime lending rate is used, following Haritos'1972 study. The same rate is applied to all modes (road, rail, civil aviation).
Levelton, W. Paul (1994)	10%		Costs in the study are for the year 1991. The discount rate is assumed to be the current long term interest rate.
Mansour-Moysey and Semmens (2001)	5% real		5% is the assumed normal return on commercial investments, and is used for the sake of economic neutrality.
Newbery, David M. (1990)	5% real	8% real	5% is the 1988 Test Discount Rate; 8% is the updated Test Discount Rate. The Test Discount Rate is stipulated in the UK Treasury's "Green Book."
Royal Commission on National Passenger Transportation (1992)*	10% real		10% is recommended by Treasury Board as the social discount rate for use throughout the federal government.
Small, Kenneth A., Clifford Winston, Carol A. Evans (1989)	6% real		The rate should represent the alternative real cost of public funds; 6% lies between the historic return on bonds and (pre-tax) return in the private sector (Table

		3-1, p. 40). 3% and 9% are used for sensitivity analysis (Appendix, p. 63).
UNITE Project*	3% real	The rate should reflect only pure time preference and be the social opportunity cost rate. Based on this consideration, and a review of existing studies, 3% is adopted as the standard rate for UNITE.
* Study described in more detail below.		

Delucchi et. al., University of California, Davis

The study by Delucchi et. al. comprises a series of 21 reports and attempts to document an analysis of the full social cost of motor vehicle use in the United States based on 1990-1991 data. Importantly, this study differs from the rest in that it does consider the discount rate matter in some detail.

Report #1 explains the motivation for the work as follows: Interest in full cost accounting and socially efficient pricing began to develop in the late 1960s. Today, the call for full cost accounting and efficient pricing is coming from many quarters but there is little agreement about the proper items in a social cost analysis, the magnitude of the major cost components or the extent to which current prices are not optimal. This reflects the wide range of conceptual frameworks, methods, data, and assumptions, and the lack of a detailed, up to date, conceptually sound and full analysis. This work aims to develop original, methodologically sound estimates of many of the major components of the total cost of motor vehicle use based on a conceptually coherent framework, the best possible data and appropriate analytical methods.[22]

[22] Delucchi, Mark A. *The Annualized Social Cost of Motor-Vehicle Use in the U.S., 1990-1991: Summary of Theory, Data, Methods, and Results*, Report #1 in the series The Annualized Social Cost of Motor Vehicle Use in the United States, based on 1990-1991 Data, Institute of Transportation Studies, University of California, Davis (revised October 2004), pp. 5-6. See also Murphy, James and Mark Delucchi, *A Review of the Literature on the Social Cost of Motor Vehicle Use in the United States*, Institute of Transportation Studies, University of California, Davis (1998)

Delucchi et. al. "…estimate the annualized social cost of motor vehicle use, as:

- 1990 to 1991 periodic or "operating" costs, such as fuel, vehicle maintenance, highway maintenance, salaries of police officers, travel time, noise, injuries from accidents, and disease from air pollution; plus

- the 1990 to 1991 value of all capital, such as highways, parking lots, and residential garages (items that provides a stream of services), converted (annualized) into an equivalent stream of annual costs over the life of the capital."[23]

The Discount Rate

Report #2 outlines the two possible conceptual approaches for determining an appropriate discount rate, well as summarizing the specific values of the discount rate applied in the various reports to the different components of the cost of motor vehicle use.

Concerning the conceptual issue, the two possibilities are:

1. Divide the relevant effects into those that displace consumption versus those that displace private investment, convert the investment displacing effects into consumption-equivalents by means of the "shadow price of capital," and discount all magnitudes at the estimated social rate pertaining to consumption, the rate at which society is willing to trade present for future consumption. This is a well-known methodology.

2. Convert capital into an equivalent annualized stream of constant future costs or benefits (an annuity) and add this to future periodic costs or

[23] Murphy, James and Mark Delucchi, *A Review of the Literature on the Social Cost of Motor Vehicle Use in the United States*, p. 33.

> benefits (future periodic costs must be constant). In principle, capital must be divided into the portion that displaces consumption and the portion that displaces investment, with the former amortized at the social rate of time preference and the latter at the rate of return on private capital. By an approximation formula, this can be simplified to a single amortization of the entire cost at the weighted average of the real rate of return on private capital and the real social rate of time preference.[24]

It is the second approach which is used in the study. Different weighted rates are applied to the numerous transport system components. In Table 5 the various weighted rates, which depend on the extent to which the opportunity costs are considered to be the based on displacement of private consumption or investment, are shown. In discounting health and environmental impacts, however, the study suggests that the discount rate should probably reflect only pure time preference as this is how society likely discounts such effects.

Delucchi et. al. do not develop their own estimates of the return on private capital or the social rate of time preference. Rather they derive sample values from the literature and apply these rates in the methodology. "We are in no position to make theoretical or empirical contributions to the controversy regarding the appropriate social rate of discount. Instead, we pick lower and upper bounds that appear to span the range of reasonable opinion."[25]

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[24] Delucchi, Mark A. *Some Conceptual and Methodological Issues in the Analysis of the Social Cost of Motor Vehicle Use*, Report #2 in the series The Annualized Social Cost of Motor Vehicle Use in the United States, based on 1990-1991 Data, Institute of Transportation Studies, University of California, Davis (revised October 2004), pp. 24-29.

[25] Ibid., p. 23.

Table 2.5

DISCOUNT RATE VALUES USED IN DELUCCHI ET AL STUDY OF THE SOCIAL COSTS OF MOTOR VEHICLE USE

Cost Component and Report	Discount Rate		Reasons as Given in the Studies
	Low	High	
Amortizing public investment in infrastructure (Report #7)	3 %	7 %	Highway investment is assumed to displace consumption and private investment according to the economy-wide proportions of consumption and investment, about 4:1. Based on values in the literature, a range of 3% to 7% is used. This same range is applied to capital used by police, fire, judicial and correctional services, to capital used by pollution regulation and control, and to public investment in the Strategic Petroleum Reserve.
Amortizing private investment in motor vehicles (Report #5): - Vehicles for personal use - Vehicles for business use	 4 % 5 %	 7 % 9 %	The opportunity cost depends on whether the motor vehicles are for personal or business use, with the former largely involving forgone consumption and the latter forgone investment. The discount rates must also take account of the transaction costs of automobile loans.
Discounting injuries and death from motor vehicle accidents (Reports # 4 and #9) and air pollution (Report #11)	2 %	8 %	Some researchers suggest that society may discount health effects solely on the basis of the social rate of time preference and thus differently from the returns from "financial" investments such as highways. Delucchi et. al. agree this is an open question. Based on values in the literature, a range of 2% to 8% is chosen, with the lower end suggested as probably the more reasonable value.
Discounting the effects of global warming (Report #9)	2 %		The question again applies as to whether it is only the social rate of time preference that should matter. Delucchi et. al. accept this notion for the purpose of discounting the costs of global warming.
Amortizing private			Investment in residential garages is considered to

investment in homes (Report #14) and residential garages (Report #6)	4 %	7 %	displace consumption more than investment in the economy. Based on this assumption and the transaction costs of mortgages, a range of 4% to 7% is assumed.
Amortizing private investment in roads and offstreet nonresidential parking (Report #6)	6 %	10 %	Private investment in local roads and offstreet parking spaces is considered to displace other private investment in the economy. Delucchi et. al. bracket the rate of return at 6% to 10%.
Source: Delucchi, Mark A. *Some Conceptual and Methodological Issues in the Analysis of the Social Cost of Motor Vehicle Use*, Report #2 in the series The Annualized Social Cost of Motor Vehicle Use in the United States, based on 1990-1991 Data, Institute of Transportation Studies, University of California, Davis (revised October 2004), pp. 23-24.			

Institute for Transport Studies, University of Leeds, U.K.

The Institute of Transport Studies, University of Leeds, in association with AEA Technology Environment, was appointed by the U.K. Department of the Environment, Transport and the Regions (DETR) in 2000 to undertake "…an assessment of the social costs of road and rail transport and of the coverage of these costs from taxes, charges and other payments in 1999."[26]

More specifically, the project's objectives are:

- To estimate the costs, excluding those borne by the final user, of the main surface modes, with track costs, environmental costs and accident costs being the main cost components. For most rail transport, this also includes the cost of maintaining and operating locomotives and rolling stock and depreciation and interest on these vehicles.

[26] Sansom, Tom et. al., *Surface Transport Costs and Charges, Great Britain 1998*, Research Commissioned by the Department of the Environment, Transport and the Regions (July 2001), Annex A, p. 71.

- To assess the extent to which the costs, both marginal and total, are covered by users, other parties and government, with the intention of comparing the extent to which each mode and vehicle category covers these costs from taxation, user charges, and fares.[27]

To respond to the objectives, two approaches were developed, a short run marginal cost approach and a fully allocated cost approach. While the latter has been used for a number of years in the road sector in the U.K., the former has been spurred by more recent developments.

The estimation of short run marginal costs was prompted by the 1999 report of the U.K. Standing Advisory Committee on Trunk Road Assessment (SACTRA), *Transport and the Economy*, and by the emphasis on efficient pricing in two EU reports - the 1995 Green Paper, *Towards Fair and Efficient Pricing in Transport,* and the 1998 White Paper, *Fair Payment for Infrastructure Use*. To date, only a few studies – including the UNITE project discussed below - have provided comprehensive empirical evidence on marginal costs.

In terms of fully allocated cost and revenue comparisons, the U.K. has a tradition of comparing infrastructure-related costs with revenues for the overall road sector, work that has been extended to cover total social costs by Newberry. Recent work has been partly motivated by the emphasis in the above EU reports and other studies on the objective of a "fair' system in which transport users pay their own way.

The Discount Rate

The cost of capital for road and rail infrastructure only enters into the fully allocated cost analysis. The basic approach is to calculate interest forgone on the net asset values, but there is no discussion, from either a conceptual or empirical perspective, of an appropriate discount rate. Only the values used for the discount rate are

[27] Ibid.

mentioned. For the road sector, the value is 6%, which is the public sector discount rate.[28] For the rail sector, the same rate is employed, although it is noted that Railtrack's cost of capital is marginally higher than the 6% public sector rate.[29] In assessing the environmental costs of road and rail vehicles, a discount rate of 3% is employed.[30]

UNITE Project

The UNITE (UNIfication of accounts and marginal costs for Transport Efficiency) project is a project of the European Community Fifth Framework Programme (1998-2002) for research, technological development and demonstration activities.[31] The Institute of Transport Studies at the University of Leeds is the Project Coordinator.

UNITE is intended to support policy makers in the establishment of charges for transport infrastructure use at both the European and country levels by providing state-of-the-art cost estimates and an analytical framework. The three core objectives are:

1. To develop pilot transport accounts for 1996, 1998 and 2005, for all modes, passenger and freight, for the EU15 plus Estonia, Hungary and Switzerland;

2. To provide a comprehensive set of marginal cost estimates applicable to a range of passenger and freight modes and relevant to various contexts around Europe; and

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[28] Ibid., p. 23.
[29] Ibid., p.40.
[30] Ibid., Annex B, p. 87 and p. 89.
[31] Information on UNITE and the publicly available deliverables can be accessed on the University of Leeds Institute for Transport Studies website: www.its.leeds.ac.uk/projects/unite

3. To provide a framework for integration of accounts and marginal costs, consistent with public finance economics and the role of transport charging in Europe.[32]

As described in Deliverable 1, the project is being carried out in the context of recent developments in infrastructure charging policy at the European level, specifically the publication of the 1998 White Paper and its predecessor the 1995 Green Paper. These emerged from an environment in which there was recognition of the need for substantial change in managing transport capacity, financing infrastructure and improving efficiency. The White Paper focused on the need to relate charges more closely to full costs. In support of the policy of relating charges to costs, and to determine the extent to which Member States are doing this, there has been a long standing emphasis on the need for consistently prepared transport accounts, exemplified by the EC High Level Group on Infrastructure Charging.

At the country level, policies have also been evolving with different countries implementing or considering a variety of measures and policies relating to heavy truck weight- and distance-related charges, fees/tolls for travel on inter-urban roads, urban road pricing and environmental taxes.

Despite these developments, implementation of the policy of relating charges to costs has been slow. This reflects a lack of evidence concerning the practical implications of the Commission's proposed approach and a common belief that the policy approach disregards the problem of how to cover the fixed costs of infrastructure and is solely concerned with economic efficiency.[33]

[32] www.its.leeds.ac.uk/projects/unite/objectives
[33] Sansom, Tom et. al., *Deliverable 1: The Overall UNITE Methodology*, Version 2.2 (revised 23 August 2000), pp. 2-4.

The Discount Rate

The discount rate used in UNITE is discussed only briefly in Deliverable 5, Annex 3 as follows:

"There is a distinction between discount rates for pure time preference and discount rates as a way of correcting for relative price changes and other compound growth trends over time. In general, we favour the use of the former but not the latter.

In the UNITE accounts and MCs, infrastructure costs should be valued on a social basis. This means that when discount rates are required they should be *social* discount rates. There are various possible bases….Generally, we feel that a social opportunity cost rate is appropriate. Furthermore, all prices in UNITE are in constant 1998 prices, so the discount rate should be a real rate rather than a nominal rate."

Rates used in national level studies reviewed have ranged from 2.5% to 3% real (two studies), and 5.3% to 8.3% nominal (two studies). The EC Externalities of Energy (ExterneE) project used a rate of 3%, except for global warming where 0.3% and 6% were used as sensitivity tests.

In view of the above considerations and evidence, *"…the standard rate of discount in the main UNITE accounts should be a 3% real rate."*

Where consistent, robust evidence suggests an alternative is appropriate in a particular country, additional tables may be included using that rate as a sensitivity test. "However, this is optional and most of the study resources should be devoted to tables using the 3% default rate."[34]

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[34] Quotations and paraphrased text from Nellthorp, John et. al., *Valuation Conventions for UNITE*, Version 1.0 (11 April 2001), p. 13.

Royal Commission on National Passenger Transportation

The Royal Commission on National Passenger Transportation (RCNPT) was appointed in 1989 with a mandate to "…inquire into and report upon a national integrated inter-city passenger transportation system to meet the needs of Canada and Canadians in the 21st century and to ensure that transportation links among Canada's regions and communities are maintained and improved…" [35] The terms of reference also advised that the study examine the role of a national integrated inter-city passenger transport system, its structure and the relations among the modes, the potential for and constraints on achieving an integrated system, and the appropriate financial arrangements.[36] In appointing the Commission, "…the government of the day acknowledged the absence of a coherent national passenger policy…." [37]

To accomplish its goals and support its recommendations, the Commission developed the first estimates ever attempted for Canada of the system-wide costs of passenger transportation and how much is covered by users and others, the latter providing an estimate of direct and hidden subsidies. The methodology involves the development of financial, economic and environmental valuations within a common accounting framework. Such integrated accounts "…make it possible to compare investments in ways that make economic and ecological sense and generate the information needed for political prioritization, decision-making and accountability."[38] The Commission emphasized, however, that its estimates can only be considered preliminary because of the lack of proper data necessary to develop the more precise estimates required for future policy decisions.

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[35] Royal Commission on National Passenger Transportation, *Directions: the final report of the Royal Commission on National Passenger Transportation*, Volume 1, Appendix A, p. 427.
[36] Ibid., pp. 427-429.
[37] *Canada Transportation Act* Review Panel, Vision and Balance, Report of the *Canada Transportation Act* Review Panel, June 2001, p. 199.
[38] Gaudry, Marc, *On Using the Royal Commission-Transport Canada RC-TC 1991 Infrastructure Cost Allocation Procedures for Integrated Trans-European Network (TEN) Accounts*, University of Montreal Centre de recherche sur les transports publication CRT-98-48, (revised August 1999), p. 1.

The total costs estimated by the Commission for each mode include transportation infrastructure costs, environmental costs, accident costs and the taxes and fees specific to transportation but which are not designated by governments as charges for infrastructure, environmental impacts or accidents. Total costs also include vehicle and carrier costs, which are the capital and operating costs incurred by owners of private vehicles or by carriers providing public transportation.[39]

The Discount Rate

In estimating the opportunity cost of invested capital, the Commission used an opportunity cost of capital rate of 10% (real), the figure recommended by Treasury Board for use throughout the federal government as a social discount rate. The Commission noted that, when adjusted for inflation, this figure is very close to the cost of capital rate for Canadian Pacific as calculated by the National Transportation Agency.

The Commission used the same 10% discount rate for all operators and modes. "Applying a common rate of capital cost to estimates of the replacement value of the capital stock in use helps make cost estimates for the different modes comparable. In particular, these cost estimates are not affected by differences in the extent to which a given entity is debt financed or may have received what might be viewed as equity capital at no charge from governments."[40]

[39] Royal Commission on National Passenger Transportation, *Directions: the final report of the Royal Commission on National Passenger Transportation*, Volume 1, pp. 34-45.
[40] Royal Commission on National Passenger Transportation, *Directions: the final report of the Royal Commission on National Passenger Transportation*, Volume 2, p. 82.

2.3 Conclusion

This chapter has reviewed approaches to estimating capital costs in the regulatory and transport costing literature. Table 6 summarizes the various approaches used in the transport studies examined and the resulting discount rates that were applied.

Table 2.6

SUMMARY OF METHODS USED TO ESTIMATE DISCOUNT RATES AND RESULTING RANGES OF ESTIMATES

	Discount Rate Range		
Methodology	**Low**	**High**	**Methodology**
Use public sector discount rate stipulated by government for project evaluation.	5 % (real)	10 % (real)	Use public sector discount rate stipulated by government for project evaluation.
Directly adopt rate from previous study.	6 % (real)		○ Boucher, Michel (1996) ○ Lall, Ashish (1990)
Use long term borrowing rate, rate of return on private investments, or an average of these	5 % (real)	10 % (nominal 1991 value)	Use long term borrowing rate, rate of return on private investments, or an average of these
Use pure time preference rate. Determine the value from reviewing existing literature.	3 % (real)		○ UNITE Project
Use different weighted average rates depending on whether resources are withdrawn from private investment and/or consumption. Determine the different opportunity costs from reviewing existing literature.	3 % (real)	10 % (real)	○ Delucchi et al.

Some observations are possible based on this review but, for the most part, this literature offers little useful guidance on the proper approach to estimating capital costs in full cost accounting system.

The regulatory literature provides information on one widely accepted and well developed approach for estimating the opportunity cost of capital. Agencies in different countries generally take the same approach to estimating cost of capital rates. This involves estimating the weighted average cost of capital (WACC) and, as part of this exercise, employing a methodology such as CAPM or DCF to estimate the cost of equity. The regulatory approach focuses on the cost of capital to the firm and this may diverge from the opportunity cost of capital to society. This distinction need to be given attention. In developing a measure of the social opportunity cost of transport capital, it will also be important to consider the relevance of the specific adjustments made by regulatory agencies, including adjustments to take account of risks, differences in the financing costs of public and private organizations and taxation.

In transport studies concerned with the full costs of transport activities, there is a preference for the use of social discount rates rather than financially-based rates, but it is difficult to draw much that is instructive beyond this. In almost all the ten studies that have been examined, there is little or no explanation for the choice of interest rate.

Only one study applies different discount rates to different cost components depending on whether the opportunity cost is forgone consumption or investment. The remaining studies use a single discount rate, and only one (the Royal Commission on National Passenger Transportation) provides a rationale for doing so. Two studies, however, do apply different discount rates to costing infrastructure versus costing the health or environmental effects of transport. One of these (Delucchi et. al.) posits that society may well discount health and environmental effects based solely on pure time preference.

The social discount rate offers a clear alternative to the WACC measures employed by regulatory agencies and it is significant that this is the measure of choice in most full cost studies. If the social discount rate is to be adopted, then the question arises as to what is the correct social discount rate. The literature offers different views on how this rate is to be constructed and whether the requirement is for one rate or several rates. While the regulatory literature suggests that it may be appropriate to adjust rates for risks, the costing literature raises the prospects of applying different discount rates based on the source of funds and on whether the focus is on a physical asset or a long-term environmental asset. These issues will all be considered in the following chapters.

3. CONCEPTUAL FRAMEWORK

3.1 Introduction

In this chapter we examine the questions arising from the review of costing studies and identify an approach that will lead to capital cost measures that are appropriate for the Full Cost Investigation (FCI) being undertaken by Transport Canada. In Section 3.2, we consider the notion of opportunity cost in general and social opportunity cost in particular. The discussion shows that while regulatory and related finance-based approaches to estimating capital costs are consistent with the notion of opportunity costs, they do not satisfy the requirement for a measure of *social* opportunity costs.

The transport cost studies reviewed in Chapter 2 that use the social discount rate to measure the opportunity costs of capital are more instructive, but they do not adequately address a number of issues that are central to the development of capital charges that reflect the social opportunity costs of capital in Canada. These issues are considered in Section 3.3. The discussion questions whether, following some of the studies reviewed in Chapter 2, it is useful and appropriate to attempt to distinguish among assets on the basis of their likely funding sources or to apply a different rate to very long-lived assets. It is found that there is a basis, however, for adjusting social opportunity costs for the different degrees of systematic risk associated with different types of transport assets. The discussion leads to a proposed approach to estimating the social opportunity costs of capital that involves developing an updated measure of the social discount rate and then adjusting this benchmark measure to account for the nature of the systematic risk associated with different transport assets.

The final section looks at how a proper measure of the social opportunity cost of capital can contribute to the achievement of a more efficient and equitable transport system. The development of a full cost accounting system that includes a proper accounting of capital costs helps lay the basis for policies that can promote equity and efficiency by acquainting users, especially users of publicly provided transport facilities and services, with the full social costs of their transport activities.

3.2 The Nature of Opportunity Cost

In a world of limited resources, the costs of employing land, labour, capital and other factors depend on the opportunities for otherwise utilizing these resources. Opportunity costs exist because resources are scarce and choices must be made among competing demands. The term *opportunity cost* refers to the value of the rejected alternative, "the value of 'that which might be' if choice were made differently",[41]

In his discussion n *The New Palgrave*, Buchanan emphasizes that opportunity cost is an *ex ante* or forward-looking concept. It is "choice-influencing rather than choice-influenced".[42] Accordingly, the concept cannot be applied to the consequences of past decisions. Opportunity costs only exist where there are choices to be made and alternatives to be evaluated.

Another feature of opportunity cost is that it apples to the choices available to and being considered by the particular decision-maker. It is the value of the most highly valued of the rejected opportunities within the decision-maker's choice framework. As Feldstein (1972, 319-320) points out, this value may be less than what would result if opportunity costs were instead evaluated with reference to all possible alternatives:

> Economic textbooks often define opportunity cost as the value of resources in the best alternative use to which these resources *could* be put…. In fact, the actual opportunity cost of any resources is their value in the alternative use to which they *would* have been put. The two coincide in the perfect functioning economy; if resources are not used in one activity they would be used in the most valuable alternative to which they could be used. But it is the very essence of the second-best

[41] James Buchanan in *The New Palgrave: A Dictionary of Economics*, John Eatwell et al. (eds.), 1998, 719.
[42] Ibid, 719

problem that resources that could be invested with greater value are instead consumed.

Since opportunity cost is forward-looking, it is incorrect to apply the concept to past transport investments. Sunk costs are irrelevant from an opportunity cost perspective. The funds required for new investment though, of course, do have an opportunity cost. Private sector firms recognize that to attract capital they must offer outside investors a return comparable to that provided by other investments of comparable risk. This return constitutes the firm's opportunity cost of funds. In their capital budgeting decisions, managers establish a hurdle rate based on the return the firm must generate to meet the expectations of capital providers.

Therefore, while opportunity costs are not attached to existing assets that are specialized for transport use, they do apply to the resources required to renew these assets and sustain transport systems. The opportunity cost of funds would be taken into account in a proper analysis of current transportation investment options. Alternatively, if there is satisfaction with existing transport systems, the opportunity cost of funds can help determine the transport charges that are required to meet these systems' funding requirements.

Opportunity Cost under Regulation

The role of the opportunity cost of funds as an input to the establishment of product prices is well understood by those involved in the regulation of firms with significant monopoly power. Under rate-of-return regulation, regulators set the price limit for gas, electricity, water, telecom and other utilities, by determining what is required to cover operating costs and provide a "fair" rate of profit. Chapter 2 describes how, to establish an appropriate rate of return, regulators assess the expectations of investors based on what they could earn by investing in other firms with a comparable level of risk[43]

[43] While under the other main regulatory approach, price-cap regulation, allowed price increases are linked to inflation and the firm's expected productivity gains, the firm's required rate of return still

In transportation, a similar appreciation of the importance of opportunity cost underlies the concept of "revenue adequacy". In administering the legal regimes applying to railways, regulatory authorities in Canada and the U.S. have recognized that pricing controls must be tempered to take account of the major railways' responsibility for sustaining and upgrading rail infrastructure. To meet the capital requirements of the system and to continue to attract debt and equity capital, the railroads must be able to compete successfully in capital markets. Accordingly, as discussed in the previous chapter, the regulatory process in the two countries includes a calculation of the cost of capital based on the opportunity cost of the funds invested in individual railroads.

Under the regulatory approach, opportunity costs are thus measured with reference to the interest rates needed to attract funds and allow a firm to undertake justifiable investments and it is these costs that inform the board's pricing decisions. As a way of establishing full cost estimates for the overall transport sector, this approach to opportunity costs has a number of limitations. First, in using funding requirements to set prices, the underlying assumption is that firms are operating productive assets that are worth sustaining on commercial grounds, an assumption that does not hold for many transport assets. The regulatory approach is not well suited to funding assets that convey non-commercial benefits and that require periodic social evaluation and political review.

Second, the cost of capital for governments and not-for profit corporations tends to be lower than for private corporations and, under the regulatory model, this implicit subsidy will be reflected in lower prices for public and not-for-profit transport services. It has long been recognized that governments, which can use their taxing power to avoid loan defaults, and public agencies, which benefit indirectly from governments' taxing power, are in a highly advantageous position in capital markets

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enters into consideration. In setting the initial price for monopoly services and in reviewing the price cap, regulators consider what prices need to be charged to allow the firm to earn a satisfactory rate of return.

and that this can result in misleading market signals.[44] In addition to having low borrowing costs, public and not-for-profit entities, generally do not pay a return on equity and are exempt from taxes on income. These advantages may lead to over-expansion of public organizations and unfair competition with private firms.
As was shown in Chapter 2 in the discussion of the Canadian Transportation Commission's treatment of CN when it was a Crown corporation, regulatory agencies can attempt to adjust for these advantages in calculating the cost of capital. However, adequate adjustments are often not made or translated into policies that influence investment and pricing. . In one study of Canadian publicly owned electric utilities, for example, Zuker and Jenkins (1984) argued that lower capital costs resulting form provincial loan guarantees had led to lower prices, higher electricity demand, greater hydro growth and more capital intensive production than would otherwise occur. Another early study estimated that the earnings of public electrical utilities, which reflected the organizations' financial cost of capital, were only about half the social cost of capital deployed.[45]

Third, for private as well as public corporations, the financial cost of capital will tend to differ from the true social opportunity cost of capital. Taxes create a wedge between the after-tax cost of debt and equity on which private firms make their investment decisions and the return foregone by society when funds are used for transport investment. Moreover, to the extent the financing requirements of transport firms put upward pressure on interest rates, they will impact on other capital market participants, including governments and private savers and investors.

The possible impact of transport investment on domestic users and suppliers of capital would not be an issue if Canada enjoyed a perfectly elastic supply of foreign capital so that foreigners were willing to fill supply all Canada's unmet funding requirements at a given real interest rate. In this case, transport firms could access capital at the foreign supply price, adjusted as necessary to compensate for the risk

[44] This will only be the case if there are no externalities or other market failures to justify the subsidies.
[45] Berkowitz and Halpern (1981).

associated with their activities, and this before tax rate would also reflect the cost society incurs to finance the investment.[46] But, although Canada is small, open economy that has easy access to foreign resources, it does not fit the model of a country that draws all its incremental capital requirements, directly or indirectly, from foreign sources.

For the above reasons, and particularly because there is a disparity between the social and financial costs of capital, the regulatory approaches examined in Chapter 2, such as the capital costing methodologies adopted by the CTA, are not appropriate for the current exercise. Related approaches based on the financing costs of investment can also be dismissed on the grounds that they would not reflect the social opportunity costs of capital. This applies, for example, to the suggestion that opportunity costs be measured using the borrowing rate of the government or public organizations. Moreover, if capital costs based on this latter approach were used to establish transport charges, an implicit subsidy would be provided to users of publicly financed services, an approach that runs contrary to the principle of modal neutrality.

Opportunity Costs and the "Full Costs" of Transport

The objective of the accounting exercise in which Transport Canada is engaged is to estimate "the comprehensive financial and social costs associated with transportation services and activities".[47] In investigating the costs of sustaining transport investments, therefore, the appropriate focus is on opportunity costs from the perspective of society, not from the perspective of the firm. This requires an assessment of the macroeconomic changes that follow when organizations go to the capital market to fund transport investments and of the costs of any resulting displacement of economic activity and loss in government tax revenue.

[46] It is being assumed that withholding taxes are not being applied in Canada and that a debt guarantee is not being provided by a foreign government.
[47] Transport Canada, "Investigation of the Full Costs of Transportation: A Discussion Paper," Sept. 2003.

In an idealized economy with perfect competition, no uncertainty, no taxes, and no credit restrictions, the market rate of interest would establish the social costs of new investment. The interest rate would represent the cost of capital to firms and also the rate at which individuals can borrow or lend to arrive at the point where they are indifferent between consumption today and consumption in the future. In this idealized economy, the market rate of interest would be the discount rate governing both public and private sector investment and would reflect the opportunity cost of capital for organizations and for society as a whole. To estimate the full opportunity cost of transport capital, it is necessary to investigate how the situation changes when we move from this ideal economy to a "second best" world characterized by taxes, risks, subsidies and various other market imperfections.

3.3 Measuring the Economic Opportunity Cost of Capital

The Social Discount Rate as a Measure of Economic Opportunity Cost

The literature on the social discount rate (SDR) provides initial guidance on the estimation of the economic opportunity cost of transport capital for Canada. This literature does not provide a complete guide, for the SDR generally does not incorporate an adjustment for project risk and in our view, as is argued below, risk adjustments belong in a proper measure of the economic opportunity cost of capital.

Although the SDR was developed to measure the opportunity cost of public investment, the analysis applies equally to private sector investment. Harberger makes this clear in an early paper where he considers the consequences of a shift in private investment within a closed economy:[48]

> In Section 1, the disturbance that was analyzed was an increment in the rate of public-sector borrowing, with given private-sector investment and savings functions. But exactly the same results are obtained when the disturbance being analyzed is an autonomous shift of the private-sector investment function or of the private-sector

[48] Harberger (1968), 113.

> savings function. If additional (new) private-sector demand appears on the scene, interest rates are bid up in precisely the same way as in the case of incremental public-sector borrowing, and the real resources needed to make the new investment are in part bid away from other private-sector investments and, in part, provided by the increment to savings that the rise in the interest rate itself generates.

While a number of the transport costing studies discussed in Chapter 2 adopt the SDR or variations of this measure, these studies do not probe the issues involved in the development of a rate that reflects social costs. Deluchhi gives more attention than most researchers to the choice of interest rates, but his efforts to identify the displaced activities that correspond to particular investments are, in our view, misdirected. Transport investments, be they an individual's investment in an automobile or a government's investment in new roads, are drawn from the general pool of capital that would otherwise be available to fund some combination of consumption and investment. Since the costs of transport investments depend on how they impact on capital markets, these costs do not vary by asset or by mode.

The rate proposed for use in the UNITE accounts is below most generally applied measures of the real social discount rate. This rate does not reflect the true costs of the activities displaced by transport investment, including the costs of foregone private sector investment.

In other costing studies, researchers have relied on established country-specific SDRs, but given little or no attention to whether these rates are still relevant and reliable. The RCNPT relied on the social discount rate for Canada that was (and still is) recommended for use by federal government departments, but which was based on calculations made 15 years prior to the Commission's research.

The calculation of the SDR starts with the recognition that in the real world of taxes and other distortions, the rate at which individuals are willing to exchange consumption now for consumption in the future, or the marginal rate of time preference, differs from the marginal rate of return on private sector investment. These two rates will also differ from the cost of borrowing abroad, which will be the most relevant rate for countries that rely heavily on foreign financing. Under the framework that Harberger employs, the social opportunity costs of investment is calculated as a weighted average of these three rates, with weights determined by the relative importance of displaced consumption, displaced investment and foreign borrowing.

The weighted average approach has been widely adopted in the calculation of the SDRs and can be easily applied to assessing the social costs of private investment. Under this approach, the tax structure is assumed to be predetermined so the marginal source of funds for any project is the capital market. The SDR is therefore independent of the project. It simply depends on what is displaced by a marginal dollar of funding obtained from the capital market. Ease of implementation makes this approach attractive.

An alternative procedure first proposed by Feldstein (1972) would trace the impacts of the project and how it is financed on consumption over time and then discount the equivalent consumption flows at the marginal rate of time preference. Under the approach, which was refined by Bradford (1975), displaced investment is translated into consumption through its "shadow price", which is the present value of the future stream of consumption benefits foregone from the loss of one dollar of private investment. To calculate foregone consumption, estimates must be made of the returns to investment over time, taking account of earnings reinvestments and the effects of capital depreciation. Illustrative calculations, based on reasonable U.S. values for the underlying variables – i.e. the savings rate, before tax gross investment returns, the depreciation rate, the marginal rate of time preference – suggest that in the mid-1990s the shadow price of capital was likely to range between 1.20 and 1.97.[49] There is considerable uncertainty, however, about the value of the key parameters and the shadow price will differ substantially depending on whether, for example, the savings rate is applied to gross investment returns as in these calculations or net investment returns. Perhaps more importantly, it is assumed that specific taxes can be imposed to finance specific projects, so the assessment of any

[49] Boardman et al. (1996).

project depends upon how it is financed. In general, projects financed by consumption taxes are treated more favourably than projects that are financed by borrowing. This approach fails top recognize that as long as there is outstanding public debt, taxes from any source could be used to pay down the debt, so the marginal cost of funding for any project remains the capital market.

To develop a benchmark measure of the economic opportunity costs of capital, we adopt the weighted average methodology that Canada and most other countries have used to derive rates for evaluating public projects. As in other studies, published market data are used to measure the after tax return on savings and the before tax return on investment. With respect to the use of savings rates, questions have been raised about whether rates based on individual saving decisions accurately reflect the tradeoffs society as a whole is willing to make between present and future consumption. While some argue that society has a longer time horizon than individuals and the social rate of time preference is below the individual rate, others point out that the effect of lowering the discount on longer-term benefits would be to benefit future generations that are already inheriting the wealth (including knowledge capital) to sustain a higher standard of living. This issue is of most significance for investments with consequences that extend far into the future, well beyond the lifespan of most transport assets. The approach in this study, however, is consistent with the position of those who point to the complications and inconsistencies that are bound to plague economic studies once market prices are overridden on ethical grounds. Advocates of the use of market-determined interest rates also observe that this is likely to ensure the most efficient use of resources, which will contribute to the well-being of future as well as present generations.[50]

Questions have been raised, as well, about the use of published data representing the average pretax return on capital to measure the costs of displaced investment. It is argued that the focus should be on the marginal rate of return because it is marginal investments that will be displaced if crowding out occurs and marginal returns on

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[50] The latter two points are discussed in Bruce, Lee and Haites (1996).

capital will tend to be below average returns. But this argument assumes that there are limitations in the availability of certain resources or other market impediments that allow capital to earn more than its marginal product. It also assumes that the owners of firms in this position are able to prevent such monopoly profits from being appropriated by workers. In a competitive economy, the average rate of return on capital will provide a good approximation of the marginal rate and accurately reflect the return that society foregoes from displaced investment.

While Jenkins' (1977) study for Canada that provides the basis for the SDR currently mandated by Treasury Board does not resolve these difficult measurement issues, our main concern is that it fails to take into account adequately the openness of the Canadian economy to international capital flows, and the estimates of rates of return on savings and investment based on data from the 1960s and 1970s may not reflect current returns. Most observers would agree that, notwithstanding the complexities associated with the development of a SDR, it is possible to come up with a reasonable measure that provides a good sense of the economic opportunity costs of investment. To derive a benchmark measure of economic opportunity cost that can be applied in measuring the capital cost of transport assets, however, it is necessary to update the initial analysis of the SDR for Canada. This is the task that is pursued in Chapter 4 of the report.

Applying a Risk Adjustment to the Measure of Economic Opportunity Cost

The treatment of risk has been one of the most controversial issues in the literature on the SDR. It is generally recognized that individuals are risk averse and require compensation for incurring higher risk, but there has been no consensus on what this implies for the SDR. There has been debate about whether there are risks associated with public sector projects that need addressing; and, if there are risks, whether it is appropriate to take them into account by adjusting the social discount rate. In addition, if risk adjustments are to be implemented, there are questions about how the risks of services that are not sold on the market are to be measured. In this subsection we examine these issues and consider their implication for the development of a measure (or measures) of the opportunity cost of public and private transport investment.

On the nature of project risk in the public sector, one view is that these risks are insignificant and can be ignored. The riskiness of an asset depends on how it affects the variability of the returns from a total portfolio. If government investments are pooled in a portfolio in which variations in project returns are largely offsetting – i.e. there is zero covariance among the returns - then any single project will add little to portfolio risk. If, in addition, the government can spread investment risks over a large number of individuals, this substantially lowers the cost of any risk, reducing it to zero in the limit, as shown by Arrow and Lind (1970). Both risk pooling and risk spreading, however, are also achieved in financial markets and some, including Hirshleifer (1965) and Bailey and Jensen (1972), contend that the private sector is at least as efficient as government in reducing risks.

Given that one of the purposes of the current exercise is to abstract from factors that undermine the neutrality between public and private providers of transport services, if there is a distinction between public and private risk, it may be appropriate to follow Baumol (1968) who argues that such a distinction resembles a tax distortion and should be included in calculating the cost of publicly used capital. Lind (1982), however, points out that the results he and Arrow derived are not incompatible with the findings of those who advocate the use of risk–adjusted discount rates for evaluating public projects. If risks can be adequately spread for both public and private investments,[51] the critical issue is the extent to which a project adds to "systematic" risk faced by individuals. In their 1971 paper supporting the use of risk-free discount rates for public investment, Arrow and Lind assume that the distribution of investment returns is independent of returns to the economy as a whole. But the same model suggests that risk-adjusted rate should be used if, as Bailey and Jensen

[51] Risks will not be efficiently distributed if project benefits and costs are concentrated on a small segment of the population. Bailey and Jensen (1972) contend this is the situation for much government investment.

argue, the outcomes of public projects are influenced by the business cycle and correlated with national income. Lind (1981, p. 72) points out that government should in fact take account of risks in the same way as individuals concerned with their own investment decisions:

> To the extent these returns are correlated with other components of the individual's income, a risk–averse individual will discount them for risk. Therefore, because it is basic to the benefit-cost approach that individual valuations be used to measure the present value of benefits and costs, and because these individual valuations will reflect any adjustment for risk, it is appropriate to adjust for risk in computing present values of benefits and costs when evaluating public investment decisions. Furthermore, the adjustment for risk should be the same in evaluating public investments from the individual standpoint as for evaluating an identical private investment from the individual's point of view…

The second broad question is whether, insofar as there are differences in systematic risk, these are appropriately taken into account through adjustments in the discount rate. There is no difficulty in applying risk-adjusted discount rates to investments that are held for one period. But when risk-adjusted rates are applied to investments that extend beyond one period, there is an implicit assumption that the risk inherent in a project's cash flows increases over time. In the same way that the mathematics of discounting reduces postponed benefits and costs progressively over time, so the impact of a risk premium increases as project outcomes extend into the future. While project risks may well increase over time, the distribution of project net returns may not become increasingly diffuse in the manner indicated by the application of a risk premium.

Due to the latter concern, benefit-cost guides typically recommend against the use of risk-adjusted discount rates in project evaluation. One frequently proposed methodology for dealing with the risk attached to future cash flows is the "certainty equivalent approach". The present value of an investment is calculated by replacing the uncertain cash flow in each year by an amount that is judged to be its certainty equivalent and these reduced cash flows are then discounted by the risk free discount rate. This and other proposed methodologies for incorporating project risk do not provide realistic options for adjusting a measure of the economic opportunity cost of capital. The relevant question in the context of the current exercise is whether the distortions that may be introduced from applying an imperfect adjustment that may not accurately reflect changes in project riskiness over time exceed the costs of not incorporating any adjustment for differences in project risk in the economic opportunity cost of capital. In our judgment, the incorporation of a risk adjustment is the preferable option.

Distortions from the use of risk-adjusted discount rates are more of a danger for longer-lived transport assets, such as roads and ports, than for shorter-lived assets such as vehicles, but even in the former case, this danger is minimal if the incorporation of risk does not require a substantial change in opportunity cost rates. This is likely to be the case in the current situation since the risk adjustments being contemplated are not those that would be applied to a risk-free rate but rather the adjustments that would be made to a benchmark measure of opportunity cost that incorporates a measure of average risk within the economy. Since the focus is on the extent to which systematic risks depart from the economy-wide average risks incorporated in the benchmark SDR, adjustments introduced to take account of more risky types of transport capital, along with possible distortions arising from these adjustments, are likely to be relatively modest. At the same time, however, risk-adjustment will give recognition to possibly significant differences between assets incorporating less than average risk and assets entailing risk above the average for the overall economy.

In addition to contributing to rates that more closely approximate the true opportunity cost of capital, the application of a risk adjustment will help equalize conditions for publicly and privately provided transport assets. While our intent is to develop a methodology that can be applied to measure the opportunity costs of both public and private assets, most policy significance is likely to attach to the measures of opportunity cost that are developed for public assets providing services that are currently unpriced. For competitive neutrality, it is desirable that the opportunity costs that influence the setting of charges for these assets incorporate a risk adjustment similar to that which enters into the setting of charges for private sector transport assets.

Private firms often apply risk-adjusted discount rates in project evaluation, notwithstanding the limitations discussed above. A popular Canadian finance text (Lusztig et al., 2001, p. 407), for example, observes:

> In spite of these shortcomings, risk-adjusted discounting represents one of the most popular and useful practical approaches to handling the problem of risk, and it is often a good compromise between what is operationally workable and what may be conceptually desirable.

Even where discount rates are not directly adjusted, however, risk is an important factor that enters into the weighted average costs of capital estimates firms use to establish the returns new investments must generate. The costs of equity capital will reflect the compensation that must be paid to induce individuals to take on the systematic risk represented by the corporation's activities. Moreover, empirical studies suggests that the premium that individuals demand to bear additional systematic risk is substantial, much higher than what would be expected from standard models of a representative individual who maximizes utility over time by choosing between alternative assets. Research by Mehra and Prescott (1985) highlighting the magnitude of gap between returns on stocks and safe assets has been confirmed by other historically based estimates of the so-called "equity premium".[52] Although the reasons for a substantial equity premium have yet to be fully explained, its existence suggests that individuals place a highly value on a smooth pattern of consumption and are highly risk averse.

Since private transport firms must incorporate the consequences of individual investors' risk aversion in their planning and budgeting decisions, it is appropriate that capital charges (actual or implicit) applied to public providers of transport services also take account of risk and the differences in risk associated with various

[52] For example, Kocherlakota (1996)

transport services. Incorporation of risk adjustments in the opportunity cost of transport capital facilitates the required policy response.

The third general issue relates to the practical problems in developing measures that reflect the systematic risk associated with different transport assets. For private sector assets, systematic risk can be determined by calculating the covariance with the market portfolio. Under the Capital Asset Pricing Model in which:

$$R_i = r + ß_{im}(R_m - r)$$

where R_i is the expected rate of return on asset "i" , r is the risk-free interest rate and R_m is the return on a portfolio comprising and stocks in the market, the regression coefficient $ß_{im}$ provides the desired measure of systematic risk. If an asset's returns are statistically independent of returns to all other investments, it will have a beta coefficient of zero and should earn the risk-free rate of return. The beta will be positive, pointing to the need for a risk premium, when returns are positively correlated with the market portfolio and it will be negative, indicating that required returns are below the risk-free rate, when an asset's returns are negatively correlated with the market portfolio.

The CAPM was initially developed to analyze returns in the context of a one period investment by an individual and when it is applied over multiple periods, it gives rise to the concerns discussed above. Nonetheless, and despite the recognition that it has empirical shortcomings, the CAPM remains the most popular approach for calculating required rates of return on equity. Most regulators use the CAPM to determine acceptable rates of profit and investment firms rely on it to calculate required rates of return on equity. Published estimates of the CAPM beta are available for most publicly traded companies and these are widely used. While the published data pertain to the corporate entity, in most cases, these data will also reflect the systematic risk of the assets that serve the corporation's main activities

While the development of risk factors is more problematic for not-for-profits, which do not have publicly traded shares, and for public transport enterprises, which in some cases do not even charge for their services, there are a number of plausible indicators of systematic risk for the relevant assets. In industries where public and private firms are performing the same activity, data derived from the experience of private firms might shed light on the risk encountered by investors in public assets. In other situations, systematic risk as indicated by the correlation of returns with national income can be examined using proxy indicators of the returns from public and not-for-profit projects. Real output is likely to closely track real returns so it is reasonable to expect, for example, that transport activities that suffer a more than proportionate fall in output during downturns and experience a sharper than average rise in output during upturns have a degree of systematic risk.

The development of risk indicators that can be incorporated in a benchmark measure of opportunity cost is the subject of Chapter 5 of the report. Our approach in that chapter is based on the recognition that risk measurement is not an exact science. Even for companies with publicly traded shares, risk estimates are subject to a significant margin of error.[53] Moreover, moderate differences in estimated risk are unlikely to significantly affect calculations of the opportunity cost of capital. Rather than aiming for false precision, therefore, our approach is to classify transport assets into risk categories or bands. All assets that have a similar degree of risk will fall within one band and have the same opportunity cost of capital. Risk-banding has been adopted by others, including the Australian Competitive Neutrality Complaints Office (1998), which reviews risks as part of its efforts to ensure government businesses set an appropriate target rate of return that will not disadvantage private competitors.

[53] Bruner et al. (1996) suggest that best practice companies with publicly traded shares should expect to estimate their cost of capital with an accuracy of no more than plus or minus 100 to 150 basis points.

3.4 Using Opportunity Costs to Achieve a More Efficient and Equitable Transport System

Acquainting Transport Providers and Users with the Opportunity Cost of Capital

In an efficient system, prices would reflect the marginal social costs of providing transport services and investment in facilities and vehicles would reflect the true social opportunity cost of these investments. In a system that is also equitable in the sense described in *Straightahead*, marginal cost-based prices that are insufficient to cover infrastructure costs would be efficiently marked-up to a level where they more fully reflect the full costs of the service.[54] Under such a system, providers of different transport services would operate on a level playing field and transport firms would compete fairly and efficiently for inputs against firms in other industries.

To achieve such a vision it is not sufficient to understand the nature of social opportunity costs. There is also the need for mechanisms to ensure providers and users are acquainted with these costs. These mechanisms, moreover, must be tailored to the institutional arrangements governing the provision of different transport services.

In Table 3.1 below, vehicles and transport structures have been grouped by sector. Sectoral distinctions are not particularly significant for the development of social opportunity cost measures since all investment resources are drawn from the capital market. The costs of these resources are not affected by whether they are being used for public or private investment, or for commercial as distinct from non-commercial activities. The distinctions in the table are important, however, when it comes to consideration of the policies that may be needed to ensure recognition of social opportunity costs.

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[54] As discussed in Gillen and Oum(1992), the welfare losses from raising prices above social marginal costs are likely to be minimized through a demand-based approach, such as Ramsey pricing or two-part pricing.

Table 3.1

TRANSPORTATION ASSESTS BY MODE AND SECTOR

		Public		**Not-for-Profit & Gov. Enterprise**		**Private Sector Commercial**		**Private Sector Non-Commercial**	
		Vehicles	*Structures*	*Vehicles*	*Structures*	*Vehicles*	*Structures*	*Vehicles*	*Structures*
Road	***P***	Transit buses	Roads, Bridges, Parking			Intercity buses, School buses, Taxis	Bus terminals, Parking, Roads, Bridges	Cars	Driveways & garages
	F					Trucks (for-hire & private)	Trucking depots		
Air	***P***		Airports		Airports, Air traffic control	Airplanes		Airplanes	
	F								
Rail	***P***	Transit trains	Commuter rail lines, subway lines	Trains	Train stations		Railway tracks		
	F					Trains			
Water	***P***	Ferries	Ferry Terminals	Ferries	Ferry Terminals	Ferries	Ferry Terminals	Boats	Docks
	F		Ports		Ports, Seaway	Cargo ships	Company terminals		

Note: ***P*** stands for passenger. ***F*** stands for freight

Policies designed to give recognition to the social opportunity cost of transport capital will have the most significant impact on the management of public assets. For roads, the most important publicly managed asset, governments currently calculate costs by simply tallying annual expenditures, including both short-term operating costs and construction spending with an impact that may extend 50 or more years. While these expenditures are often compared with the annual revenues generated by road taxes and road-related fees, the latter are generally not dedicated payments and they bear no necessary relationship to road spending. For the most part, federally, provincially and locally managed roads are financed out of general tax revenues.

To expose users to the full social costs of road use, including depreciation and the social opportunity costs of road capital, governments could directly apply road charges, including usage-based charges such as tolls that vary by vehicle type, and access charges such as license fees. Alternatively, the imposition of road charges could be delegated to an independent agency that is mandated to achieve full cost recovery. In this latter case, the government's role would be to establish a governance framework that obligates the agency to cover annual road costs, including depreciation, and generate a return that reflects the social opportunity cost of the road assets it is managing.[55]

In the case of not-for-profits and government enterprises, the need is for policies that encourage these organizations to take the social opportunity cost of the assets they are managing into account in their pricing decisions. While the port and airport authorities, Nav Canada and the St. Lawrence Seaway Management Corporation are independent organizations with broad authority to set fees to meet their financial requirements, there is no assurance that current charges reflect the full costs, including social opportunity costs, of the resources being employed

With private firms that must compete for funds in competitive capital markets, there is less reason for concern that capital costs will be inadequately assessed and not fully incorporated in prices. There may be some degree of mis-pricing from a social perspective, since private firms base prices on their own costs of finance rather than the social opportunity costs of capital. Financial costs consist of the weighted average costs of debt and equity. What is relevant to the firm is the hurdle rate it must of return it must achieve to meet its after tax cost of funds. Following Bruce (1992), this can be expressed (assuming the absence of investment tax credits) as:

$$Hj = p\ [r - u\pi/1\text{-}u] = (1 - p)\ \sigma/1\text{-}u$$

where Hj is the hurdle rate of return, p is the fraction of investment financed with debt, r is the real interest rate, u is the rate of corporate taxation, π is the expected inflation rate, and σ is the required real return on equity.

[55] Such an agency would also presumably be required to set charges based on efficiency criteria.

With privately provided services, as with public and not-for-profit transport services, it is appropriate to use the social opportunity cost of capital as part of a broad assessment of the extent to which users are paying the full social costs of their activities. While little can be done about the general taxes that are partly responsible for the disparity between Hj and the social opportunity costs of capital, the government can, if necessary, use modal-specific policies to encourage prices that better reflect social costs. As well, in areas such as freight rail where there continues to be some degree of direct regulation, information on the social opportunity costs of capital can inform government and regulatory board decisions. Policies to expose users to the social opportunity cost of capital, however, are of less importance in the private than in the government and not-for-profit sectors where there the organizations managing transport assets are not under pressure to consider the opportunity costs of capital or where information on opportunity costs is distorted by loan guarantees and payment conditions established in organizations' lease arrangements or letters patent.

Taking Account of Commercially Non-viable Transport Assets

While a market-based policy framework in which users pay the full costs of their transport activities is a desirable objective, the reality is that substantial components of the transportation system are unable to cover their operating costs let alone their social costs. In course of building the infrastructure to foster this country's development, transport facilities have been established in a number of low-density regions where the population base cannot support transport structures with their typically high fixed costs. A recent Transport Canada (2004) study of regional and small airports, for example, finds that deficit airports are generally located in catchment areas with small (often below 15,000), and generally declining, populations. While cost-recovery is achievable within modes, it would not be realistic to expect each individual facility and link to be financially viable.

Under a regime in which users as a group bear the social opportunity costs of capital along with the other social costs of modal activity, users of surplus-generating facilities subsidize the users of nonviable components of the modal network. Some degree of cross-subsidization of this nature may be justified since the smaller nodes in the system may generate traffic that contributes to the viability and strength of major facilities. It is reasonable, for example, that some of the surplus of the major airports within the National Airport System (NAS) be used to support the smaller airports that provide the feeder traffic on which NAS airports depend. But existing networks have not been designed to maximize system-wide net benefits. Many nonviable facilities exist mainly because of the perceived social or political benefits from providing access to smaller and/or more remote communities. Under these circumstances, it is more appropriate that support is provided by taxpayers than by other users of the network.

While these considerations do not affect the measurement of social opportunity costs of capital, they should influence the policies that are introduced to expose users to these costs. Policymakers should attempt to ensure that prices are based not on accounting numbers, but on full costs that are adjusted to remove that portion of social costs that are properly borne by taxpayers. Apportioning costs between users and taxpayers requires difficult policy judgments. Moreover, this exercise should ideally be part of a broader process of rationalization that involves pursuing options for cost reduction and eliminating nonviable facilities that no longer offer significant social benefits.

3.5 Conclusion

Transport capital has opportunity costs because the resources required to renew these assets and sustain transport systems could be put to alternative uses. To fully measure these costs, it is necessary to estimate the costs of the activities society must sacrifice to free up resources for transport investment. These costs are not captured in studies and regulatory reviews that examine the opportunity costs of capital from the perspective of particular firms or sectors. Similarly, it is not possible to estimate the social opportunity costs of public investments by looking simply at government financing costs. The Social Discount Rate provides an estimate of the sacrifices society makes in releasing resources for public projects and it can also be applied to estimate the social opportunity costs of private and not-for-profit investments. To derive a benchmark measure of social opportunity cost that can be applied in measuring the capital cost of transport assets, it is necessary to update the analysis of the SDR for Canada that was undertaken many years ago by Jenkins. This benchmark rate must then be adjusted to derive social opportunity cost measures that take account of the different systematic risk associated with various transport assets.

Proper measures of the social opportunity cost of capital in conjunction with policies to acquaint users with these costs can contribute to the realization of a more efficient and equitable transportation system. The development of appropriate policies, however, will require difficult judgments about the appropriate share of costs to be borne by taxpayers rather than users, and about the type of governance mechanisms that are likely encourage public and not-for-profit transport organizations to take account of the social opportunity costs of capital in their pricing and investment decisions.

4. AN UPDATED ESTIMATE OF THE SOCIAL OPPORTUNITY COST OF CAPITAL

4.1 Introduction

The social opportunity cost of capital (SOCC) used in a particular transport mode or asset measures the real rate of return that that the capital would have earned if it were not invested in transportation. To predict what the capital would have earned requires a model of the economy which specifies the alternatives available to those who own or control the capital, as well as the constraints they face. A key assumption that is made here is that the capital market is the marginal source of funding for any project, whether it is financed privately or publicly. The SOCC is then the real rate of return that the capital would have earned for society as a whole if it were returned to the capital market and reinvested in the economy. The SOCC is a weighted average of the pre-tax rate of return on investment in the various sectors of the economy that compete with the transportation sector for capital, the after tax rate of return that is earned by the various domestic suppliers of capital, and the marginal cost to the economy of drawing incremental funding from abroad. The weights reflect the proportions of funding that come from each source when an additional dollar of funding is required for transportation. To obtain a precise estimate of the SOCC is a complicated empirical exercise that involves estimating the pre-tax rates of return on investment in the various sectors that compete for funding, the after tax rates of return on saving for those domestic residents who supply funding, and the marginal social cost of drawing additional funding from foreigners. Differences in the rates of return on investment across sectors and on saving among savers primarily reflect differences in tax treatment.[56] Taxes on capital income at the corporate and personal level drive a wedge between the income that society earns on a dollar invested in a particular sector and the income that the individual who supplies the funding earns. In this chapter we attempt to provide an updated estimate of the SOCC for an investment in a particular transport mode or asset that has 'average' risk, meaning that its risk is the

[56] Differences in (systematic) risk across sectors can also account for differences in measured rates of return even if all sectors faced the same effective tax rate.

same as that for the average investment in the economy. In the next section we review the theoretical foundations for the SOCC. In subsequent sections we derive an updated estimate of the key components of the SOCC, and in the final section we put it all together to arrive at an updated baseline estimate for the SOCC.

4.2 Theoretical Foundations for the SOCC

Equilibrium in the capital market occurs when the demand for funding needed to finance private investment in the various sectors of the economy, plus exogenous funding required for transportation, plus funding required to finance government expenditures in excess of taxes, is equal to the supply of funding provided by residents and by foreigners. If government expenditures exceed taxes, the government enters the capital market as a borrower; if taxes exceed government expenditures, the government surplus is a source of funding to the capital market. If we combine the supply of funding provided by residents with supply of funding provided by government into national saving, we can express the capital market equilibrium condition as:

national saving + net foreign funding = private investment + exogenous funding required for transportation

Denote national saving by S, private investment by I, net foreign funding by F, and exogenous funding for transportation by B. If all other variables that influence national saving, private investment and net foreign funding are taken as given except for the rate of interest i, then S, F, and I will all depend on i, and the capital market equilibrium condition can be written as:

$$S(i) + F(i) = I(i) + B$$

Now suppose there is an exogenous increase in the amount of funding required for transportation. A small increase in B will result in an increase in the interest rate to restore equilibrium in the capital market, and the change in the interest rate will affect saving, investment and net foreign funding in amounts that depend upon how sensitive each is to the interest rate.

The effect of a small change in B on the interest rate is given by:

$$di/dB = 1/(dS/di - dI/di + dF/di)$$

This is positive because saving and net foreign funding respond positively to an increase in the interest rate, whereas private investment responds negatively (all other determinants being held fixed).

The effects of a small change in B on saving, investment and foreign funding are then given by:

$$dS/dB = (dS/di)(di/dB)$$
$$dI/dB = (dI/di)(di/dB)$$
$$dF/dB = (dF/di)(di/dB)$$

The social opportunity cost of capital used in transportation is defined as the rate of return foregone when a dollar of funding is withdrawn from the capital market for this purpose. Let r denote the social rate of return on a dollar of funding that is drawn from national saving S, let R denote the social rate of return on a dollar of funding that is drawn from private investment, and let r* denote the social rate of return on a dollar of funding that is drawn from abroad. Then the SOCC is defined as:

$$SOCC = r\ dS/dB - R\ dI/dB + r^*\ dF/dB$$

Since $dS/dB - dI/dB + dF/dB = 1$, it is clear that the SOCC is a weighted average of r, R and r*, where the weights reflect the proportions of funding drawn from each source.

The social rate of return on a dollar of funding drawn from national saving is a weighted average of the marginal rates of time preference of those who postpone consumption to supply funding. Those who postpone consumption can be separated into those who are net savers and those who are net borrowers. Those who are net savers will be induced to increase their saving if they earn a return marginally greater than the after tax rate of return they are currently earning. Those who are net borrowers will be induced to reduce their borrowing if they face a borrowing rate marginally greater than the rate they are currently facing. The social rate of return on a dollar drawn from national saving is an appropriately weighted average of the after tax rate of return facing those who are net savers and the borrowing rate facing those consumers who are net borrowers that finance consumption on credit. The household sector as a whole is a net saver, meaning that the representative household consumes less than its income and the social rate of return on postponed consumption (incremental saving) is well approximated by the after tax rate of return on saving.

The social rate of return on a dollar of funding drawn from private investment is a weighted average of the pre-tax rates of return on all of the sectors that are crowded out when an incremental dollar of funding is needed for transportation. Pre-tax rates of return will differ across sectors because some sectors face heavier effective tax rates than others, and risk neutral investors will arbitrage away any differences in after tax rates of return. Pre-tax rates of return may differ across sectors even if they face the same effective tax rates if investors are risk averse and some sectors have higher non-diversifiable risk than others.

The social rate of return on a dollar of funding that is drawn from abroad measures the marginal cost to the nation of a dollar increase in net foreign liabilities. If the nation were a significant net borrower the marginal cost would exceed the average cost as reflected in the current external borrowing rate whenever the nation faces an upward sloping supply schedule for external funding. However, if the nation’s foreign liabilities are approximately equal to its foreign assets the prevailing cost of foreign funding will be a close approximation to the marginal social cost of foreign funding.

In the following sections we focus on the measurement of the key parameters that enter into the SOCC formula.

4.3 Estimating The Social Rate of Return on Displaced Private Investment

How can we derive an estimate of the pre-tax (social) rate of return on the private investment that would be displaced by incremental borrowing for transportation? An obvious approach is to estimate the rate of return on the capital in place, by computing the income accruing to the owners of this capital before taxes but after genuine economic depreciation divided by the replacement cost of the capital. This is the approach taken by Jenkins (1977), who estimated the economy wide rate of return using a “bottom up” approach by calculating the rates of return to capital in 33 sectors of the Canadian economy over the period 1965-1974 and weighing them by the proportion of capital invested in each sector. To update Jenkins’ work would be a data intensive exercise that is beyond the scope of this project. As an alternative, it is possible to apply “top down” approaches to measuring returns on private investment. Below we consider two “top down” methodologies. The first involves analyzing the contribution of capital to total production. The second and more satisfactory approach estimates capital returns on the basis of total productivity calculations.

Aggregate Production Function Approach

If the markets for capital and labor are competitive and the production function exhibits constant return to scale, the growth rate of real output (real GDP) can be expressed as a weighted average of the growth rates in each type of input, plus the effect of changes in the terms of trade (relative price of exports to imports), plus total factor productivity growth.[57] The weight on each input reflects its income share in GDP. Thus, capital’s contribution to the growth rate of real output in period t is

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[57] For example, assume there is just one output that can be either consumed (privately or publicly), invested or exported so gross final output (deliveries to final demand) Y=C+G+I+X. Let real GDP be represented by the production function Y=A.F(K,L,M)-p.M, where K represents capital input, L represents labor input, M represents imported input, p represents the relative price of imports to exports, and A represents the level of technology. Total differentiation allows us to express the growth rate of real GDP as the sum of the growth rate of technology (total factor productivity), plus the growth rates of each factor input weighted by its income share, plus the growth rate in the terms of trade. Thus dGDP/GDP = dA/A + sdK/K + (1-s)dL/L -mdp/p, where s represents the share of capital income in GDP, m represents the share of spending on imports in GDP, and dp/p represents the change in the relative price of imports to exports (terms of trade).

skt.Δkt/kt, where Δkt/kt represents the growth rate of capital input in period t and skt represents capital's income share in period t. If capital is paid its marginal product, then capital's share is kt.fkt/yt. Re-arranging terms we see that the marginal product of capital in period t, denoted by fkt, is equal to capital's contribution to the growth rate of real output in period t divided by the share of investment in output in period t. If output is defined net of depreciation, then fkt represents the pre-tax or social rate of return to capital in period t.[58]

Using this methodology, capital's contribution to the growth rate of real output in 1997 is estimated to have been 1.23 percent (Diewert, 2002, Table A6), and the share of net investment in net output for that year was .09 (International Financial Statistics, IMF Yearbook 2004). The implied social rate of return to capital is therefore 13.7%.

This calculation pertains to a particular year. One could perform the calculation for several years and compute the average, but further simplification is possible if the capital-output ratio is approximately constant over time.[59] Then the social rate of return is just capital's share of net output divided by the capital-output ratio. According to data available from the Centre for the Study of Living Standards (CSLS) website, the capital-output ratio for the economy as a whole remained fairly stable over the period 1984-2003: real GDP per dollar of capital was virtually trend-less, with the average being .545. (This number masks definite trends both upward and downward at the industry level.) To convert real GDP to net output, a depreciation rate of 8.0% per annum is applied. (This is consistent with half the capital stock being structures depreciating at 3.5% per annum, and the other half being machinery and equipment depreciating at 12.5% per annum.) Then real (net) output per dollar of capital is 0.5, so the ratio of capital to net output is 2.0. Capital's share of GDP was also fairly stable over the period at approximately 30%. According to these figures, the implied social rate of return to capital over the period 1984-2003 is 15%.

[58] Harberger (1998) pursued this approach.
[59] Summers (1990) pursued this approach. He found that although the capital-output ratio was fairly stable, capital's share of GDP declined over time in the U.S., so he concluded that the social rate of return to capital was falling.

These estimates are compatible, but there are a number of reasons to be skeptical about them. First, the data for the calculation come from more than one source raising issues of consistency. Second, the measure of capital consumption allowances reported in the National Accounts and deducted from GDP to determine net output is based upon accounting estimates of depreciation that tend to overstate genuine economic depreciation. Third, important components of the capital stock may not have been taken into account, such as land, inventories, R&D expenditures and infrastructure. The rate of return to capital will be overstated if capital depreciation is overstated, and if the capital stock does not include all of its components. For example, if the income accruing to capital is obtained residually by subtracting labor income from the value of output, it will include rents from any public sector capital made available to firms either for free or below cost. Finally, it is important to aggregate the various components of capital appropriately.

Productivity-Based Approach

A preferable approach to estimating the pre-tax rate of return to capital emerges from a study of Canada's productivity performance over the period 1962-98 by Diewert (2002). He takes a "top down" approach by focusing on the aggregate private business sector, which is modeled as producing various types of output for final demand (i.e. various types of consumption goods, investment goods, government purchases and exports) using labor, the services of various types of capital (i.e. non-residential structures, machinery and equipment, inventories and land) and imports. The growth in real output for each year can then be decomposed into the effects i) of changes in the terms of trade (the relative price of exports to imports), ii) total factor productivity growth, iii) the growth in labor input, and iv) the growth in the various types of capital input. The major advantages of this framework are: i) a top down approach avoids the need to rely on questionable data on the flows of intermediate services between sectors; ii) the change in the terms of trade is explicitly taken into account as a source of productivity growth rather than being falsely attributed to other causes; iii) the contribution made by capital is decomposed into the contributions made by each type of capital, namely machinery and equipment, structures, land and inventories.

Capital stocks for each type of capital are built up from a benchmark estimate of the capital stock in the base period (1962) and data on gross investment in each subsequent period, along with assumptions about the depreciation rate. Non-residential structures are assumed to depreciate at a rate of 3.5% per annum and machinery and equipment at a rate of 12.5%. The flow of capital services is assumed to be proportional to the stock. Total compensation to capital, or operating surplus, is the difference between the value of gross output and the value of labor input. Operating surplus is the sum of the value of capital services from each type of capital, where the value of capital services from a particular capital type is the quantity of capital services times its rental rate or user cost. The rental rate for a particular capital type is the sum of three components: the opportunity cost of capital (which is the beginning of period price of newly produced investment goods multiplied by the rate of return that capital must earn to be willingly supplied); the depreciation rate (which is the end of period price of newly produced capital goods times the proportion of the capital that must be replaced to restore its initial value); any property taxes that are levied on that capital type.

The above provides a basis for estimating the rate of return. In any period investors are assumed to earn the same rate of return R on all capital types, net of property taxes. If we focus on just one capital type, its user cost, U, can be expressed as a function of the purchase price of new investment goods, P, the depreciation rate, d, the property tax, t, and the real rate of return, R, by the expression $U=(R+d+t).P$. Total compensation to capital, or operating surplus, is the sum of the rental payments on all types of capital so $OS=\sum UK$. The rate of return R is then defined as $R= (OS - \text{depreciation} - \text{property taxes})/\sum PK$.

Using Diewert's framework and data, the average rate of return to capital in the private business sector over the period 1962-98 is estimated at 10.11%.[60] This rate of return is remarkably stable, varying from a high of 12.3% to a low of 8.1%. It includes personal and corporate taxes, but it excludes property taxes. If property taxes are included as part of the social rate of return to capital the estimate should be grossed up by approximately 1.0 percentage points to 11.11%.

Incorporating an Estimate for Residential Investment

Diewert's analysis pertains to the private business sector, so the capital stock excludes residential capital (land and structures).[61] Residential capital escapes the corporate income tax and indirect business taxes, but it pays the property tax. An estimate of the rate of return on residential capital can be derived by assuming that investors equate the rate of return on residential capital to the rate of return on investments in the private business sector net of corporate and indirect business tax, but before personal income tax. Financial data on equity and bond returns can be used to derive an estimate of the rate of return earned by the owners of claims on the non-residential capital stock before personal income tax. The real rate of return is an appropriately weighted average of the returns on corporate bonds and equities over the period, adjusted for inflation. Ideally the ex ante expected inflation rate would be deducted rather than the ex post rate, but if the time period is sufficiently long and agents have rational expectations, any discrepancies between the actual and expected inflation rates year to year should wash out. The compound annual rate of return on the TSX for the 15 year period from 1990-2004 was 8.2%, and the comparable rate for the RBC CM intermediate bond index was 7.7%. (FP Mutual Funds 15 Year Review Survey, National Post, Feb.14 2005) The compound annual inflation rate as measured by the CPI was 2.2%. If equities account for 60% of the value of claims on capital and bonds the other 40%, then the implied real rate of return to owners of capital, net of corporate, sales, excise, indirect business taxes and property taxes, but before

[60] This estimate is an ex post rate of return that incorporates whatever risk premiums are present in investment returns in the private business sector.
[61] It also excludes consumer durables.

personal income tax, over the period 1990-2004 was 5.8%. If investors can expect to earn a real rate of return of 5.8% on their wealth invested in marketable claims on the private business sector, it is reasonable to assume that they expect to earn approximately the same rate of return on their investments in residential capital.[62]

An alternative procedure for deriving an estimate of the rate of return on residential capital is to subtract the corporate and indirect business tax, and add the property tax to Diewert's baseline estimate of the rate of return in the private business sector of 10.11%. Reliable data on indirect business taxes are difficult to obtain. Using a statutory corporate tax rate of 40% and applying it to 60% of the total return to capital, the net of corporate tax rate of return becomes 7.68%. If residential structures pay the same rate of property tax as non-residential structures, this return must be grossed up by .77%, which gives an estimate of the social rate of return on residential capital of 8.45%. This is significantly higher than the estimate derived from financial data. One reason is that it includes sales, excise and indirect business taxes, some of which will not apply to residential capital. In the absence of details on indirect business taxes, it can be assumed that the rate of return on residential capital is the simple average of the two estimates (5.8% and 8.5%), which is 7%.

The social rate of return to capital in the private sector as a whole is an appropriately weighted average of the pre-tax rate of return in the private business sector and the pre-tax rate of return on residential capital, where weights reflect the proportions of a dollar of displaced investment that is drawn from each source. Residential investment accounted for approximately twenty percent of total investment on average over the period. If twenty percent of every dollar of displaced private sector investment comes from residential investment, the implied social rate of return to capital is .2(7.0) +.8(11.1) = 10.28%.

[62] Ignoring taxes, the real rate of return on an asset, R, is related to the user cost (rental rate) u, the purchase price p, the depreciation rate d, and the rate of capital gain g by $R=u/p-d+g$. I am assuming that residential capital and capital in the private business sector earn the same real rate of return R. If there are real capital gains on residential capital but not on capital in the private business sector, and their depreciation rates are identical, then the (implicit) rental rate for residential capital divided by its asset price will be lower than the rental rate (user cost) divided by the asset price for private business capital.

This estimate of the pre-tax (social) rate of return to capital is remarkably close to Jenkins' estimate of 10.08%. The above analysis supports the conclusion that the rate of return to capital in the private sector is in the order of 10%. It is noteworthy that despite numerous structural changes that could have impacted the rate of return over the years (the post 1973 productivity slowdown, slower labor force growth, episodes of both high and low inflation, periods of large fiscal deficits followed by periods of fiscal surpluses, major changes in the tax structure) there is no evidence of any secular decline in the social rate of return to capital in Canada.

4.4 Estimating the Contribution of Incremental Saving

The early literature on the social opportunity cost of capital was based upon a closed economy. Harberger (1973) argued that the SOCC would be approximately equal to the pre-tax rate of return in the private sector because the marginal public expenditure is debt financed and the tax structure is given at any point of time. In a closed economy, a dollar of government borrowing will crowd out a dollar of private investment unless saving is responsive to the interest rate.[63] The econometric evidence of saving being responsive to the interest rate was weak, but investigators typically failed to properly control for other determinants of saving.

From a theoretical standpoint, the appropriate measure of the responsiveness of saving to the rate of interest is the "compensated" response involving a pure substitution effect, with the real income of the saver held fixed. If saving were expressed as a function of the interest rate and wealth, or income, the coefficient on the interest rate would capture both a substitution effect and an income effect that works in the opposite direction. An increase in the interest rate represents a reduction in the relative price of future consumption in terms of current consumption so the individual tends to reduce current consumption thereby saving more. But the higher

[63] This assumes that "Ricardian equivalence" does not hold. According to Ricardian equivalence, a dollar increase in government borrowing will increase private saving by a dollar because the private sector perceives that government debt is a future tax liability of equal present value. Here we assume that private sector saving is affected by public sector borrowing only to the extent that public sector borrowing affects the interest rate.

interest rate also increases the purchasing power of wealth, thereby increasing current consumption. The two effects are combined in any specification where saving is expressed as a function of the interest rate and wealth or income, which explains why the interest responsiveness of saving was estimated to be low if not negligible. Investigators who were careful to isolate the pure substitution effect found that the interest rate responsiveness of saving was not negligible, but the consensus remains that it is still quite small relative to the interest responsiveness of investment.

From a review of the literature it seems reasonable to assume that the interest elasticity of demand for investment ed = (dI/di)(i/I) is in the order of -.7 to -1.0, while the compensated interest elasticity of supply of saving es = (dS/di)(i/S) is in the order of .2 to .3.[64] In a closed economy with saving equal to investment (because the government runs a balanced budget) somewhere between 5/6 and 7/10 of a dollar of government borrowing will come from displaced private investment. If the pre-tax (social) rate of return on displaced private investment is 10%, and the after-tax (private) rate of return on postponed consumption (incremental saving) is 4% (consistent with a corporate tax rate of 33% and a personal tax rate of 40%), the implied SOCC would be somewhere between 8.2% and 9%.[65] Therefore, if the Canadian economy were completely closed with respect to the international capital market it would be difficult to justify a SOCC much below the pre-tax rate of return on capital in the private sector.

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[64] An elasticity of demand for investment with respect to the cost of capital of -1.0 is in the midrange of estimates of demand elasticities from empirical studies, which range from -0.5 to -2.0. See Mintz (1995) for a review of the literature. Mintz (2001) uses an investment demand elasticity of -1.0 in his calculation of the cost of withholding taxes on interest and dividend income paid to non-residents. Feldstein and Bacchetta (1991) provide statistical evidence that investment responds to shifts in domestic saving, but domestic saving does not respond to shifts in investment. This is consistent with the view that investment is much more responsive to the interest rate than is saving. A compensated elasticity of supply of saving with respect to the interest rate of es = 0.2 is consistent with Wright (1969). Boskin (1978) estimated es at 0.4. Wright's estimate of 0.2 was used by Jenkins (1977) in his calculation of the 10% social discount rate for Canada.

[65] The social discount rate (SOCC) in the closed economy can be expressed as SOCC = (r Ses –R Ied)/(Ses –Ied). In a closed economy national savings equals investment so S=I. If es =0.2 and ed =-1.0 while r=4% and R=10% then SOCC = 9%.

4.5 Estimating the Contribution of Foreign Funding

A closed economy analysis of the SOCC is inappropriate for a country like Canada that has access to an increasingly well integrated international capital market. In an open economy, a key parameter in the determination of the SOCC is the external supply price of capital, and the elasticity of the supply of external funding with respect to its price. The more elastic is the supply, the larger will be the proportion of the funding for any project that is drawn from abroad, ceteris paribus.

Canada as Price-Taker

A starting point in determining the role of foreign funding is to understand Canada's position as a small economy that is a "price taker" in terms of international interest rates and commodities.

The main issues can be seen by considering a two country model with perfectly integrated goods and capital markets and risk neutral investors. A single interest rate governs saving and investment in both countries, with one country being the borrower and the other the lender. What would be the interest rate elasticity of supply of foreign funding for the borrowing country? The supply of foreign funding is the lending country's excess supply of funds, which is the difference between its saving and its investment. The elasticity of supply of foreign funding therefore depends on the foreign country's elasticity of supply of saving and its elasticity of demand for investment.[66] Specifically, $e= (S^*/F)\, e^*s- (I^*/F)\, e^*d$, where e^*s is the elasticity of supply of foreign saving and e^*d is the foreign elasticity of demand for investment. Suppose that foreign saving is 20% of foreign GDP, and foreign investment is 18% of foreign GDP. Foreign is therefore running a current account surplus of 2% of its GDP, and 10% of foreign saving flows abroad to finance investment there, so $S^*/F = 10$ and $I^*/F = 9$.

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[66] Net foreign funding (F) is the difference between Foreign saving (S^*) and Foreign investment (I^*) so $F(i)=S^*(i)-I^*(i)$. Therefore $dF/di = dS^*/di - dI^*/di$. The elasticity of supply of foreign funding is then $e = (dF/di)(i/F) = (dS^*/di)(i/S^*)(S^*/F) – (dI/di)(i/I^*)(I^*/F) = (S^*/F)e^*s – (I^*/F)e^*d$.

As noted above, plausible values for e*s and e*d are 0.2 and -1.0 respectively. The implied estimate for the elasticity of supply of foreign funding with respect to the interest rate is then e =9.2. This means that if the prevailing real interest rate at which foreign funding is available is 6% the marginal cost of incremental foreign funding is 6.67%.

If either e*s or e*d increase, or if either S*/F or I*/F increase, e will be larger. Thus, if the *proportion* of foreign saving that flows abroad is reduced from 10% to 5% (which would occur if the *size* of the foreign economy were doubled with the amount of foreign funding left unchanged), the elasticity of supply of foreign funding doubles to e =18.4. With the prevailing real interest rate at 6%, the marginal cost of incremental foreign funding is 6.33%. In the limit as the size of the foreign country increases with no change in the amount of foreign funding, the marginal social cost of foreign funding converges to the prevailing real interest rate.

According to the above model, the only way the supply of external funding can be upward sloping for the borrowing country is if it has monopsony power in the capital market; a small country faces an infinitely elastic external borrowing rate.[67] Since Canada's share of OECD saving and investment in any year is in the order of 4-5%, there is no basis for assuming that an increase in government borrowing in Canada will affect the prevailing interest rate and thereby result in any displacement of investment or consumption in Canada. The SOCC would be the external borrowing rate.

The SOCC for a small country like Canada with no influence over the world interest rate can still exceed the external borrowing rate if government borrowing (which raises the government debt/GDP ratio) drives up the risk premium that lenders (both foreign and domestic) demand, and the higher yield on government debt spills over to

[67] Monopsony power refers to the power of the buyer to influence the price that he pays because he is a significant proportion of the market. The U.S. faces an upward sloping supply of funds schedule simply because its share of OECD saving is 40-50%. Thus the SOCC in the U.S. must place a significant weight on the pre-tax rate of return to capital in the U.S.

corporate debt and other instruments. There is some evidence that the yield spread between Canadian and U.S. 10 year government bonds is influenced by the government debt/GDP ratio. According to Fillion (1996) if government borrowing raises the government debt/GDP ratio by one percentage point, the foreign debt/GDP ratio increases by .22 percentage points and the interest rate at which the international capital market is willing to supply funding rises by 3.1 basis points.

Even if there were no endogenous risk premium, not all of Canada's GDP is tradable at predetermined world prices. Thus, even a perfectly integrated international capital market with no tax distortions would not ensure that the real interest rate in Canada would equal the world rate. The real interest rate in each country is denominated in terms of its own consumption basket, so interest rates can differ if the relative prices of the Home and Foreign consumption baskets change, or are expected to change.

The Role of Foreign Funding

In trying to derive estimates of the proportions of a dollar of incremental funding that comes from displaced private investment versus incremental domestic saving (postponed consumption) and incremental foreign funding, it is helpful to review the literature that has emerged as a result of the Feldstein-Horioka (F-H) finding.[68] When they ran a cross section regression of each OECD country's investment rate on its saving rate (defined as the ratios of investment to GDP and saving to GDP averaged over a business cycle or a decade) plus a constant term using data from the 1960-1980, F-H found a statistically significant "savings retention coefficient" in the order of .7 to .9. They concluded that 70% to 90% of an incremental dollar of an OECD country's saving would finance investment within the country rather than financing investment elsewhere. When similar regressions are run on data from more recent periods, the savings retention coefficient is somewhat lower- in the range of .5 to .7- but still statistically different from zero.

[68] Feldstein and Horioka (1980).

F-H inferred that the international capital market must be far from perfect, since in a perfectly integrated international capital any increment to a country's saving would be expected to augment the global pool of savings and go towards financing the most attractive investments worldwide. Therefore, most of any increase in a country's saving should show up as a current account surplus, with little or no impact on domestic investment. Subsequent investigators recognized, however, that there was no necessary conflict between the F-H finding and a perfectly integrated international capital market. For example, imperfectly integrated goods markets alone could account for a high saving retention coefficient.[69]

So there are sound reasons why a small open economy like Canada has some influence over the real interest rate which governs its saving and investment decisions. To derive some sense of the extent of this influence and the implications for the SOCC, it is useful to look at the inferences that can be drawn from available estimates of the savings retention coefficient. The starting point is the capital market equilibrium condition that can be re-written as:

$$S(B,i)+F(i) = I(i)+B$$

As was noted earlier, the capital market equilibrium condition determines the country's real interest rate as a function of the level of exogenous borrowing, B, given the real interest rate prevailing in the rest of the world. (Private saving is expressed as a function of B because an increase in B, if B represents public sector borrowing, may **directly** increase private saving. According to Ricardian Equivalence, the private sector will fully offset any increase in public sector borrowing by reducing its consumption and increasing its saving, leaving national saving unaffected. The empirical evidence in support of Ricardian Equivalence is weak, but this doesn't preclude a partial response.) The impact of a small increase in B on the interest rate is given by:

$$di/dB = (1-\partial S/\partial B)/(\partial S/\partial i + \partial F/\partial i - \partial I/\partial i)$$

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[69] See Frankel (1986).

This expression is positive as long as private saving doesn't increase to fully offset the reduction in public saving, i.e. as long as Ricardian Equivalence fails to hold. The impact of a small increase in B on investment is given by:

$$dI/dB = (dI/di)\ (di/dB) = -(1-\partial S/\partial B)/(1-(\partial S/\partial i + \partial F/\partial i)/(\partial I/\partial i)).$$

This expression is negative because $dI/di < 0$. National savings is defined as $NS = S(B,i)-B$. The impact of a small increase in B on national savings at the prevailing interest rate represents the exogenous change in national savings. It is given by $\partial NS/\partial B=\partial S/\partial B-1$, which is negative as long as Ricardian Equivalence fails to hold. If private saving were unaffected by public sector borrowing a dollar increase in B would represent a dollar decrease in national saving at the prevailing interest rate.

The "savings retention coefficient" (SRC) estimated by Feldstein and Horioka measures the impact of an exogenous increase in national savings on investment. It is given by:

$$SRC = dI/dB/(\partial NS/\partial B) = 1/(1-(\partial S/\partial i + \partial F/\partial i)/(\partial I/\partial i)).$$

The SRC does not depend on $\partial S/\partial B$, but it does depend on the interest rate responsiveness of saving and foreign funding compared to the interest rate responsiveness of investment. Thus, if we have reliable estimates of the interest rate responsiveness of saving and investment and if we have a reliable estimate of the savings retention coefficient, we can infer the interest rate responsiveness of foreign funding and thereby derive an estimate of the SOCC.

The Cost of Foreign Funding

The final step is to derive an estimate of the rate of return that foreign investors require to supply funds for investment in Canada. This funding comes in various forms, with varying degrees of risk attached. It ranges from private and public debt instruments, to equities and direct investment (equities with a controlling interest). A reasonable first approximation for the social cost of foreign funding is the rate of return on investment in the private business sector net of corporate, sales, excise, and indirect business taxes, i.e. the rate of return that Canadian investors earn before personal income tax.[70] It can be argued that foreign investors are likely to be somewhat less risk averse than the average Canadian investor, and if so they would earn a somewhat higher rate of return on average to compensate for the additional risk that they assume. The compound annual real rate of return on investment in claims on the Canadian capital stock according to financial data was 5.8% over the 15 year period from 1990-2004. This is in line with Diewert's estimate of the average net of corporate tax rate of return in the private business sector of 6.1% over the period 1962-98. Therefore, a reasonable estimate of the rate of return earned by foreign investors in Canada is 6%.

4.6 Putting it all Together: Towards an Updated Estimate of the SOCC

There is no evidence that saving and investment have become any more or less responsive to the rate of interest than they were decades ago. Investment continues to be substantially more interest rate responsive than saving. There is evidence that the international capital market has become more integrated, but the extent to which this increased integration applies to Canada is debatable since Canada has been free from virtually all restrictions on capital movements for decades. Whether it is home bias in portfolio choice, imperfectly integrated goods markets, the presence of a country risk premium or the combination of all of these factors, the savings retention coefficient for OECD countries continues to be in the range of .5 to .7, implying that at least half of any exogenous increase in a country's saving finances investment within the country rather than investment abroad.[71]

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[70] This is the procedure followed by Jenkins (1977), who arrived at an estimate of 6.11% for the social cost of foreign funding.

[71] J. Helliwell and R. McKittrick (1999). When they control for cross-country heterogeneity by allowing a separate intercept for each country, the saving retention coefficient continues to be statistically significant from zero, but falls to about .3. This explains the lower bound estimate for the SRC that is used in Table 4.1. It would be preferable to estimate a savings retention coefficient that was specific to Canada, but time series regression of a country's investment rate on its saving rate is riddled with simultaneous equation bias, rendering any estimate an unreliable predictor of how an

In Table 4.1 below, estimates of the SOCC are provided for values of the savings retention coefficient ranging from .3 to .75, and for three values of the pre-tax rate of return to capital, namely 8%, 9% and 10%. These values span the range of what might reasonably be assumed to be the marginal rate of return on displaced private investment in Canada. Behind the calculations are the following assumptions: first, that national saving equals investment i.e. NS=S-B=I, so the current account balance CA=F=0; second, that the net of tax rate of return on saving (which represents the rate at which society is willing to postpone consumption) is 4%.- which assumes that Canadian investors can earn 6% before tax and are subject to a marginal personal income tax rate of 33%[72]; and third, that the marginal cost of incremental foreign funding is 6%, which coincides with its average cost because Canada's current account balance has averaged approximately zero over the past decade, so the country is neither a net borrower nor a net lender.[73]

If the pre-tax rate of return on investment is 10%, the implied rate of tax on capital (including corporate, sales, excise, property and indirect business tax) is 40%. According to Chen and Mintz (2004), the effective tax rate on capital investment in Canada (a weighted average of the effective tax rates on the various sectors that compete for capital) before personal income tax was 33.1% in 2003. Assuming that Canadian investors earn a real return of 6% before personal income tax, this would imply that the pre-tax rate of return on the marginal investment is 9%. This explains the intermediate estimate for the social rate of return on displaced private investment that is used in the Table. The lower bound estimate of 8% is intended to reflect the

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exogenous increase in saving will affect investment. For the same reason, a comparison of Canada's saving rate with its investment rate over the past five years provides no indication of how an exogenous increase in saving affects investment.

[72] The marginal tax rate is 46% for high income savers, and they constitute the major source of saving. Retirement saving in RRSP's and registered pension funds (RPP's) is tax exempt until withdrawn, but there are contribution limits the amount that can be sheltered. As a result, the marginal saver faces the personal income tax. The 33% figure is intended to represent the marginal tax rate facing the average or representative saver. It is probably an understatement of the true marginal tax rate, but by the same token, the 40% effective corporate tax rate is probably an overstatement according to Mintz (2002).

[73] Canada ran a current account surplus of approximately 2% of GDP from 2000-2003, after years of running current account deficits (IMF Statistics Yearbook 2004). For purposes of estimating the SOCC it is appropriate to take a long run perspective. A current account balance of zero is a reasonable benchmark.

possibility that the rate of return on the marginal investment that would be displaced by incremental funding for transportation is below the rate of return on the capital in place. Finally, the compensated interest elasticity of supply of saving is 0.2, and the interest elasticity of demand for investment is -1.0. No assumption is made about the interest elasticity of supply of foreign funding because, as we have shown above, its value is determined implicitly by the assumed value of the savings retention coefficient.[74]

Table 4.1

SOCIAL OPPORTUNITY COST OF CAPITAL

Savings retention coefficient	**R=10 %**	**R=9 %**	**R=8 %**
.3	7.08 %	6.78 %	6.48 %
.4	7.44 %	7.04 %	6.64 %
.5	7.80 %	7.30 %	6.80 %
.6	8.16 %	7.56 %	6.96 %
.7	8.53 %	7.83 %	7.13 %
.75	8.71 %	7.96 %	7.20 %

[74] The SOCC is given by the following expression: SOCC = $r\partial S/\partial B - R\partial I/\partial B + i\partial F/\partial B$. This is a weighted average of r, R and i, where the weights reflect the proportions of an incremental dollar of funding obtained from each source. Given values for the interest elasticity of supply of saving and the interest elasticity of demand for investment, the weights are fully determined for any given value of the savings retention coefficient SRC. Specifically, with es =.2 and ed =1.0, $\partial S/\partial B$=.2 SRC, $\partial I/\partial B$= -SRC, and $\partial F/\partial B$=1-1.2 SRC. So for any value of the SOCC appearing in the Table one can calculate the proportions of funding obtained from each source by using the SRC that appears in the same row and applying the above formulae.

4.7 Conclusion

A review of available evidence suggests that the implied value of the SOCC ranges from 6.5% to 8.7%. Our judgment is that the most appropriate choice for the savings retention coefficient is .5 and the best estimate of the pre-tax rate of return on private investment is in the middle of the range, namely 9.0%. This would mean that 10% of an incremental dollar of funding for any exogenous increase in demand for funds would come from incremental Canadian saving, 50% would come from displaced private investment, and 40% would come from abroad.[75] The implied value for the SOCC would be 7.3%.

[75] According to these values a one dollar decrease in national saving will increase foreign funding by .40 dollars. Fillion (1996) estimated that a one dollar increase in government borrowing would increase foreign funding by .22 dollars. There is no necessary conflict between these two results if private savings responds directly to any change in public savings. Thus, suppose that if public saving falls by one dollar (because of a dollar increase in government borrowing) private savings increases directly by .50 dollars (partial Ricardian equivalence). Then according to my assumed parameter values, a one dollar increase in government borrowing would cause a .50 dollar decrease in national saving, which would increase foreign funding by .20 dollars. This would accord with Fillion's findings.

5. RISK-ADJUSTED DISCOUNT RATES FOR INVESTMENTS IN TRANSPORTATION

5.1 Introduction

Chapter 4 provides an estimate of the social opportunity cost of capital (SOCC) in Canada. The value of 7.3 percent incorporates the weighted average risk of capital drawn from three sources: Canadian savings (or deferred consumption), displaced private sector investment and foreign borrowing. The SOCC is the primary reference for evaluating public sector investment in Canada. Since it is a discount rate that represents a broad average of social costs associated with an unspecified average investment, the SOC implicitly incorporates a premium for the risk associated with a public sector investment of average risk.

A "riskless SOCC" ($SOCC_f$) can be derived from the general equation for SOCC. The parameter values that generate SOCC equal to 7.3 percent correspond to $SOCC_f$ equal to 4.7 percent. From the social perspective, the risk premium for an investment of average risk is SOC minus $SOCC_f$ or 2.6 percent.

Private sector financial asset pricing, represented by the Capital Asset Pricing Model, involves comparable concepts of average risky return, riskless return and a risk premium, the three market-based asset pricing parameters. The capital market puts a "price" on risk in the form of extra points of return required to compensate investors for the risk they bear.

Risk for private sector equity securities is measured as the variance of asset-specific returns. However, when less-than-perfectly-correlated risky assets are held in a portfolio, the overall risk of the diversified portfolio equates to something less than the simple sum of the variances of the individual securities. The contribution of each individual asset to the risk of the portfolio is mitigated by its covariance with the other assets. The risk of individual securities that *cannot* be diversified away is referred to as "systematic" risk since it relates directly to the variance-generating process of the market as a whole, the “system”. In the modern theory of financial asset pricing, only systematic risk is rewarded with additional points of return above the riskless return.

In capital markets today, the required return for average risk faced by private investors and the return they earn on the riskless asset combine to generate a required average risky return that, with low inflationary expectations, is remarkably similar to the SOCC estimated in Chapter 4. With the current return on the riskless financial asset (the yield on Government of Canada 10+ year bonds) of 4.7 percent and an equity risk premium of 4.5 percent, the required return on an equity-financed capital expenditure of average risk is 9.2 percent. The use of corporate debt for a typical 40 percent of the finance of a capital expenditure results in a weighted average corporate cost of capital (WACC) that is similar to the real return of 7.3% proposed for the SOCC..

Although the SOCC and the CAPM represent different processes and generate their parameters in fundamentally different ways, the similarity of the empirical values of the risk-inclusive discount rate in the two models is convenient for estimating an array of discount rates for investment in Canadian transportation assets that span both the public and privates sectors and includes both structures and vehicles.

In the CAPM, the asset-specific (or risk-class) index of systematic risk is simply a regression coefficient in the regression of time-series data for …

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_i [r_{m,t} - r_{f,t}] + e_{i,t}$$

where $r_{i,t}$ = return on asset “i” in period t

$r_{f,t}$ = return on the risk-free asset (e.g., a Treasury Bill)

$r_{m,t}$ = return on the market index (e.g., the TSX/S&P)

$e_{i,t}$ = an error term; $E[e_{i,t}] = 0$ with zero serial correlation.

To compute the measure of systematic risk of asset “i”:

$$\beta_i = [\sigma_i / \sigma_m] \rho_{i,m}$$

where σ_i = standard deviation of the return on asset “i”

σ_m = standard deviation of the return on the market index

$\rho_{i,m}$ = correlation coefficient between the return on asset “i” and the return on the market index

The average value of β_i is one which corresponds to the average amount of risk in the “system”, i.e., the risk associated the market portfolio. A value of β_i greater (less) than one corresponds to asset-specific risk that is proportionately greater (or less) than the risk of the market.

Public sector assets, of course, are not financed with asset-specific securities traded in financial markets. The government finance of a road, a harbour or an airport is drawn from general government resources. As we have seen in the derivation and estimation of the social opportunity cost of capital, the social opportunity cost of such funds includes a premium for average risk. To estimate asset-specific risk-adjusted discount rates for an array of publicly financed assets in transportation, the practical empirical issue is to devise a measure – an index - of socially relevant risk that is consistent with the use of public sector funds and the specific risk of the asset. This can be done in a way that is structurally similar to the private-sector CAPM.

5.2 Socially Relevant Risk and its Empirical Representation

An empirical measure of risk of public sector investment must reflect risk that is relevant to the public sector. The measure ought to be comparable across different categories of investment.

The average public sector investment bears average risk that calls for an average risk premium within the social opportunity cost of the capital used in the project. On the other hand, a riskless public sector investment requires no premium for risk. In that case the riskless social opportunity cost of capital is the relevant discount rate.

Inasmuch as average risk and zero risk represent relevant benchmarks, what defines "average"? Or "riskless"? A useful reference is GDP, the most fundamental measure of economic performance. In turn, the volatility or variance of GDP is a basic measure of economic risk. The variance of GDP is axiomatically the *average* risk in the economy. An appropriate measure of risk of specific investments must somehow be tied to the variance of GDP.

Specific assets are intended for economic use. Roads, harbours or airports, for example, provide economically important services. The risk of investment in such assets, from a public perspective, is that the road, the harbour or the airport may fail to generate a socially justifiable level of use. The uncertainty of whether a specific asset will be fully used through its life is reflected in the volatility of use of that category of asset.

The empirical focus of risk is thus on the relation between the use of a specific asset and real GDP. The relation can be represented in the following form …

$$\ln X_t = a_i + b_i \ln GDP_t$$

where

X_t = a measure of asset use in period t.

GDP_t = real GDP in period t

a_i and b_i are investment-specific regression coefficients to be estimated.

With the variables X_t and GDP_t expressed in natural log form, the estimated value of b_i has a convenient interpretation. The coefficient on GDP equals dlnX/dlnGDP which is to say b_i is a ratio of the percentage change in X over the percentage change in GDP (on average through the observation period). The practical interpretation of a ratio of two percentage changes, which economists refer to as elasticity, is that …

$b_i = 1$ ➔ percentage change in X = percentage change in GDP

$b_i > 1$ ➔ percentage change in X > percentage change in GDP

$b_i < 1$ ➔ percentage change in X < percentage change in GDP

In analysis of the social risk attached to assets in transportation, our recommended measure of asset-specific risk is the coefficient *b* in the log-linear regression of a time-series of asset-specific activity (X) against real GDP. As an empirical measure of risk, *b* has number of desirable features. First, it is consistent through time and across assets. Second, it captures the social risk of assets regardless of whether ownership is public or private/commercial. Third, the measure is in the form of an index that readily indicates whether a specific asset has high, average or low risk. Finally, and perhaps most important, the index of risk is directly applicable to known parameters – the SOCC and $SOCC_f$ – that enable computation of asset-specific, risk-adjusted social opportunity costs of capital. The index is amenable to estimation with readily available data.

The framework will be illustrated in detail in the next section.

Useful reference values of b_i are 0 and 1. An estimate of b_i equal to zero (or not significantly different from 0) indicates the absence of a statistical relation between the use of the specific asset - whose activity is measured by X_i - and real GDP. A potential explanation for b_i equal to zero is that X_i is stable in the face of varying real GDP. On the other hand, X_i and real GDP may both vary but may do so independently with a resulting zero estimate for b_i. Regardless, in terms of social risk in asset-use, b_i equal to zero indicates a riskless investment.

An estimate of b_i equal to one (or not significantly different from one) indicates a statistical relation between the use of the specific asset whose activity is measured by

X_i and real GDP. When b_i equals one, the percentage change in X equals the percentage change in GDP.

If b_i is greater than one, a given percentage change in real GDP, say quarter-to-quarter, is associated with an even greater percentage change in X_i. In other words, the ups and downs of activity X exceed the up and downs of real GDP, wherein the latter is the reference for average risk.

There is no economic or statistical reason to believe the mean or expected value of *b* is 1 for Canadian transportation assets as a group. For instance, it may well be that the use of transportation assets is more stable than real GDP in which case transportation assets *as a group* would have an average *b* less than 1. However, at the more disaggregated level of specific transportation assets, there is likely to be substantial variance in asset-use and, accordingly, in asset-use vis-à-vis real GDP. In our effort to identify transportation assets that have above-average, average or below-average social risk within the Canadian transportation sector, we must recognize that the reference $b = 1$ is not necessarily the average for transportation assets. Above or below average social risk within the group of transportation assets must be assessed in view of the average within the transportation sector itself.

While this representation of the risk of publicly financed investment has obvious similarity to the Capital Asset Pricing Model, there are important differences between public and private perspectives on risk.

The CAPM is concerned with private after-tax returns to equity capital. The CAPM is built on the reasonable assumptions – for market-traded financial assets – that the securities markets are informationally efficient, liquid and readily accessible to a large number of informed investors. The CAPM risk measure is a company-specific "β_i" obtained by regressing a time-series of returns on company i equity against the contemporaneous returns on a diversified market portfolio of equities. β_i captures risk as undiversifiable covariance between an individual stock's return and the market.

The return on the market portfolio, of course, is an ever-present opportunity for a private-sector investor in risky assets. Similar to our depiction of public-sector risk, a CAPM β equal to one indicates "average" private-sector risk. CAPM β_i greater (less) than one indicates more (or less) than average market risk.

Public sector investments, especially in transportation infrastructure, are typically not financed with liquid, traded securities within which risk is embedded in required return. The risk of public sector investments is born by the nation as a whole as opposed to private investors. The risk is not inherently financial. Public sector investment capital is public sector debt which is not a counterpart to private-sector equity. The average public sector investment that is defined as "average" in risk is expected to generate a flow of economic services that closely parallels the economy as a whole. A less risky public investment would supply a more stable flow of services. An investment with above average risk is more volatile than GDP.

A significant difference between the private sector CAPM – and the constellation of β's – and the public sector risk framework lies in the different indices of returns against which asset-specific risks are determined. In the CAPM the index of the "system", and hence the defining basis of systematic risk, is a broad equity market portfolio such as the S&P/TSX or the S&P 500. In the public sector risk framework, the index is real GDP, a macroeconomic accounting measure. The representation of the risk of investment in publicly provided assets (or privately provided assets from a social perspective) is similar to the risk of holding financial assets. In both cases, risk is related to the probability of loss.

The CAPM is a model of equilibrium prices of financial assets traded continuously in highly liquid markets. The concept of risk in the CAPM (beta) incorporates assumptions regarding investor behaviour, especially that all assets are held in diversified portfolios. In the SOCC framework, on the other hand, risk and risk-premia are imputed to public capital in transportation in light of the probability that the specific investment will fail and *ex post* be socially wasteful and costly.

The risk-adjusted discount rates in SOCC framework are not market determined equilibrium values, except for the anchoring points of the risk-free SOCC and the SOCC with average risk. The definition and calibration of average risk associated with the SOCC-with-average-risk is defensible in social-risk terms, i.e., a pattern of asset usage in lock-step with real GDP reflects the risk of GDP, hence average risk. Likewise, the definition and calibration of the riskless SOCC is defensible in social-risk terms, i.e., a pattern of asset-usage uncorrelated with real GDP. As far the full range of risk is concerned, activity-based risk measures provide a useful empirical basis for categories of risk – zero, below average, average, above average et cetera, with even more precision depending on the statistical confidence in the regression coefficient. The table, *Proposed Activity Indicators for Risk Analysis*, presents a menu of the data requirements to determine asset-specific social risk prior to determining the risk-adjusted SOCC.

There is structural similarity between the measures of risk in the CAPM and in the risk-adjusted SOCC framework. In both cases risk is represented by a regression coefficient that is ultimately determined by the distribution of the benefits-and-losses of holding the asset (financial returns to financial assets, usage/activity for real transportation assets). In each case, too, the distribution of benefits is related to an index of the relevant "system" (a broad market index for financial assets, real GDP for transportation assets).

There is strong conceptual, empirical and practical rationale for the use of our activity-based measure of risk. The measure is consistent with the concept of risk from a social perspective. The metric, a regression coefficient, has an average value of 1.00 and hence serves as an index that is comparable across all assets. The user-confidence in the estimate of the activity-based measure of risk is read directly from standard descriptive statistics, i.e., t-statistics and R-squared.

In summary, the CAPM is a market-based equilibrium financial asset *pricing* model whereas the public sector risk-adjusted SOCC framework imputes risk relative to a social average.

5.3 An Illustrated Application of Risk-adjusted SOC

Consider an investment in transportation infrastructure, say a federally funded expansion of harbour facilities in Halifax. The investment has potential economic value in facilitating international trade for the nation as a whole. The funds directed to the investment have a three-dimension opportunity cost: displaced private-sector investment (the cost of which is foregone private sector return), displaced household consumption, (the cost of which is the rate of time preference) and foreign borrowing (the cost of which is the foreign borrowing rate). The opportunity cost of the each of these sources of funds incorporates a source-specific risk premium. The weighted average cost of the three sources of funds therefore incorporates the average risk of funds – inclusive of the average risk premium – for public sector investment.

The social and economic usefulness of the investment in Halifax harbour derives from its facilitation of trade and its direct contribution to GDP. If the ups and downs of the harbour usage are in synch with the ups and downs of the economy as a whole, then the risk of the harbour facility parallels the "average risk" of the economy. With harbour use and national output in synch, then viewing usage as the counterpart of the financial concept of "return", the returns to the harbour facility are perfectly correlated with GDP.

To express the risk of the harbour investment in empirical terms, a non-financial measure of the use of the harbour can be compared to GDP. The focus is on the covariance of harbour use and GDP. Let's say the empirical measure of harbour use is tonnage per quarter (seasonally adjusted).

The estimating equation …

$$\ln \text{TONNAGE}_t = a + b \ln \text{GDP}_t$$

Since the variables are expressed in natural logs, the estimated coefficient (b) in the log:linear specification is interpreted as “the elasticity of TONNAGE with respect to GDP”.

The estimate of b has a useful interpretation for analysis of risk. A value of b equal to one indicates that, on average through the observation period, an x percent change in real GDP corresponds to a similar x percent change in the ocean shipping tonnage moving through the harbour. A value of b greater (less) than one indicates that an x percent change in one variable, say GDP, corresponds to a greater (less) than x percent change in harbour use. The statistical relation does not imply a causal relation, although in many situations the direction of causation would be obvious.

To illustrate these points with data, consider the relationship between Canadian harbour use and real GDP. Harbour use can be represented by “Ocean Shipping Tonnage” measured quarterly from 1990 to 1999.

$$\ln \text{TONNAGE}_t = a + b \ln \text{GDP}_t$$

$$\ln \text{TONNAGE}_t = -5.72 + 1.37 \ln \text{GDP}_t \qquad R^2 = 0.43$$

The estimate of b is 1.37. This value is statistically significantly different from 0 (t = 5.30). However, it is not statistically significantly different from 1 (t = 1.43). The coefficient estimate indicates a positive relationship between harbour usage and GDP. Taking the value of b to be 1 (since the point estimate of 1.37 is not statistically significantly different from 1), the indication is that a one percent increase (or decrease) in quarterly GDP is associated with a one percent increase (or decrease) in Canadian harbour usage. One might then reasonably conclude that Canadian harbour infrastructure has the same risk as the GDP, i.e., the economy as a whole.

If we repeat the exercise with railways, we obtain consistent results. The following regression is based on seasonally-adjusted quarterly contributions of Canadian railways to real GDP through the period 1997 to 2004.

$$\ln \text{RAIL}_t = a + b \ln \text{GDP}_t$$

$$\ln \text{RAIL}_t = -6.77 + 1.23 \ln \text{GDP}_t \qquad R^2 = 0.82$$

With the railway, the coefficient *b* is statistically significantly different from both 0 and 1. If we take the point estimate, *b* = 1.23, the interpretation is that a one percent increase (or decrease) in quarterly GDP is associated with a 1.23 percent increase (or decrease) in railway contribution to real GDP. The "use" and social value of the railroad is more volatile than GDP itself, more risky than the economy as a whole, and an investment in the railway is more risky than the average public sector investment.

Finally, we can repeat the exercise with Canadian commercial trucking. The following regressions are based on seasonally-adjusted quarterly contributions of Canadian trucking to real GDP through the period 1997 to 2004.

$$\ln \text{TRUCKING}_t = a + b \ln \text{GDP}_t$$

$$\ln \text{TRUCKING}_t = -6.78 + 1.30 \ln \text{GDP}_t \qquad R^2 = 0.92$$

With Canadian commercial trucking, the coefficient *b* is statistically significantly different from 0 (t = 18.74) and from 1 (t = 4.29). If we use the point estimate *b* = 1.30, the interpretation is that a one percent increase (or decrease) in quarterly GDP is associated with a 1.30 percent increase (or decrease) in the contribution of Canadian commercial trucking to real GDP. The use of commercial trucking assets appears to be riskier than GDP itself. One might reasonably conclude that, from a social perspective, investments in Canadian commercial trucking, like harbour usage and railways, are riskier than the average investment.

The practical point from these illustrations based on actual Canadian data on transportation infrastructural usage is that the we have derived an empirical measure, the coefficient *b* in the log:linear specification, that relates to risk - as risk is defined for this project - that is comparable across standard categories of transportation assets.

5.4 Computing the Risk-adjusted Discount Rate

With estimated activity-based measures of assets in transportation defined relative to average risk, the measure can be incorporated into the social opportunity cost of capital framework as follows …

$$r_i = SOCC_f + b_i\,(SOCC - SOCC_f)$$

r_i is the risk-adjusted discount rate. SOCC is the average-risk-inclusive social opportunity cost of capital. $SOCC_f$ is the risk-free social opportunity cost of capital.

The activity-based index of risk is the regression coefficient *b* obtained in a log:linear regression of a time-series of a relevant measure of asset-use against real GDP. The value of *b* for an asset with average risk is one. The value of *b* for a riskless asset is zero. An estimate of *b* used as a risk-adjustment index must be checked for statistical significance against both zero and one. A non-zero, non-one point estimate should be used to compute a risk-adjusted discount rate only if the point estimate is statistically significantly different from both zero and one. If the estimate of *b* is statistically different from zero but not from one, one should be used. If the estimate of *b* is statistically different from one but not from zero, zero should be used.

From Chapter 4, our estimate of the "average" social opportunity cost of capital is 7.30 percent while the risk-free social opportunity cost is 4.70 percent.[76] Considering a range of the *b* from 0 to 2, the risk-adjusted social opportunity cost of capital at each level of *b* is given below …

[76] The Bailey-Jensen formula for the risk free SOCC is SOCCf = rf ((1-tp)dS/dB –{(1/1-tc)dI/dB + dF/dB} where rf is the risk free real interest rates and the other symbols are as defined in chapter 4. Using the results of chapter 4, a risk free social opportunity cost rate of 4.7% equates to a risk-free real interest rate of 3.85%. One measure of the risk free interest rate is the yield on real return bonds, which over 1990-2004 has varied from a low of around 2.4% to a high of 4.9%.

Table 5.1

THE RISK ADJUSTMENT INDEX AND CORRESPONDING ASSET-SPECIFIC

Social Discount Rates

b_i	*Asset-specific SOC*
0.00	4.70
0.10	4.96
0.20	5.22
0.30	5.48
0.40	5.74
0.50	6.00
0.60	6.26
0.70	6.52
0.80	6.78
0.90	7.04
1.00	7.30
1.10	7.56
1.20	7.82
1.30	8.08
1.40	8.34
1.50	8.60
1.60	8.86
1.70	9.12
1.80	9.38
1.90	9.64
2.00	9.90

Table 5.1 sets out a mapping system that can be directly applied where there is a high degree of confidence in the specific numbers that emerge from risk measurement calculations. For the most part, such confidence is likely to be unwarranted. A more reasonable and more tractable approach is to divide assets into categories of low, medium and high risk and apply an SOCC that is appropriate for the category. Even where there are questions about the specifics of the risk adjustment calculations, analysts should not be uncomfortable identifying whether an activity is high, low or medium risk. Based on how the risk-adjusted SOCC relates to the calculated beta, reasonable SOCC for different categories of transport assets are presented in Table 5.2.

Table 5.2

SOCC BY RISK CATEGORY

Systematic Risk	***Risk Adjusted SOCC***
Low Risk	6.0%
Average Risk	7.3%
High Risk	8.6%

5.5 Activity-based Risk for a Range of Assets In Transportation

Measurement Issues

In implementing the proposed risk adjustment methodology, consideration must be given to the activity indicators that are to be used in the empirical analysis. Since risk derives from variations in the social returns from investment, indicators are required that reflect changes in the flow of benefits associated with different transport investments. The benefits from an investment will rise and fall over time depending on the asset's use. The latter, in turn, is likely to correspond to changes in real output of the underlying activity. For the assets of transport firms, therefore, the pertinent activity indicator is the output of the relevant transport industry. The risks associated with airport assets, for example, can be analyzed using indicators of activity at Canadian airports. In the case of non-transport firms that have integrated into transportation, the appropriate activity indicator is the real output of the enterprises' transport divisions.

Ideally, an output indicator would express an industry's value added in constant or base year dollars. The indicator would aggregate the industry's sub-activities into a single constant dollar measure of value added. In practice, changes in industry production over time are often measured using data pertaining to gross output rather than net output, and gross output is measured using indicators applying to a limited number of an industry's main activities. Activity indicators are typically constructed by calculating the weighted average movement in the industry's main activities, with the weights based on each component's revenues or value added in a base year. In some cases, a single activity measure is all that is available and changes in output will be represented by variations in quantity of, say, passenger kilometers or tonne kilometres being produced. (The resulting quantity measures could be converted into constant dollar measures of value by multiplying each number by base year revenue per passenger kilometre or base year revenue per tonne kilometre but this adjustment does not affect the output index or the risk calculation.)

A number of proposed activity indicators are described in Table 5.3. Quarterly or monthly data are needed for estimation of the risk coefficients and this limits the choice of output indicators. The proposed indicators are based on data that are available monthly or quarterly, although, in some instances, numbers are published in raw form and need to be seasonally adjusted. For a number of assets, the most appropriate indicator is the corresponding industry quarterly, seasonally adjusted real output measure published by Statistics Canada. In some cases, such as rail transport, where the Statistics Canada numbers are not sufficiently disaggregated, the proposed output measures are similar to the component indices (i.e. for passenger and freight) that comprise the published Statistics Canada published measure.

In a few cases, additional analysis is required to construct the proposed output measure. For private trucking, information on the importance of own-activity trucking in different industries is needed to develop the base year weights for the proposed output measure. This information is available, but it would require a special analysis of the information contained within Statistics Canada's input-output database. In the case of roads, it is suggested that an index depicting the imputed real value of toll revenue would serve as a reasonable output measure. The required quarterly output index could be constructed using information on the tolls charged by a commercial operator, such as the operators of the 407 ETR, published monthly data on vehicle fuel sales and available data on vehicle fuel use.

With the exception of airports, the proposed activity indicators are industry-based. In some cases, it may be desirable to examine the risk profile of sub-components of an industry. In addition to distinguishing between major and "other" airports, for example, it may be desirable to analyze road and private trucking activity in different provinces and urban transit activities in different municipalities. The lack of published monthly and quarterly data, however, limits the extent to which it is possible to analyze risks at the sub-modal level. An industry-based focus will be adequate in most cases, for, although different components of an industry may operate in different environments, they are generally subject to the same general economic influences and face similar systematic risks. Moreover, when modal assets are aggregated at the national level, the opportunity cost of capital will be determined by the risk characteristics of the industry's dominant members. The time and effort required to analyze risk at the sub-modal level would be difficult to justify since the additional detail would have little influence on the costs of capital numbers that are entered into the accounting system.

Table 5.3

PROPOSED ACTIVITY INDICATORS FOR RISK ANALYSIS

Asset	***Proposed Indicator***
Aircraft	Real, quarterly, seasonally adjusted GDP for air transportation industry (# 481).
Major airports, NAV Canada (Toronto, Vancouver, Montreal, Calgary, Edmonton. Ottawa, Winnipeg, Victoria)	Quarterly, seasonally adjusted landings and takeoffs, weighted by base year major airport average landing and takeoff fees.
Other airports	Quarterly, seasonally adjusted landings and takeoffs, weighted by base year “other airport” average landing and takeoff fees.
Freight rail- vehicles and track	Quarterly, seasonally adjusted tonne kms. for major commodities weighted by base year revenue per tonne km. of each commodity.
Passenger rail assets	Quarterly seasonally adjusted passenger km. multiplied by base year revenue per passenger km.
Domestic shipping fleet,	Real, quarterly, seasonally adjusted GDP for water transport (# 483) is reasonable (although, ideally, ferries, which are part of industry 483, would be separated out).
Inland ports	Quarterly, seasonally adjusted domestic cargo in tonnes multiplied by base year port revenue per cargo tonne handled.
Major international ports	Quarterly, seasonally adjusted international cargo in tonnes multiplied by base year average port revenue per cargo tonne handled.
For-hire trucks	Real, quarterly, seasonally adjusted GDP for truck transportation (# 484).
Private trucking fleet	Quarterly, seasonally adjusted data on constant dollar shipments of industries that are major users of private trucking weighted by base year data on private trucking costs of each industry. Base year data on importance of private trucking by industry should be available from input-output statistics
Passenger vehicles	Quarterly, seasonally adjusted passenger vehicle kms. Data on vehicle kms.are available from the Canada Vehicle Survey but cover a short period and are not seasonally adjusted. Data on monthly gasoline sales can be translated

	into a measure of passenger vehicle km. using annual data on the percentage of gasoline consumed by passenger vehicles, passenger fleet composition and average litres/100 km. by vehicle type (The annual data can be calculated from data made available for 1990 – 2002 on the NRCan Office of Energy Efficiency website). Gasoline sales data need initially to be turned into a seasonally adjusted quarterly time series.
Roads, bridges	Quarterly, seasonally adjusted data on imputed passenger and freight vehicle toll revenues. Passenger vehicles kms.can be calculated as above. Using a similar procedure and available data on gasoline and diesel fuel sales, freight vehicle kms. can be calculated and translated into a seasonally adjusted, quarterly time series. A combined indicator of passenger and freight road usage can be calculated by weighting each series by a measure of base year tolls (e.g. av. 407 tolls for passenger cars and trucks).
Urban transit assets	Real, quarterly, seasonally adjusted GDP for urban transit systems (# 4851).
Interurban and rural buses	Real, quarterly, seasonally adjusted GDP for interurban and rural bus transportation (# 4852).
Courier and messenger vehicles	Real, quarterly, seasonally adjusted GDP for courier & messenger services (# 492)

Illustrative Calculations

Table 5.4 presents the results of activity-based risk assessments for a range of sub-sectors of the Canadian transportation system. In most cases reported in Table 5.4 the sector activity-measure is quarterly seasonally-adjusted contribution to real GDP through the period 1997-2004. Alternative measures are adopted for air transportation and ocean shipping.

Looking first at air transportation, we see that the selected measures of the use of aircraft, - passenger kilometres and hours flown – produce remarkably similar and statistically significant estimates of the social risk index of approximately 0.50. For airport usage, applying an activity measure of seasonally-adjusted itinerant movements – departures and arrivals of flights – the results likewise indicate below-average risk for four major Canadian airport. Since airplanes and airports are clearly complements in the provision of air transportation, if one is identified as below-average social risk then the other would reasonably be in that category as well.

On the ground, in the commercial bus sector, social risk varies substantially across sub-sectors. Inter-urban and rural bus systems exhibit above-average risk whereas ground transportation (to airport, primarily) and tourist buses exhibit below-average risk.

The Canadian railway system, as discussed earlier, is somewhat riskier than average. Commercial trucking exhibits risk that is quite similar in its above-average value and statistical significance.
Courier, urban transit and water transportation systems all present risk profiles approximately the same as the average risk in the economy.

Ocean shipping, with an estimate of *b* equal to 1.37 that is not significantly different from 1, also appears to have average risk. The activity-based measure, total cargo tonnage, would reasonably apply not only to ocean going ships but also to the harbour facilities that ships use.

When ocean ship cargo is disaggregated into Canadian loaded cargo (exports) and unloaded cargo (imports), an interesting picture emerges. The measure of risk is much higher for import cargo than for export cargo. This observation involving shipping and harbour use is consistent with the well-known idea that imports are a function of real GDP whereas exports are exogenous. Since Canada's exports contribute dollar-for-dollar to GDP, the estimate of *b* of 1 is reasonable and, indeed, confirms the relevance and validity of our measure of risk in transportation assets. The high risk of transportation assets involved in importing reflects the relatively high elasticity of demand for imports with respect to GDP.

Table 5.5 takes the asset-specific risk measure estimates (the b_i's) for selected sectors from Table 5.4 and applies our earlier estimates of the average SOCC (7.3%) and the risk free SOCC (4.7%) to compute risk-adjusted discount rates for an array of assets in transportation.

Table 5.4

Activity Variables as Indicators of Risk

Sector	***Activity Variable***	***Time Period***	***b***	***t-stat from 0***	***t-stat from 1***	R^2
Air Transportation	Passenger Kms	1981-2003, Quarterly	0.48	12.02	12.02	0.62
Air Transportation	Hours Flown	1981-2003, Quarterly	0.49	9.99	9.99	0.53
Airports …						
Toronto	Itinerant Movements	1995-2004, Quarterly	0.29	2.60	6.33	0.15
Montreal	Itinerant Movements	1995-2004, Quarterly	0.08	0.77	8.68	0.02
Edmonton	Itinerant Movements	1995-2004, Quarterly	0.61	2.58	0.01	0.15
Winnipeg	Itinerant Movements	1995-2004, Quarterly	0.27	2.59	7.13	0.15
Bus, Ground Transport	Contribution to Real GDP	1997-2004, Quarterly	0.74	11.10	3.85	0.80
Bus, Inter-urban & Rural	Contribution to Real GDP	1997-2004, Quarterly	1.41	7.89	2.31	0.82
Bus, Tourism	Contribution to Real GDP	1997-2004, Quarterly	0.52	11.20	10.47	0.81
Couriers	Contribution to Real GDP	1997-2004, Quarterly	1.00	16.11	0.02	0.90
Postal Service	Contribution to Real GDP	1997-2004, Quarterly	0.03	0.35	11.16	0.00
Railway	Contribution to Real GDP	1997-2004, Quarterly	1.23	11.86	2.20	0.82
Shipping	Ocean Tonnage, Total	1990-1999, Quarterly	1.37	5.30	1.43	0.43
Shipping	Ocean Tonnage, Loaded	1990-1999, Quarterly	1.07	4.36	0.71	0.33
Shipping	Ocean Tonnage, Unloaded	1990-1999, Quarterly	2.70	6.47	4.08	0.52
Trucking	Contribution to Real GDP	1997-2004, Quarterly	1.30	18.47	4.29	0.92
Trucking	Tonnage	1990-2003, Quarterly	1.02	12.93	0.27	0.76
Urban Transit	Contribution to Real GDP	1997-2004, Quarterly	0.93	11.58	0.89	0.82
Water Transportation	Contribution to Real GDP	1997-2004, Quarterly	1.09	11.37	0.95	0.81

Table 5.5

RISK-ADJUSTED, ASSET-SPECIFIC SOCIAL DISCOUNT RATES

Sector	***Activity Variable***	b_i	***Calculated SOCC***	***Risk Category***	***Proposed SOCC***
Air Transportation	Passenger Kms	0.48	5.95	Low	6.0
Airports … *Toronto*	Itinerant Movements	0.29	5.45	Low	6.0
Montreal	Itinerant Movements	0.08	4.91	Low	6.0
Edmonton	Itinerant Movements	0.61	6.29	Low	6.0
Bus, Ground Transport	Contribution to Real GDP	0.74	6.62	Low	6.0
Bus, Inter-urban & Rural	Contribution to Real GDP	1.41	8.37	High	8.6
Bus, Tourism	Contribution to Real GDP	0.52	6.05	Low	6.0
Couriers	Contribution to Real GDP	1.00	7.30	Average	7.3
Railway	Contribution to Real GDP	1.23	7.90	High	8.6
Shipping / Harbours	Ocean Tonnage, Total	1.37	8.26	Average	7.3
Trucking	Contribution to Real GDP	1.30	8.08	High	8.6
Water Transportation	Contribution to Real GDP	1.09	7.30	Average	7.3

5.6 Risk-adjusted Discount Rates: The Perspective of the Private Sector

The relevant measure of risk for corporate equity capital is the systematic risk of the returns on the corporate stock. As discussed earlier, the corporate-specific index of systematic risk is the estimate of β_i in the regression …

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_i [r_{m,t} - r_{f,t}] + e_{i,t}$$

β_i's estimated from financial market data require several adjustments before they can provide useful, reliable information on the risk of the industrial sector that the firms are in. First, it is wise to estimate β_i's for a number of firms from the same sector in order to reduce firm-specific estimation error. Second, for each estimated β_i an adjustment is required to account for financial leverage which generally varies from firm to firm. A firm with debt in its capital structure causes the observed value of its equity β to increase (vis-à-vis the firm with no debt) by a factor of $[1 + (1-t_c)(D/E)]$ where D/E is the firm's debt-to-equity ratio. Adjusting β_i for financial leverage results in β of unlevered corporate assets for each firm. The next step is to take the average of the unlevered β_i's. Third, since firms in fact make use of corporate debt, the average debt-to-equity for the sector is re-introduced to the average unlevered β to construct the finance of the representative firm. The sector-average levered β is then used together with the parameters of the CAPM (r_f and r_m) to estimate the levered cost of equity for the representative firm. Finally, the result enables calculation of the industry weighted average cost of capital or WACC.

This empirical exercise is applied to the airlines & air transport sector in Canada, the railway sector and an "other" sector involved primarily in shipping. In all three sectors the industry average β, either unlevered or levered at the industry-average debt ratio, is below overall financial market risk associated with β equal to 1. The closest to average risk is the airlines and air transport sector. While the perspective towards risk that underlies these studies differs from social risk perspective that motivates the previous analysis, the results lend support to the finding that rail freight and air transport have less than average systematic risk.

The resulting sector specific WACCs are similar to what professional analysts would use to value transportation firms in Canada.

Table 5.6

SELECTED CANADIAN SECTORS IN TRANSPORTATION: WEIGHTED AVERAGE COST OF CAPITAL

	Levered Equity β	Error of β	Debt to Assets	Unlevered β of Assets
Airlines & Air Transport				
CHC Helicopter Corp (NYSE)	0.47	0.21	0.54	0.22
Transat A.T.	0.93	0.43	0.24	0.71
Westjet	1.23	0.36	0.57	0.53
Vector Aerospace	1.25	0.53	0.57	0.54
Sector Average	0.97		0.48	0.50
Beta, unlevered, industry average	0.50			
Beta, levered at average D/A	0.82			
Cost of levered equity	6.45			
WACC at industry average D/A	5.31			
Railways				
Algoma Central	0.10	0.22	0.14	0.09
CN	0.96	0.16	0.36	0.61
Canadian Pacific Railway (CP)	0.79	0.16	0.46	0.43
Sector Average	0.62		0.32	0.38
Beta, unlevered, industry average	0.38			
Beta, levered at average D/A	0.50			
Cost of levered equity	5.02			
WACC at industry average D/A	4.72			
Other				
CP Ships	1.14	0.33	0.30	0.80
Laidlaw	1.10	0.23	0.30	0.77
Mullen Transportation	0.55	0.24	0.15	0.47
Vitran Corporation (NYSE)	0.75	0.27	0.11	0.67
Sector Average	0.89		0.21	0.68
Beta, unlevered, industry average	0.68			
Beta, levered at average D/A	0.81			
Cost of levered equity	6.39			
WACC at industry average D/A	5.90			
Financial market parameters …				
Canada Treasury Bill Rate	2.77			
Canada Government Long Bond Rate	4.70			
Canada Corporate Long Bond Rate	5.82			
Canada Equity Risk Premium	4.50			
Canada Corporate Tax Rate	0.30			

5.7 Conclusion

This chapter developed and illustrated a methodology for measuring the socially relevant risk of investments in Canadian transportation assets. The measure of risk is a sector-specific activity-based index that focuses on the covariance of asset usage and real GDP. The index of risk is economically relevant, comparable across assets, independent of (public or private) ownership and easily computed in a log:linear regression of asset-use against real GDP. Our applications for the most part use seasonally-adjusted use quarterly data.

The index of socially relevant risk is used in computations involving the social opportunity cost of capital and the risk-fee social opportunity cost of capital to produce asset-specific risk-adjusted social discount rates.

The empirical illustrations indicate substantial variation in risk and the social opportunity cost of capital for investments in Canada's transportation sector.

The discussion in this chapter made reference at several points to the structural similarity of the proposed approach to estimating social risk-adjusted discount rates and the well-known CAPM. The two models – our framework in the social realm and the CAPM – have a common concern for risk and risk-adjustments to discount rates that are crucial for valuation and investment decisions. However the similarity between the two approaches is limited. Private sector *financial* signals, which reflect private perceptions of risk and market opportunities to address such risk, are of questionable use in determining socially relevant risks or opportunity costs of public capital. On the other hand, *operating* data of corporations involved in transportation could be useful in the expanding the empirical base for the assessing the social risk of investments in transportation assets.

6. CONCLUSION

The establishment of capital charges that can be incorporated in a full cost accounting framework raises significant issues of both a conceptual and practical nature. Initially, a choice must be made between the business finance and the social opportunity cost approach to determining interest costs. Whatever approach is chosen, there are conceptual and empirical questions to be addressed and these must be resolved so as to come up with a methodology that is suitable for application within an overall cost accounting system.

The existing literature on transport costing offers little guidance on how to develop an appropriate capital charge. Costing studies suggest that infrastructure costs are an important component of total transport costs – with, for example, the RCNPT estimating that, in 1991, they amounted to 14 percent of Canadian intercity travel costs, and Delucchi estimating that infrastructure and related publicly provided services accounted for 7 to 8 percent of the costs of motor vehicle use in the U.S over 1990-91 – and that the choice of interest rate will significantly affect total cost calculations. But there is wide variation in the interest rates that have been adopted and most studies include little or no discussion of what underlies the choice of rates. What stands out from a review of the existing literature is that in full cost studies, as distinct from regulatory studies, there appears to be a preference for the adoption of social opportunity cost measures of transport capital.

Given the objective of measuring the full social costs of transportation activities, what is required is an estimate of the sacrifices society as a whole makes in freeing up the resources for the investment needed to sustain Canada's transportation system. While this suggests that studies that have adopted social opportunity cost measures are on the right path, further thought needs to be given into what constitutes a proper measure of the social opportunity costs of capital. The sacrifices that society makes to release resources for transport investment are not captured by a rate based simply on individuals' preference for present over future consumption (as in UNITE). Nor is it possible to evaluate these sacrifices by trying to identify the particular activities being displaced by different transport investments (as in Delucchi). Basing capital costs on rates below those observed in the market (as in the Univ. of Leeds and Delucchi), has the effect of clouding the results through the insertion of arbitrary and debatable ethical judgments. The social discount rate provides a more defensible basis for estimating the sacrifices associated with transport investment, but studies adopting this approach (such as RCNPT) sometimes rely on outdated SDR measures.

In this report, capital charges are estimated based on calculations of the risk-adjusted social opportunity cost of capital. An updated estimate of the SDR provides the benchmark estimate of interest costs and this is adjusted up or down to take account of the different degrees of systematic risk associated with different transport assets. The question of whether to apply risk adjustments to the discount rate has generated significant discussion in the literature. It is generally recognized that with public as with private investment, if outcomes are influenced by the business cycle and correlated with national income, there is systematic risk that needs to be taken into account. In the evaluation of public projects, there are generally alternative and preferable ways to allow for risk than through adjustment of the discount rate. But in estimating the opportunity cost of capital, where these alternatives are not available, not adjusting the discount rate to reflect the added compensation individuals require for assuming additional systematic risk would lead to misleading results. Risk is factored into the pricing decisions of private sector firms and, to promote competitive neutrality, it is important that the opportunity costs used to determine charges for public assets incorporate a similar risk adjustment.

To derive an updated baseline measure of social opportunity cost, estimates were made of the costs and relative importance of the different activities likely to be displaced by transport investment. The returns that could have been earned if resources were instead directed to private sector investment were estimated using a “top down” productivity-based approach to calculate pre-tax returns on capital employed by the aggregate business sector. This methodology suggests that through the 1960s to the 1990s, returns to capital in the business sector have been remarkably stable, averaging just over 10%, or just over

11% when allowance is made for property tax payments. Residential investment, which accounts for about 20 percent of total investment, is estimated to have earned a somewhat lower return, and when this is incorporated in the estimate, the average pre-tax return on private sector investment comes out to 10.3%. Alternative methodologies result in lower estimates, but the evidence suggests that real pre-tax returns on marginal investment are at least 8 percent or higher.

Transport investment will displace consumption rather than private investment to the extent the interest rate increases resulting from this investment cause individuals to spend less and save more. The real after-tax return on incremental saving, which is a measure the value individuals' place on postponed consumption, is about 4 percent. Since the responsiveness of saving to higher interest rates tends to be quite low, displaced consumption has a much lower weight than displaced investment in calculations of the social opportunity costs of capital.

The other major source of funding for transport investment is foreign borrowing. While Canada has access to increasingly well integrated international capital markets, higher interest rates are needed to attract the additional foreign resources required to fund transport investments. The responsiveness of foreign funding to interest rates was calculated using available econometric evidence on "saving retention coefficients," which measure the impact of exogenous increases in national savings on investment. With information on savings retention coefficients and an understanding of the responsiveness of domestic saving and investment to interest rates, it is possible to indirectly come to an assessment of the relative importance of foreign funding as a source of the additional resources required for transport investment. Foreign borrowing costs less than displaced private sector investment and more than displaced private consumption; based on what foreign investors require to fund investment in Canada, the estimated real cost of this component of the social discount rate is 6 percent.

The SOCC was calculated for a range of saving retention coefficients and for real pre-tax private investment returns of between 8% and 10%. The resulting estimates of the SOCC range from 6.5% to 8.7%. Applying a reasonable mid-range savings retention coefficient and a 9% pre-return on investment, 50% of the resources required for additional transport investment come from displaced private investment, 10% from displaced private consumption, and 40% foreign sources. The implied value of the SOCC is 7.3%.

To develop risk adjustments that could be applied to the SOCC, an approach was adopted that is similar to private sector techniques of risk measurement based on the traditional capital asset pricing model. The purpose of this approach is to understand the relation between the use of a specific asset and real GDP. By regressing activity levels against GDP, it can be determined whether the relevant assets have a high or low degree of systematic risk and the SOCC should accordingly be adjusted upwards or downwards. There is a need to identify an appropriate output indicator (or indicators) for which suitable data is available, but the proposed methodology is economically relevant, independent of whether an asset is publicly or privately owned and relatively easily computed. Since the benchmark SOCC incorporates the average degree of risk in the economy, assets will have a SOCC above (below) the preferred rate of 7.3% only if they are subject to greater (lesser) than average risk. Given the margin of error that is necessarily associated with risk calculations, the appropriate focus is not on the specific risk estimate but the general finding on whether transport assets are being employed in an activity characterized by high, low or average systematic risk.

Some illustrative calculations of systematic risk were made for a number of transport industries using quarterly using quarterly, seasonally adjusted real output data as the activity indicator. Based on these calculations and the proposed system for categorizing assets, there are some high risk assets for which the proposed risk-adjusted SOCC should be 8.6% and some relatively low risk assets for which the adjusted SOCC should be 6.0%. The general implications of this analysis is that there are substantial differences in risk among transport assets that should be taken into account and the proposed methodology provides a reasonable means for adjusting the proposed updated measure of SOCC to derive risk adjusted rates that are appropriate for application in a full cost accounting system.

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