

OPTIMAL PUBLIC INFRASTRUCTURE: SOME GUIDEPOSTS TO ENSURE WE DON'T OVERSPEND[†]

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SUMMARY

It's time to consider a more economically efficient model for financing roads, bridges and other public infrastructure.

It's true that Canada has become one of the biggest spenders on infrastructure among OECD countries, at four per cent of GDP, but using GDP to measure the share the government should spend on infrastructure is an anachronistic and arbitrary measure. We all know it is important that Canada keep pace with maintaining and building the necessary infrastructure to maximise our productive capacity and economic prosperity. But how do we know if we are on the right track? How much investment is enough, and what is the optimal level of public investment in infrastructure?

This paper proposes a framework for evaluating current and future levels of financing for public infrastructure. Rather than relying on arbitrary comparisons with Canada's post war 'golden age' of infrastructure investment (an all too common standby in political circles), we propose a standard that is based in economic efficiency and which aims to maximise the public benefits associated with infrastructure investment.

We also take a historical look public capital spending in Canada, as well as the trend toward privatization of public infrastructure and core services that began some 30 years ago after the Mulroney government was elected. This trend has seen many core services and assets that were once publicly run transition to outright privatization. It is interesting to note that the most heavily privatized sectors (utilities and communications) are also the sectors most often spared from the label of 'inadequate', a label that befalls so much of Canada's public infrastructure.

When infrastructure is financed through taxation, there is a tendency for spending to be discouraged to ease the burden on taxpayers; however, this inevitably leads to infrastructure maintenance and construction being deferred, with a significant deficit inevitably built up. A user-pay model would work to eliminate political influence, create revenue for infrastructure renewal, and facilitate an optimal allocation of infrastructure resources. All of this further helps maximise the benefits derived from public infrastructure. This model of infrastructure finance and provision could be further advanced and reinforced through the creation of provincial and federal bodies whose mandate would be to actively evaluate infrastructure investments in their respective jurisdictions, prioritizing funding for the most meritorious projects, and those offering the highest public return on investment.

When projects are funded through taxation and access is not priced, there is often little or no incentive for individuals to make efficient use of them. The lack of direct accountability means individuals fail to use infrastructure judiciously and sparingly to preserve the life of public assets or prevent unnecessary congestion. Moreover, the lack of a clear sense of cost means governments do not know the true value that the public places on one type of infrastructure over another. Thus, government budgeting for such projects remains inefficient and skewed. The best level and mix of public infrastructure can only be determined when government and private providers can reliably establish user demands in a priced (efficient) system.

The current model of funding public infrastructure deprives users of infrastructure as well as government planners from vital information they need to make informed and efficient decisions. Both remain unclear on value for money, and cost-accountability, but are bound by an innate aversion to increased tax-financing. Governments, fully cognizant of both consumer attitudes and the need to retain vote-getting power, thus swing between funding necessary infrastructure and allowing infrastructure deficits to grow. This paper advocates for a more efficient, accountable system with greater dependence on user-pay models and reinforced by an active arm's length government agency designed to advance merit based project selection, and maximise public benefit.

[†] This paper is part of a three-part series on public infrastructure spending and financing in Canada, along with *An Exploration into the Municipal Capacity to Finance Capital Infrastructure* by Almos T. Tassonyi and Brian W. Conger, and *Striking the Right Balance: Federal Infrastructure Transfer Programs, 2002-2015* by Bev Dahlby and Emily Jackson.

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Canadian federal, provincial and municipal governments have substantially upped spending on public infrastructure in the past decade, making up in part for the downtrend in public infrastructure spending since 1970.¹ Recently, as we show below, Canada has become one of the largest spenders on public infrastructure among OECD countries, at roughly four per cent of GDP. As a result, Canada's average age of public infrastructure stock has fallen dramatically from 17.8 years in 2000 to 14.7 years in 2013². Some estimates suggest that Canada's stock of public and private infrastructure is below the OECD average (58 per cent of GDP in Canada, compared to 70 per cent on average), implying that despite Canada's renewed commitment to infrastructure spending, it still has some way to go.³

Many have concluded that an increase in public infrastructure spending is currently required to make up for declining infrastructure spending in the second half of the 20th century.⁴ The last decade has seen a number of reports that estimate the so-called infrastructure deficit, some of which have argued that the cost may be as high as \$233 billion to make up for needed repair work and new infrastructure. While it is easy to observe the current level of spending on infrastructure and how much is required to maintain capital stock, it is another matter to establish what is an optimal level of public infrastructure spending. Deficit calculations are not informative or helpful in this sense.

There are good reasons to think harder about the amount of public infrastructure spending needed in an economy. Simply looking at past trends, such as public infrastructure spending as a share of GDP to determine the optimal amount to be spent in the future, is not helpful since economic circumstances change. A shift from old to new technologies means that some forms of infrastructure spending should die down while others should develop. Further, a shift from public to private spending on infrastructure reduces the need for public investment to be financed by current or future taxes, the latter arising from debt finance.

After the Second World War, Canada was building up new primary transportation infrastructure, which required significant public funding. Once built, expenditure would expectedly decline to levels necessary to maintain the quality of capital stock, a cost far less significant than financing its initial construction, at least in principle.

At the same time, Canada, once reliant on Crown investments in infrastructure, took on more privatization with the conversion of public telecommunications and transportation firms into private companies. Governments themselves grew, requiring more administrative public capital with population growth.

New forms of infrastructure spending were needed as Canada entered the communications age, as well as increased urbanization. While urbanization led to people living closer to each other (thereby reducing the need for rural infrastructure), it led to new demand for infrastructure as

¹ This data will be presented in more detail below. See also C. Cautillo, N. Zon and M. Mendelsohn, "Rebuilding Canada: A New Framework for Renewing Canada's Infrastructure," *Mowat Research #92*, Mowat Centre, University of Toronto, August 2014, p. 2.

² Infrastructure Canada, *Departmental Performance Report*, 2013-2014.

³ McKinsey Global Institute, "Infrastructure Productivity: How to save \$1 trillion a year," January 2013. Represents telecom, water, power, airports, ports and rail. The measurement of public capital stock, however, is not without its difficulties, especially with respect to valuation of non-marketed assets like roads and highways.

⁴ Including numerous publications from the Federation of Canadian Municipalities, the Residential and Civil Construction Alliance of Ontario, and notably Saeed Mirza, professor of civil engineering at McGill University.

the population grew in primarily urban centres. How much infrastructure is needed depends on economic circumstances.

In the paper below, we specifically review three issues.

The first issue is related to the definition and determinants of public infrastructure spending. We look at the choice between public and private ownership of infrastructure and determining the appropriate rate of return and the cost for infrastructure projects.

We then look at the Canadian experience. Specifically, we examine Canada's historical experience in public and private infrastructure investment, including some specific types of infrastructure, comparisons with other OECD countries and provincial experience.

As a final section, we consider two policy issues. The first issue is reliance on pricing for infrastructure. The second issue is developing a more transparent approach to measuring the returns to public infrastructure spending in the absence of pricing.

WHAT DO WE MEAN BY OPTIMAL PUBLIC INFRASTRUCTURE?

If there is one area of agreement in Canada and most economies, it is the need to build up more public infrastructure. In the 2015 federal election, all three leading parties argued in favour of more infrastructure spending, especially on urban transit. The debate has been over the size of such spending, ranging from the recent 2015 budget plans of the Conservative government to the largest new spending programs proposed by the Liberals.

Infrastructure is capital stock acquired to provide or move goods, services and people in an economy including rail, air, transit and road transport, ports, bridges, pipelines, communication services, power, pipelines, etc. Some would also include education and other related public expenditures that build human capital, even though a portion of education expenditures supports consumption rather than investment. Generally, buildings and other public administration capital are needed to support general government services. Thus, the definition of public infrastructure varies depending on its use, although we shall focus on the conventional definition related to physical capital.⁵

Measuring the stock of public infrastructure is not without its difficulties⁶. Many public assets are not marketed, such as roads, highways, bridges and parks. While statistic agencies can measure a book value of public capital by adding up past expenditures, its economic value is more difficult to measure without understanding the economic returns to investment. An asset may also be depreciated, requiring knowledge of its specific life cycle, which is possible to analyze or derive with engineering data. However, economic depreciation, measured as the reduction in the value of an asset over a period, is much more problematic without knowing valuation. The difficulty of measuring public infrastructure makes it more difficult to determine

⁵ A similar point is made by E. Gramlich, "Infrastructure Investment: A Review Essay," *Journal of Economic Literature*, Vol. XXXII, September 1994, pp. 1176-1196.

⁶ The difficulties of measuring public infrastructure stock are discussed in J. Mintz & R. Preston, *Infrastructure and Competitiveness*, John Deutsch Institute, Queen's University, 1993.

the optimal level of public infrastructure spending, as well as determining the priorities for public capital spending.

Few would disagree that public infrastructure can help improve economic growth.⁷ Added infrastructure stock would raise the productive capacity of an economy. It also increases output per worker (productivity) whether publicly or privately financed. But like all types of spending, a limit is reached beyond which infrastructure spending leads to suboptimal returns and crowds out valuable competing priorities. Thus, establishing a framework to determine the optimal amount of infrastructure needed in an economy is a key consideration for both government and industry.

Several theoretical issues could be considered in determining the optimal size of public infrastructure spending. Below, we review two specific points relevant to the policy prescriptions in this paper: (i) private versus public infrastructure spending and (ii) determining the optimal choice of infrastructure capital stock.

(i) Public versus Private Infrastructure

Studies that compare public infrastructure presume that governments are the suppliers of such infrastructure. Yet, many countries, including Canada, have changed their views on ownership and control by privatizing — supported by regulation — what has typically been viewed as public infrastructure. Privatization became more popular in the United Kingdom during the 1980s when rail transport, telecommunications, power and social housing were privatized by the government to improve efficiency. Other countries privatized companies as well, following the U.K. example, including Canada after the Mulroney government was elected in 1984. More recently, where outright privatization has not been used, it has become fashionable for governments to contract out the supply of the public services to private firms that design, construct and operate a project through a public-private partnership.

At one time, core Canadian infrastructure was publicly owned and administered including rail, airports, telecommunications and roads. Canadian National Railway, Air Canada and various government telecommunications companies later became privatized, following trends in other countries. Currently, quasi-government bodies operate airports that fully recover costs with user charges. Publicly owned companies operate transmission and distribution, although privatized power companies operate in many provinces, especially Alberta.

In many instances, what was once typically public infrastructure has now become private infrastructure. Thus, the line between public and private infrastructure becomes blurred and, to the extent privatization has taken hold, public spending as a share of total infrastructure spending would naturally decline over time. Comparing public infrastructure spending

⁷ A general result, by no means unanimous, is that the elasticity of GDP with respect to infrastructure stock is .15 – double infrastructure and GDP rises 10 per cent. Studies have tended to overestimate the positive benefits of infrastructure spending by not separating demand effects from higher income induced by more spending from supply effects from added capacity. Further, most studies do not take into account timing, spillover effects and heterogeneity in projects, since some spending can result in less GDP due to rent-seeking and corruption. See L. Serven, “Infrastructure and Growth,” *Research Brief*, World Bank, 2010. <http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:22629797~pagePK:64165401~piPK:64165026~theSitePK:469382~isCURL:Y,00.html>

across countries should also account for differences between private and public ownership of infrastructure.

Even with the private supply of infrastructure, governments could still be involved by regulating prices and standards to protect consumer interests or subsidizing capital construction. The motivation for government involvement in the supply of infrastructure is based on four factors:

1. *Public Goods*: Some services are non-rivalrous in consumption (meaning that consumption by one person does not diminish consumption by another) or non-excludable (the nature of the good is such that access to, or consumption of the good cannot be limited). The classic examples are defence and law and order, which are provided by governments, given their value to the broad population. At the municipal level for example, public infrastructure often includes some forms of transportation, sewage and drainage, lighting and parks, each of which has varying degrees and combinations of rivalrousness and excludability.
2. *Economies of Scale*: When very large capital-intensive projects are involved, only one or a few private companies may be able to operate at a level sufficient to achieve the lowest unit costs of production. This is particularly important with respect to the provision of infrastructure such as broadband, transmission lines and roads, which are efficiently provided by one or a few providers. In this case, a natural monopoly arises whereby the private producer(s) could charge a price in excess of costs by limiting supply. Output could expand if price is more than incremental variable costs, but the company may not be able to profitably cover fixed costs. In this case, a government enterprise could operate at a loss by providing supply where price is set at incremental cost, or subsidize a private producer to achieve a higher level of output, best illustrated by the construction of the Canadian Pacific Railway in the latter part of the 19th century⁸.
3. *Spillovers (externalities)*: Spillovers or externalities arise when individuals or firms take some action which has an impact on others around them, without being compensated for the benefit to others or forced to pay compensation for the harm imposed on others. Pollution is an example of harmful spillover costs imposed by producers on others in society, while the diffuse benefits resulting from innovation, research and development can be hard to fully capture/monetize for private firms. Network externalities arise, as in the case of transportation and communication, when one part of the system provides benefits to other parts by reducing transaction costs or improving overall demand for a service.
4. *Merit Goods*: Government may provide goods and services simply because they are meritorious (such as subsidizing broadband and roads in rural areas). While merit considerations are relevant to voter demands and political preferences, the concept is loose in application as it can provide a justification for many public expenditures. We discuss political decisions and voter preferences below since it is typical for political decisions to be based on current voter preferences, ignoring the preferences of future voters who will bear some of the cost of public spending.

⁸ As noted by a reviewer of this paper, the Canadian government arguably over-subsidized the development of the CPR. We agree this is likely true. Norman Bonsor's 1995 article, "Competition, Regulation and Efficiency in the Canadian Railway and Highway Industries," for the Fraser Institute, also makes this case. He further argues that this subsidy — along with that of the highway system — and also regulations surrounding the rail industry from 1927-1991, introduced tremendous distortions into the transportation market.

Each of these market failures gives rise to a rationale for government intervention in infrastructure markets. However, the type of intervention can vary. The infrastructure could be designed, constructed and operated by a government entity (such as a department, agency, non-profit government-controlled organization or Crown corporation). Alternatively, as suggested above, the infrastructure could be privately supplied with government regulatory control over pricing and standards to protect consumer interest and ensure an efficient supply⁹.

In either the case of private or public provision, costs can be covered through direct consumer pricing. With respect to public supply, governments can assess user fees related to consumption for water, power, sewage, drainage, transit and major roads. If privately supplied, the firm could recover costs through pricing of the service such as two-part pricing (an upfront fee to access the service and a charge per unit of use). Where a supplier may then be in a monopolistic position to charge prices in excess of incremental costs, governments can be justified in regulating prices to ensure that market power does not determine pricing, and consumer interests are protected.

A key aspect of privatization is that the cost of infrastructure is covered by user charges (and, perhaps, government subsidies where justified). Pricing is particularly important in determining the return to infrastructure, since prices are a measure of consumer benefits based on the degree to which people are willing to give up other expenditures to use infrastructure services.

(ii) Optimal Choice of Infrastructure Spending

The concept of a public infrastructure deficit, which is commonly used in policy circles, should be defined as the difference between the current and the optimal amount of infrastructure stock (a deficit arises if the optimal amount is more than the current level of capital stock).¹⁰ As discussed above, while it is relatively simple to measure current capital flows, it is a much more complicated matter to accurately estimate the capital stock, since many assets such as parks, roads and bridges have no market value to estimate. Instead, a value of assets based on historical or inflation-adjusted expenditures and estimated capital stock lives are used to measure the value of infrastructure stock. Even once measuring capital stock, it is very difficult to establish the optimal level of infrastructure stock without information on returns and costs as discussed below.

In the private sector, the optimal choice of capital stock is based on a well-known set of principles. Firms invest in capital if the expected rate of return on the project is at least as great as the cost of capital¹¹. If the expected rate of return is below the cost of financing, the project

⁹ Price regulation for many infrastructure projects like electrical transmission and distribution, pipeline, telecommunications, etc. has been based on providing the supplier a normal rate of return on capital or a price that recovers costs net of a productivity stretch factor (performance-based regulation).

¹⁰ Several measures of infrastructure deficits can be used, including engineering data, economic rates of return and political voting preferences (the latter often ignoring preferences of future voters). See E. Gramlich, "Infrastructure Investment: A Review Essay," *Journal of Economic Literature*, Vol. XXXII, September 1994, pp. 1176-1196.

¹¹ Throughout, the cost of capital is defined as the hurdle rate or financial cost to determine the acceptability of a project (depreciation costs are subtracted from rates of return to capital). As we note in this section, the hurdle rate is adjusted for risk and other factors, particularly taxation. If risk is added to the cost of capital, the expected rate of return on the project should be at least as high as the hurdle rate, including risk costs. Alternatively, risk costs could be subtracted from the rate of return to capital so that the rule for acceptability becomes the net-of-risk rate of return being at least as high as the riskless cost of finance. As is well known in project analysis, one can adjust returns or financing costs to determine the appropriate level of capital investment.

will be unprofitable and therefore rejected. To maximize the value of the firm's profits over time, investment takes place until the rate of return on capital is equal to the cost of capital. Too little investment results in giving up profitable opportunities. Too much investment results in lower profits.

For governments, a similar decision rule is involved in principle. The optimal amount of infrastructure capital is determined at the point in which the marginal return from additional capital spending is equal to the hurdle rate. However, unless prices are charged for the use of infrastructure, it is necessary to use other, often more subjective or speculative, measurements to determine the return to infrastructure. This requires the use of cost-benefit analysis whereby benefits are the estimated value to consumers of using the public infrastructure even if they do not pay for the product. Such benefits are adjusted by including net benefits or costs in related markets that arise from more infrastructure spending.¹²

As for the cost of capital, it should be remembered that public infrastructure is often tax-financed, whether by imposing levies on the current population, or deferred through debt finance, to be repaid at a later time by future taxpayers.¹³ If a distortionary tax is used to finance infrastructure and governments minimize the economic cost of raising taxes over time with debt finance, the cost of finance is theoretically increased by the value of lost productive activity in the private sector due to taxation. Assuming that a capital tax on private investment is used to finance public infrastructure¹⁴, the cost of financing public infrastructure (CF) is equal to the following:

$$CF = R/(1-tE)$$

R = interest rate, t = marginal effective tax rate on private capital and E = elasticity of private capital stock demand with respect to tax rate.

As a benchmark, the marginal effective tax rate on capital is 19 per cent and the elasticity is 1.0.¹⁵ This would imply that the government's cost of finance would be 23 per cent above the

¹² Measuring the rate of return to unpriced infrastructure services would require estimating the marginal willingness of consumers to pay for the service, which must be estimated from demand analysis. Indirect benefits are equal to changes in demand or supply in related markets multiplied by the difference between consumer and producer prices (consumer prices reflect what consumers are willing to pay for a product and producer prices reflect the opportunity cost of using resources to produce the product). If consumer and producer prices are equal to each other (no distortions), no adjustment is needed for indirect effects. However, if there are economic distortions (such as taxes and subsidies), indirect net benefits should be included. If the consumer price is more (less) than the producer price and the related market expands, there is a positive (negative) net benefit.

¹³ B. Dahlby and M. Smart provocatively suggest that only tax finance should be used for infrastructure unless debt is covered by future user charges to cover its costs. See B. Dahlby and M. Smart, "The Structure and Presentation of Provincial Budgets," *SPP Research Papers*, 8(25), School of Public Policy, University of Calgary, 2015.

¹⁴ This result is based on a simple two-period model in which private and public capital in production are complementary in their use as inputs. The government finances its public infrastructure with a tax on private investment with the aim to maximize economic well-being over the two periods. The optimal decision for one more dollar of public infrastructure spending is derived as above. Readers are welcome to request the mathematical derivation.

¹⁵ The elasticity of one is consistent with a Cobb-Douglas production function to represent the Canadian economy. The marginal effective tax rate is taken from D. Chen & J. Mintz, "The 2014 Global Tax Competitiveness Report: A Proposed Business Tax Reform Agenda," *SPP Research Papers*, 8(4), The School of Public Policy, University of Calgary, Calgary, Alberta, February 2015.

market interest rate. This financing cost can be larger than the interest cost faced by private-sector producers even if government debt can be issued at a lower risk cost than private debt.¹⁶

A different economic cost of tax-adjusted cost of capital would be realized if other taxes were chosen to finance infrastructure costs. If a consumption tax were chosen, the cost of public infrastructure would be less since consumption taxes distort less the allocation of resources in an economy compared to capital taxes. Also, estimates of the marginal cost of taxation, especially for the corporate income tax, can be substantially higher than what is used above. Dahlby suggests that provincial corporate taxes can be two times higher than a consumption tax.¹⁷ Recently, some governments such as Ontario and Alberta have increased reliance on the most distorting taxes (personal and corporate taxes), requiring a higher cost of finance to be used to evaluate infrastructure projects.

While these general observations in determining the optimal infrastructure stock are helpful guidelines, the implementation of these rules requires careful analysis. While we often think of infrastructure as providing higher net benefits to the economy, it will not always be the case if infrastructure spending is used to curry the favour of voters (the “bridge to nowhere” phenomenon). Measuring the return to infrastructure to ensure both the appropriate quality and quantity of stock is a task that will be further discussed below.

CANADIAN CAPITAL SPENDING: NATIONAL HISTORICAL PERSPECTIVE

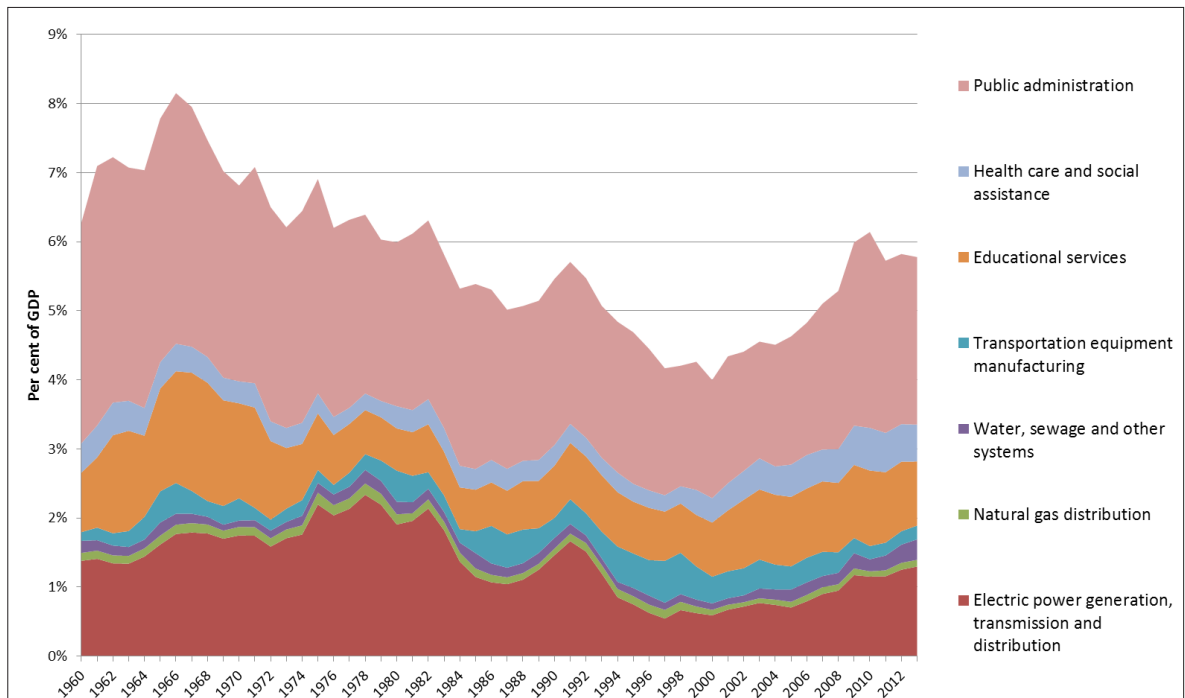
In looking at the long-term aggregate data available on public and private capital investment in Canada, there are two clearly defined trends, that of declining investment following the 1960s, and a reversal to increasing expenditures following the late 1990s. Based on available Statistics Canada data, we are not able to completely tease apart public from private investment in this longer series, though later in the paper we will be able to do so for the period following 1991.

Many of the select industries presented below in Figure 1 have traditionally been characterized exclusively by public capital expenditures, such as water and sewage, health care and social assistance, and public administration. Others, such as electricity and gas, have seen a transition from being largely publicly financed and owned, to privately held. This transition is illustrated in Figure 2.

¹⁶ As pointed out in the private-public partnership literature, the government could have a lower cost of finance than a private producer due to better credit in capital markets. However, this ignores the cost of tax financing. For a discussion of credit costs for public and private producers, see Matti Siemiatycki & Naeem Farooqi, “Value for Money and Risk in Public–Private Partnerships, Evaluating the Evidence,” *Journal of the American Planning Association*, Volume 78, Issue 3, 2012.

¹⁷ B. Dahlby, “Reforming the Tax Mix in Canada,” *SPP Research Papers*, 5(14), The School of Public Policy, University of Calgary, 2012.

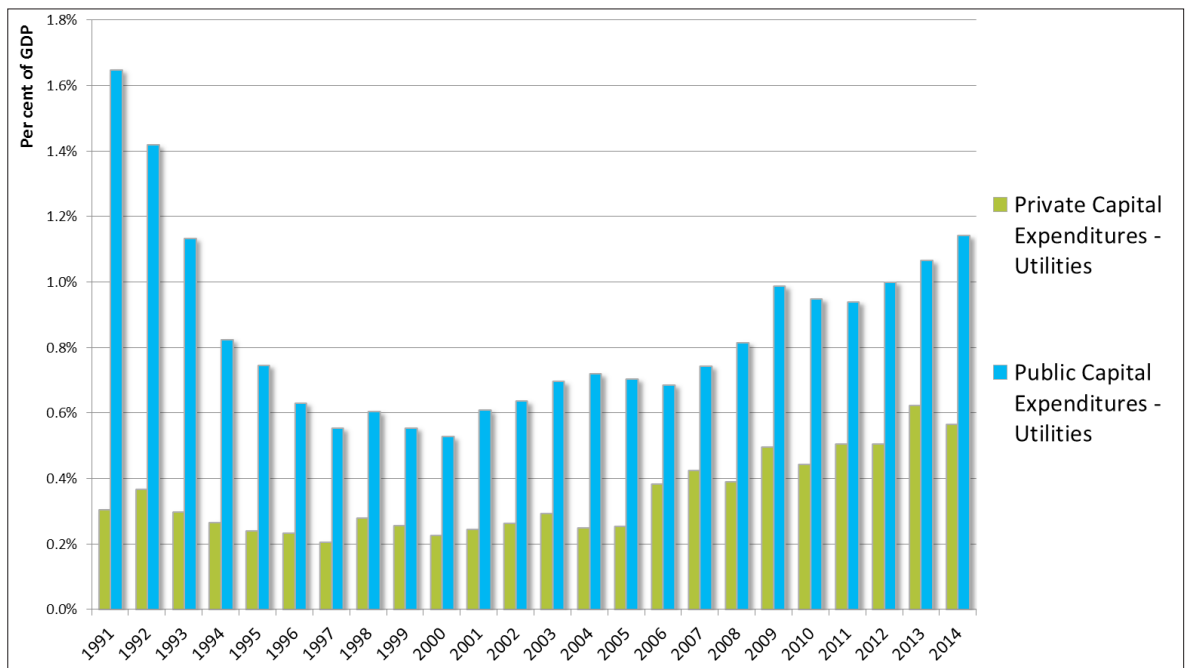
FIGURE 1 PUBLIC & PRIVATE CAPITAL INVESTMENT IN CANADA, SELECT INDUSTRIES 1960 - 2013



Note: Includes building, engineering, machinery and equipment, and intellectual property asset classes.

Sources: Statscan Table 031-0002 and World Bank Development Indicators.

FIGURE 2 PUBLIC & PRIVATE CAPITAL INVESTMENT IN CANADA - UTILITIES



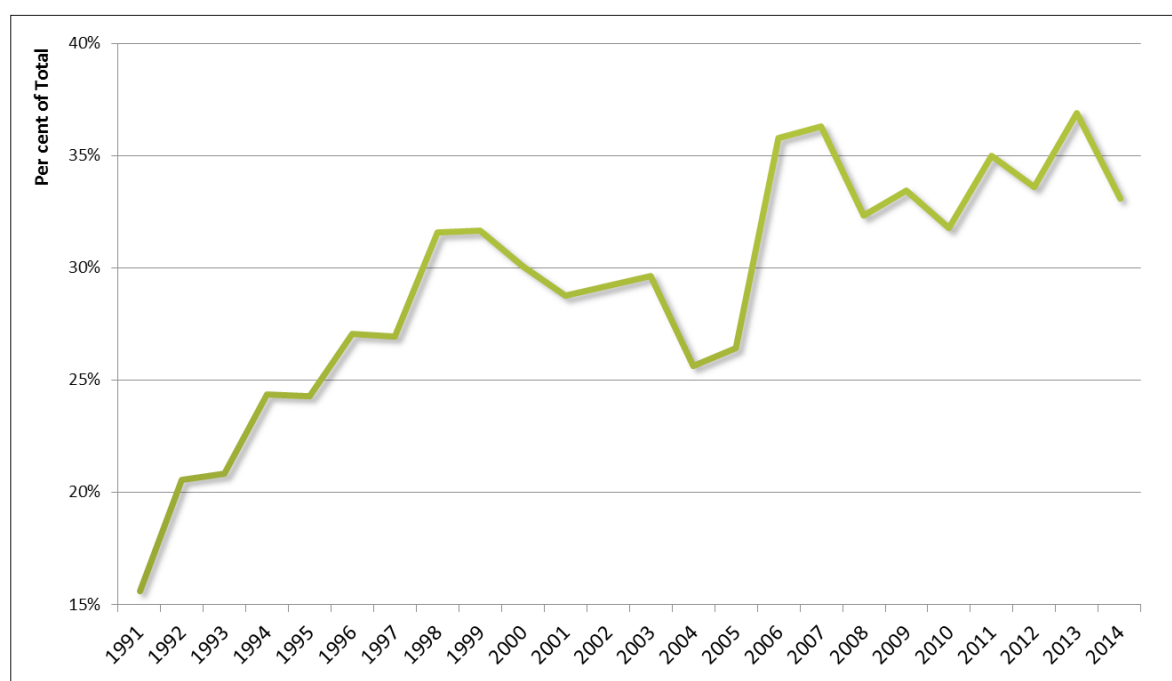
Sources: Statscan Table 031-0002 and World Bank Development Indicators.

The data in figure 2 are also not as disaggregated as we would like, though the trend is rather informative. Figure 2 shows public versus private shares of capital investment in the aggregate Statistics Canada category of Utilities, which is composed of electric power generation,

transmission and distribution, natural gas distribution, and water, sewage and other systems. The graph illustrates declining investment into the late 1990s, followed by a reversal to increasing spending thereafter, similar to the trend seen in Figure 1. In addition, Figure 2 also clearly illustrates a shifting of emphasis in utility capital investment from the public to private sector.

While public utility investment was nearly five times that of private in 1991, by 2013, private investment had grown to roughly 60 per cent of public, representing a more than doubling of private spending over the early 1990s. In absolute terms, this represented a shift in private spending from just over 15 per cent of total utilities capital investment in 1991 to a peak of 37 per cent in 2013 (Figure 3).

FIGURE 3 PRIVATE CAPITAL INVESTMENT AS A SHARE OF TOTAL - UTILITIES



Sources: Statscan Table 031-0002 and World Bank Development Indicators.

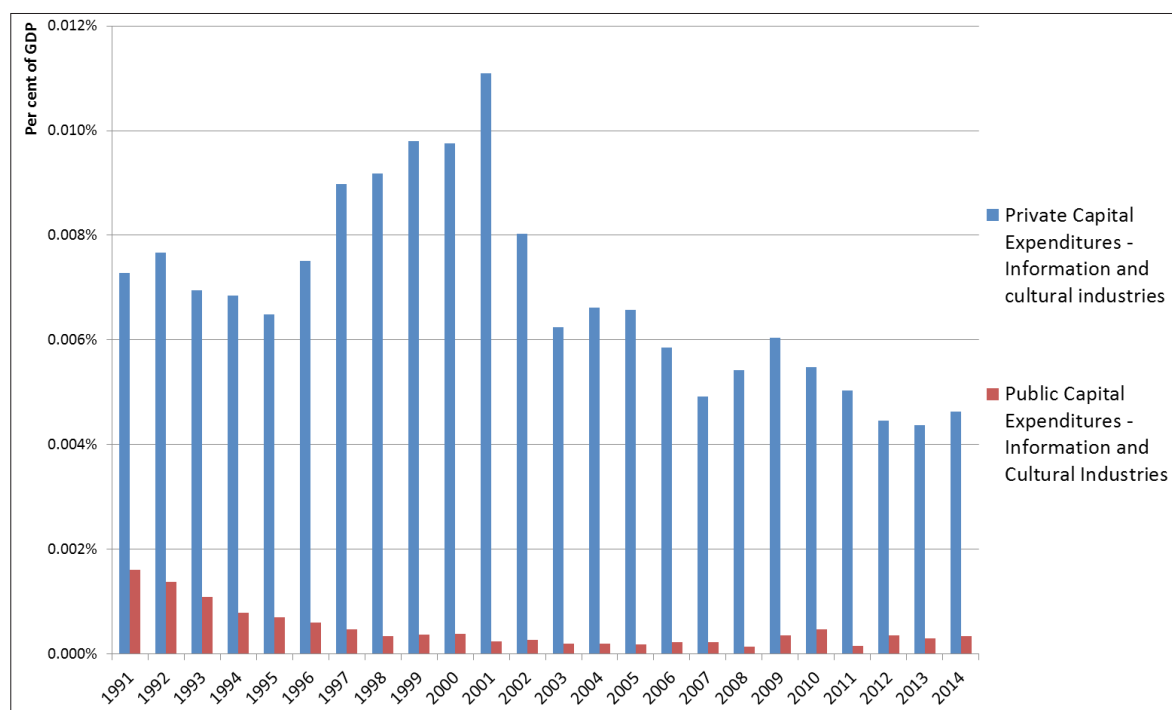
Referring back to Figure 1, we can see that the utility class of capital assets has consistently accounted for nearly half of public capital investment in Canada — if public administration is left out of the picture — establishing the utility asset class as a significant and primary component in the makeup of public capital investment. Considering the shift from public to private — illustrated in Figure 2 — and given the significance of utility assets in Canada’s capital portfolio, we can see that there has been a rather dramatic shift in the composition of capital financing, and thus provision and ownership of core infrastructure over the last 25 years.

Increased emphasis on private investment can also be seen in Figure 4, showing capital investment for Statistics Canada’s aggregate Information and Cultural Industries capital asset class, composed of telecommunications, broadcast and print.¹⁸ Unfortunately, from Statistics Canada data we cannot disaggregate the contributions of these individual industries, though we believe it is likely that a significant portion of spending trends here are accounted for

¹⁸ For a full accounting of Statistics Canada’s NAICS 51- Information and Cultural Industries asset class, see <http://stds.statcan.gc.ca/naics-scian/2007/ts-rt-eng.asp?criteria=51>

by telecommunications, with increased private spending accounting for the development of Canada's wireless network, and decreased public investment representing government's general exodus from the telecom industry. Regardless, the shift away from public spending across this asset class has been significant. While public capital investment in this asset class represented nearly 18 per cent of total investment in 1991, by 2001 this had dropped to a mere 1.7 per cent, representing less than 1/8 of what it had been only a decade earlier. There have been some modest gains in public spending among this asset class since the low point seen in 2001; however, in 2014 public spending was just over six per cent of total investment, representing roughly a third of what it had previously been in 1991.

FIGURE 4 PUBLIC AND PRIVATE CAPITAL INVESTMENT: INFORMATION AND CULTURE INDUSTRIES 1991-2014



Sources: Statscan Table 031-0002 and World Bank Development Indicators.

Given these shifts toward private provision of historically public asset classes, can we reasonably expect historical public capital investment levels to be informative for the development of current and future public capital spending policies?

Considering the increased private participation, along with the thesis presented earlier, that following the expansion of Canada's post-war core infrastructure we would expect a decline in overall capital investment as major capital erection costs give way to less costly long-term maintenance spending, it is not clear that historical levels should be regarded as benchmarks for current public capital expenditure. This is not to suggest that current spending is either optimal or inadequate, but only to suggest that historical levels may not be a useful benchmark to evaluate current public capital spending¹⁹.

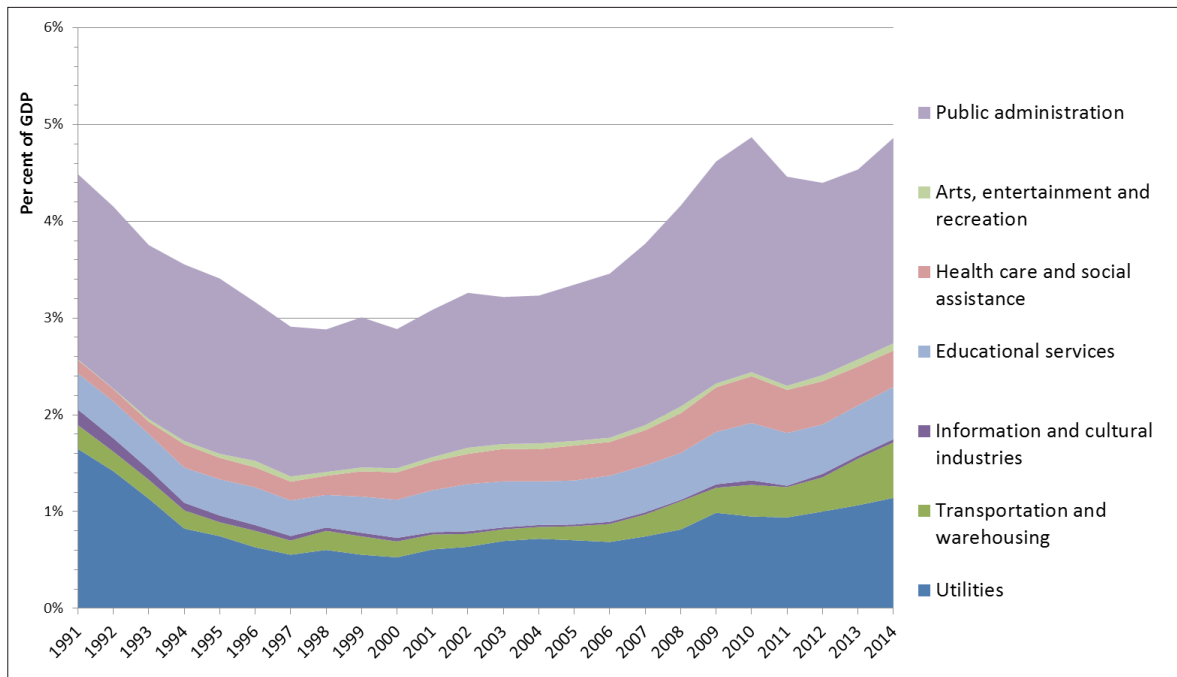
¹⁹ Ontario has argued that public infrastructure spending should be five per cent of GDP, which was similar to a half century ago. See "Wynne leads call for huge increase in federal infrastructure spending," CBC, August 6, 2014. <http://www.cbc.ca/news/canada/toronto/wynne-leads-call-for-huge-increase-in-federal-infrastructure-spending-1.2729585>

Though some continue to gauge the adequacy of current capital spending according to post-war historical trends, we would argue based on the theoretical foundation presented earlier, that governments should rather establish efficient public demand through the pricing of infrastructure.

THE AGE OF PUBLIC INFRASTRUCTURE IN CANADA: RECENT DATA

On the whole, Canada's public capital spending trend has been positive for some 14 to 15 years, and this uptick in spending has translated into tangible capital renewal as demonstrated by the most recent data available on the age of Canada's infrastructure.

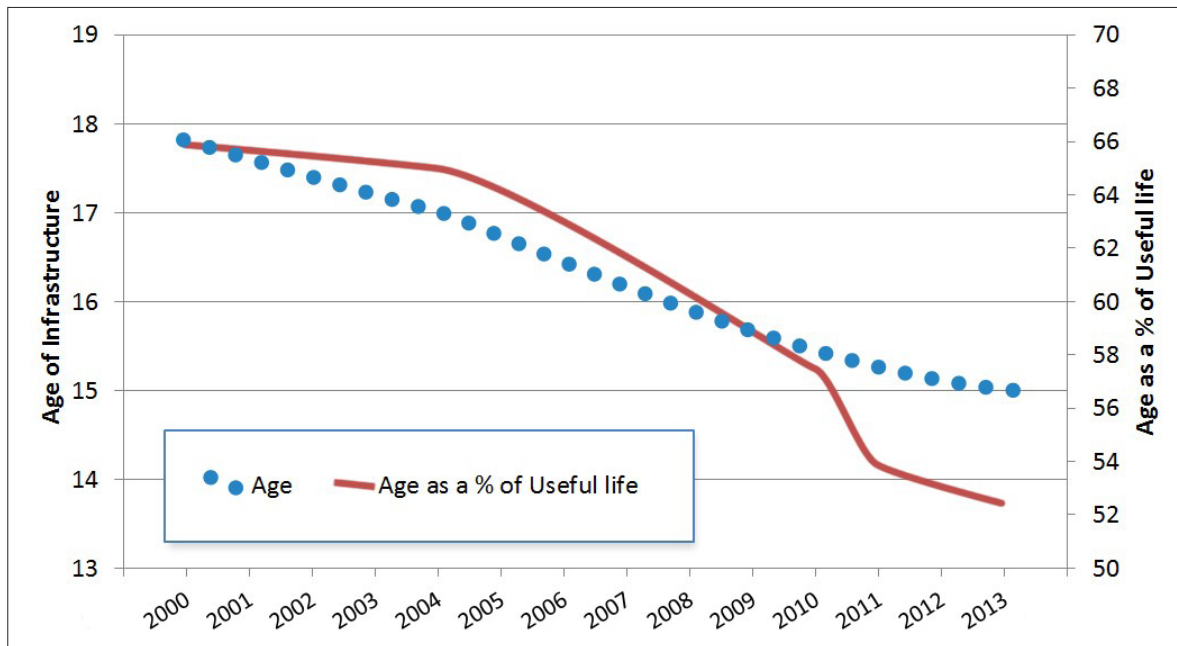
FIGURE 5 PUBLIC CAPITAL INVESTMENT BY SECTOR - CANADA



Sources: Statscan Table 031-0002 and World Bank Development Indicators.

In Figure 5 above, we can see that public capital investment, leaving out public administration, has almost doubled from a low of roughly 1.4 per cent of GDP to a current high of 2.8 per cent. This spending increase helps to explain the clear downward trend in the average age of core public infrastructure we see in Figure 6, and the corresponding increase in the average useful remaining life.

FIGURE 6 PUBLIC INFRASTRUCTURE IN CANADA - AVERAGE AGE & PERCENTAGE OF USEFUL LIFE



Sources: Infrastructure Canada and Statscan National Economic Analysis Division.

Note: Core public infrastructure (roads, bridges, transit, water, wastewater, culture, and sports and recreation infrastructure) owned by all levels of government including Crown corporations and provincial agencies. Data for 2013 based on forecast.

The “useful life” is a concept which refers to the average productive duration which can be expected at the time of acquisition. A 2006 Statistics Canada report titled *The Age of Public Infrastructure in Canada*²⁰ refers to this concept as the “service life and mortality function” and defines it as:

“(an asset’s) productive life ... the length of its useful life at the time of its acquisition. For example, an asphalt roadway — whether it is a road or highway has a mean service life of 28 years ... The mortality function reflects the retirement (decommissioning) of assets from capital stock when the assets reach the end of their useful life. The function used for asset retirement is represented by a normal distribution truncated at the tails. The distribution reflects service life variation due to asset quality and maintenance. Assets may be retired for various reasons. They can be exported, sold for scrap, dismantled, demolished or simply abandoned.”

The useful life of an asset at the time of acquisition represents an average duration based on the characteristics of the structure. However, useful duration is also a function of maintenance and so can both contract and expand based on the degree to which optimal maintenance scheduling is adhered to.

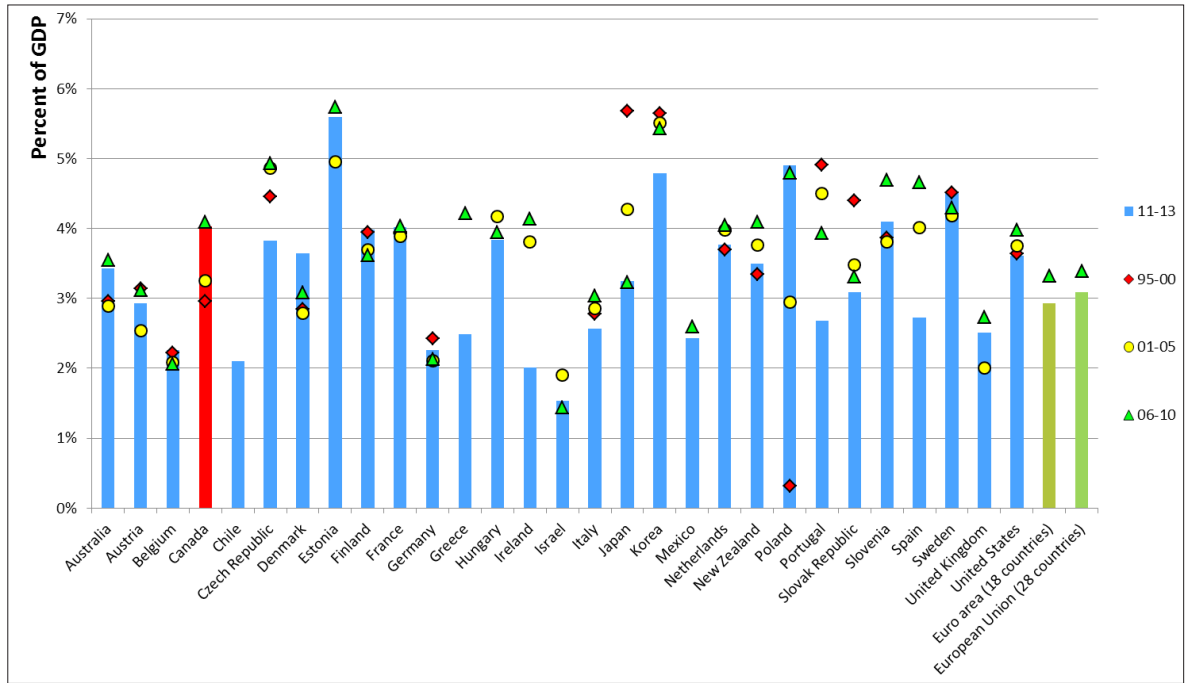
Over the period of 2000 to 2013, the average age of core public infrastructure fell 3.1 years, from 17.8 to 14.7 years old on average. Spending on additions and maintenance over this period have had a significant corresponding impact on the percentage of useful life remaining for core public infrastructure, which has seen a nearly 40 per cent increase in useful life span over the base period (1-C/B), from 34.1 per cent of useful life remaining to 47.5 per cent.

²⁰ Valérie Gaudreault and Patrick Lemire, *The Age of Public Infrastructure in Canada*.

CANADIAN INFRASTRUCTURE SPENDING: AN INTERNATIONAL COMPARISON

In this section, we will look at how Canada’s capital flows compare to those of similarly developed OECD nations using capital investment data across a selection of public capital asset classes. This comparison helps give a sense of how Canada stacks up to other developed nations in terms of infrastructure spending, and offers some insight into short-term trends in the comparative development of domestic capital and productive capacity.

FIGURE 7 PUBLIC INVESTMENT, GROSS FIXED CAPITAL FORMATION - OECD SELECT COUNTRIES



Notes: To help illustrate changing trends over time, we have included red, yellow and green markers indicating spending averages in past periods. Red is for oldest, yellow for mid, green for recent and the solid bar indicates the period containing the most recent data. Missing data points indicate spotty OECD data. We opted to include data where available, rather than exclude nations that did not have full data sets for the total period of observation.

Source: OECD Metadata.

Figure 7 illustrates investment flows in public gross capital formation for a selection of OECD nations between 1995 and 2013. In the current period between 2006 and 2013, we can see that Canada maintained a relatively strong comparative average performance of four per cent of GDP, while the pack average (nations shown) was roughly 3.3 per cent. However, in the preceding period between 2001-2005 (yellow circles), Canada finds itself below the pack average of 3.5 per cent²¹, with roughly 3.2 per cent of GDP going to public capital investment. In the earliest period of 1995 to 2000, Canada is even farther below the pack average of 3.6 per cent, with 2.95 per cent.

Referring back to the Canadian capital investment data presented earlier in Figures 1 through 5, we can see a corresponding trend of increasing capital expenditures following the late 1990s. Unfortunately, both the Canadian data and the bulk of OECD nation data used for Figure 6 do

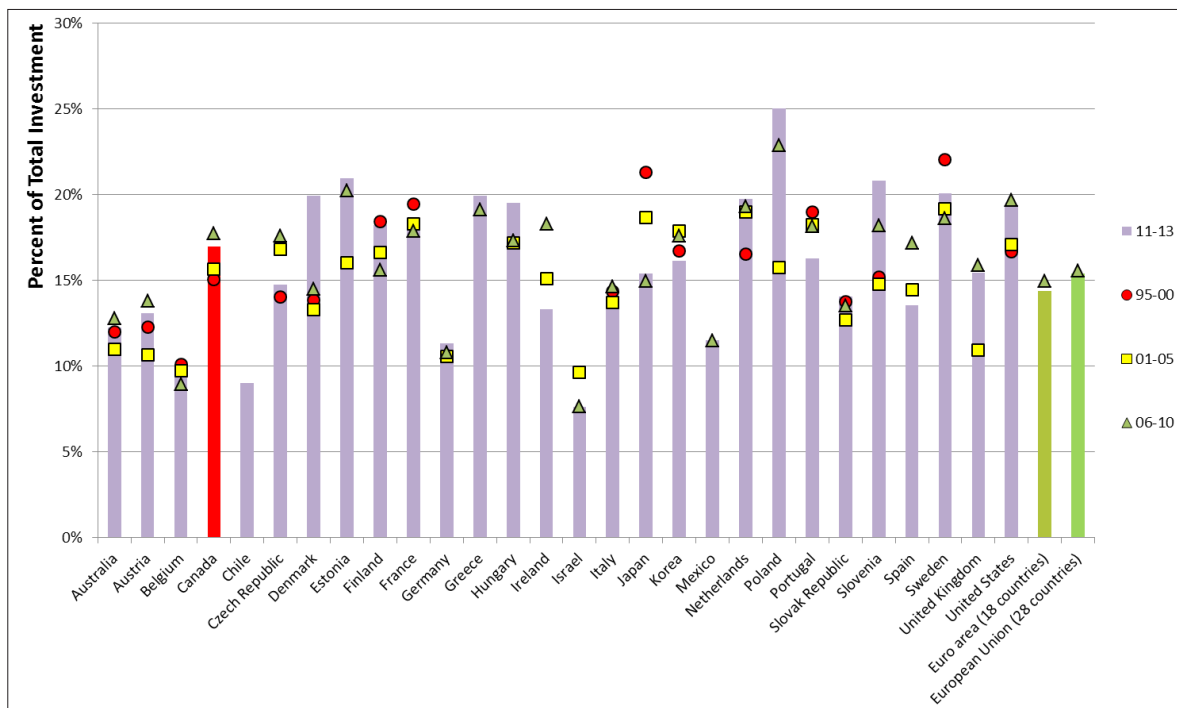
²¹ We do note that Canada was also experiencing rapid GDP growth from an economic boom during this period, and that this may bias the relative performance downward.

not go back any further. In the absence of this data, we cannot make a meaningful evaluation of the comparative trends in capital expenditures over the full course of Canada's prolonged period of declining capital investment following the 1960s. However, what we can see from the available data is that the reversal (from declining to increasing) of Canada's public capital spending trend in the late 1990s did make a meaningful comparative difference with regard to the capital spending of similarly developed nations. Although the trend in spending has been positive in Canada for some 20 years now, it is only in the most recent period that total expenditure levels have been high enough to bring Canada above the pack average.

From Figure 7 we can see that as Canada's period of prolonged capital spending hit a low point in the mid- to late 1990s, Canada had in fact fallen behind other developed nations in terms of capital spending. Conversely, Canada's renewed commitment to capital/infrastructure investment has seen our standing among developed nations substantially improved. However, as this is only with regards to rather recent investment flows, it is entirely likely that the recent uptick in investment has done more to compensate for past shortages, rather than offer any tangible comparative growth relative to other developed OECD nations.

Figure 8 illustrates the percentage of gross fixed capital that is accounted for by national public versus private entities, and thus how public capital spending is keeping pace with private. Similar to Canada, where private capital spending has outpaced public in core areas, the general trend across this select group of OECD nations appears to also show some minor amount of retrenchment in public spending. This is illustrated by the many nations with one or more past period markers clustered at the top of, or sitting above, the bars representing the current period average.

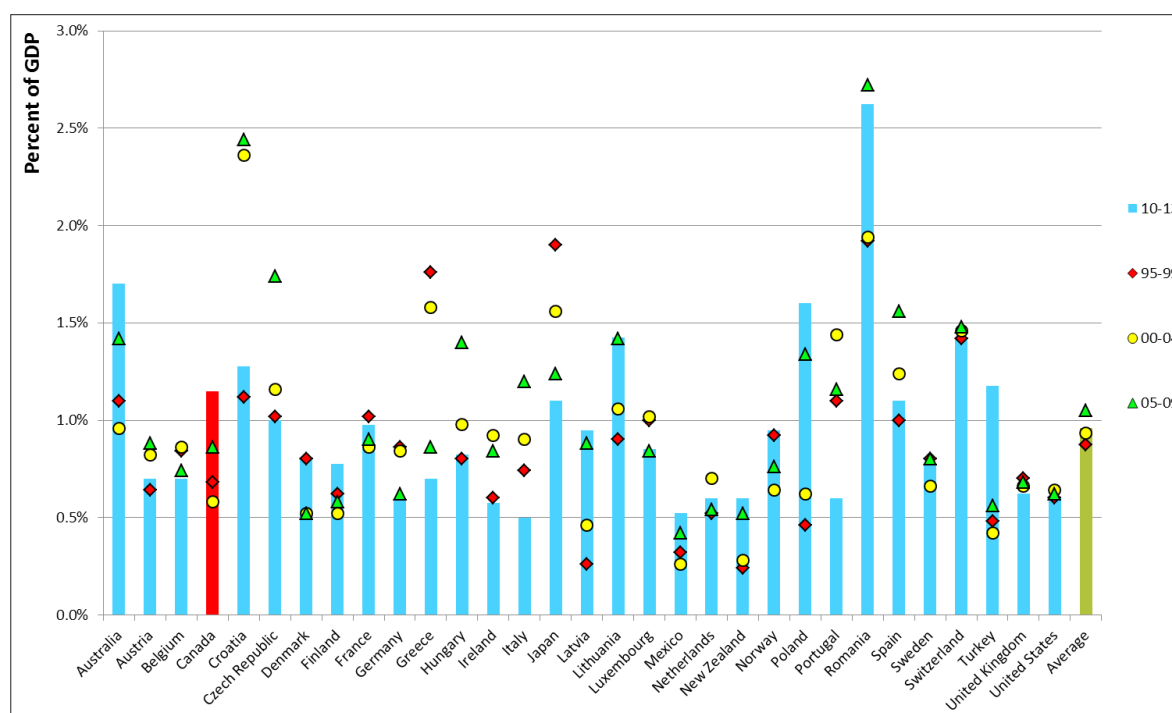
FIGURE 8 GROSS FIXED CAPITAL, PUBLIC INVESTMENT AS A PERCENTAGE OF TOTAL INVESTMENT - OECD SELECT COUNTRIES



Note: Group average represents simple average. Source: OECD Metadata.

Turning to the key category of inland transport infrastructure, we see in Figure 9 a story similar to that in Figure 7 (Public Investment, Gross Fixed Capital Formation - OECD Select Countries). Canada shows relatively good performance in the current period with 1.15 per cent of GDP, over the pack average of 0.96 per cent. However, looking back to past periods, Canada was clearly not performing as well, with spending below the pack average in the three preceding periods. Canada's spending between 2005-2009 represented only 0.86 per cent of GDP, versus a pack average of 1.05. Between 2000 and 2004, Canada spent 0.58 per cent versus a pack average of 0.93, and 0.68 per cent versus a pack average of 0.93 between 1995-1999. We note, however, that over the series, Canada's spending on inland transport infrastructure as a percentage of GDP was consistently higher than that of its North American counterpart, the United States. It grew to nearly double that of the U.S. in the most recent period which has seen Canada's spending increase dramatically.

FIGURE 9 TOTAL INLAND TRANSPORT INFRASTRUCTURE INVESTMENT - SELECT NATIONS



Note: Group average represents simple average.

Source: OECD Metadata.

Though the absence of comprehensive long-running capital flow and stock data prevents us from conducting a more granular analysis²², available data do give us a sense of where Canada currently sits among similarly developed nations. While increased investment in Canada's capital stock has been significant in recent years, a prolonged period of weak investment in past years has had a negative impact on the adequacy and quality of Canada's capital stock, and this continues to be a source of concern for federal and provincial governments.²³

²² This is area of study that would benefit greatly from improved consistency in international data, as well as public access to longer spans of comparative historical data sets, which are currently not available

²³ See the Federation of Canadian Municipalities "Canadian Infrastructure Report Card" & Saeed Mirza's "Danger ahead: the coming collapse of Canadas municipal infrastructure"

CANADA'S INFRASTRUCTURE GOING FORWARD: THE ROLE FOR POLICY

Looking at the current context, we feel there are two policy initiatives that would greatly contribute to increased efficiency in the provision of Canada's public infrastructure, and help bring Canada's capital stock closer to an optimal level. First, there should be a broader implementation of user-pay models to help reduce the tax-financing costs that discourage public infrastructure spending. Second, a provincial body should be developed that would play an active role in evaluating provincial and municipal infrastructure, and act to prioritize financing for those projects which have the greatest merit, and for which public return on investment is greatest.

USER PAY AS A MEANS TO EFFICIENCY

Greater utilization of user-pay pricing models is essential if Canadian governments wish to encourage efficient levels of infrastructure development. As recalled from our earlier theoretical discussion of the rule for optimal infrastructure, the fundamental condition for optimal infrastructure is that the collective benefit of public provision should exceed the collective cost: optimal public infrastructure is determined at the point where the marginal return to capital is equal to the tax-adjusted cost of capital²⁴. If we are to satisfy this condition, it is necessary that we embrace marginal pricing, not simply as a source of revenue, but as a mechanism to establish priced (efficient) demand, and to ensure that incentives for efficient use and decision making on the part of consumers are in place.²⁵

Unpriced access to infrastructure in Canada currently creates incentives for individuals to utilize public infrastructure beyond the point that individual benefits outweigh the associated public costs. By financing infrastructure through indirect means, such as income taxes, governments discourage efficient consumption/utilization decisions by individuals. The absence of direct marginal pricing breaks the link between individual costs and benefits, and eliminates any incentives for individuals to make efficient use of public infrastructure by adopting rationing and/or substitution strategies that would reduce over-utilization of congestible facilities. Pricing forces a trade-off in which an individual must consider if an additional unit of a good or service outweighs the cost necessary to acquire it. When this mechanism is obscured through indirect taxation there is no incentive for individuals utilize public goods and services efficiently, or in a manner that maximizes total public benefit.

The absence of pricing also greatly diminishes the potential for efficient planning and prioritizing of public capital spending on the part of governments.

Planning involves the evaluation of competing alternatives, each with varying cost and benefits characteristics. The problem here is that governments cannot honestly claim to know how their constituents collectively value one alternative over another, as constituents are never forced

²⁴ This further implies that for inframarginal units of capital expenditure, public benefit is in excess of public costs, and that investment is optimal where the excess public benefit (surplus) is fully captured, and marginal benefits and costs are equal.

²⁵ Here we do not discuss the implications of, or means of accounting for, the regressive effects of certain taxes. For a discussion of this topic, see P. Bazel & J. Mintz, "The Free Ride is Over: Why Cities, and Citizens, Must Start Paying for Much Needed Infrastructure," *SPP Research Papers*, May 2014.

reveal their collective preferences²⁶. In a sense, a government cannot plan efficiently in the absence of efficient demand, and demand that is not informed by the true and full cost of goods and services is by definition inefficient. Governments are thus left to budget based on inefficient constituent demands for unpriced infrastructure. This creates political incentives to allocate funding away from capital priorities and essential services which are priced, in order to satisfy voter demands for the expansion of competing forms of unpriced infrastructure.

If we want to encourage the efficient use of public infrastructure, it is essential that prices reflect the full costs associated with individual demands and inform the choices that individuals make. Only when individual preferences are revealed in a priced context will governments or private developers know where, when and how much infrastructure is economically efficient. Only then can we move toward an optimal level and mix of core public infrastructure.²⁷

AN EXPANDED MANDATE FOR PROVINCIAL CAPITAL FINANCE AUTHORITIES

It is important to recognize that over the past 60 years, municipalities have become increasingly responsible for the management, maintenance and provision of infrastructure. In our 2012 paper “The Free Ride is Over”²⁸ we take an extended look at this trend and its implications, highlighting the shift in capital stock held and financed by each order of government between 1960 and 2011. We find that during this period, the municipally held share of the total public capital stock rose from roughly 22 to 49 per cent, and further that this shift of capital stock assets took place primarily from the federal level to the municipal level. Over this period, municipalities also saw increased federal and provincial transfers to help deal with the cost of their newly acquired responsibilities.^{29 30}

In our 2012 paper, we present arguments concerning the problematic nature of intergovernmental transfers to fund capital projects. We continue to feel that intergovernmental transfers undermine political accountability by lowering the own source cost of provincial and municipal governments, and thus the political cost of capital projects.³¹

²⁶ Revealed preference is a basic economic concept which essentially says that we cannot know how much someone values a good or service until we force them to trade some of their hard-earned and limited resources (money) to attain it. In the context of public capital, this implies that a planner can only know how much someone (much less their collective constituents) values a good or service by forcing an incremental trade-off to attain incremental access, i.e. by pricing it. Furthermore, unless consumers are allowed to choose freely from among competing alternatives with varying benefit characteristics and costs, no one can honestly claim to know where they find value, or judge how they value a given good, relative to any other good, in a monetary sense.

²⁷ For an expanded discussion on the forms of infrastructure which are best suited to the use of user-pay financing models, please see the section entitled “User Fees” in our 2012 paper.

²⁸ P. Bazel & J. Mintz, “The Free Ride is Over: Why Cities, and Citizens, Must Start Paying for Much Needed Infrastructure,” *SPP Research Papers*, May 2014.

²⁹ IBID. See the section entitled “Public Funding of Urban Infrastructure.”

³⁰ Our findings echo those of Harchaoui, Tarkhani and Warren: “Public Infrastructure in Canada, 1961-2002,” *Canadian Public Policy/Analyse de politiques* 30(3), 303-318, 2004.

³¹ For an extended discussion, see P. Bazel & J. Mintz, “The Free Ride is Over: Why Cities, and Citizens, Must Start Paying for Much Needed Infrastructure,” *SPP Research Papers*, May 2014.

However, we recognize that Edward Gramlich³² and others have made the case that federal grants which account for the value of positive spillovers, or benefits accruing to users who do not reside in a particular jurisdiction, are justified, if measurable, insofar as they are proportionate to such spillovers. However, as provinces are constitutionally responsible for municipalities, we would argue that federal infrastructure funding should focus on federal responsibilities — especially with respect to transportation infrastructure.³³

To this point, and consistent with our earlier work, we continue to see the potential for municipalities to undertake increased infrastructure development with their own source revenues, supplemented by provincial transfers when appropriate.

Currently, a significant portion of municipal infrastructure is financed through a combination of federal and provincial government money that trickles down to municipalities in the form of conditional and unconditional capital grants. In addition, provinces also establish capital finance authorities to help municipalities access debt under preferential terms.

With respect to municipal capital financing, the provinces create authorities (PCFA) that function as provincial lending institutions through which municipal governments can access debt to finance capital projects. PCFAs consolidate borrowing on behalf of many municipalities and issue rounds of bonds representing the collective municipal debt. In this way, municipalities are able to reduce the administrative and transaction costs associated with individual bond issuances, and are further benefited by access to the provinces' preferential AAA borrowing rate. The PCFAs currently operate largely as passive institutions that simply lower the borrowing costs for municipalities.

We believe that a new provincial institution with an expanded mandate could be built on this foundation. This institution would develop a common process for structuring loans and selecting projects from among municipal loan applications. Unlike the current passive PCFA, it would have the capacity to:

- 1) Prioritize financing for proposed capital projects which can be shown to contribute to efficiency and an optimal allocation of public resources;
- 2) The institution would have some degree of authority to offer financing incentives on a project-by-project basis for proposals that embrace efficient economic planning, such as user-pay financing models and real-time variable pricing where appropriate;
- 3) The institution would retain a staff with the inbuilt capacity to evaluate and aid in the development of large-scale infrastructure projects from the perspectives of design, engineering, financing and economics. Proposal design aid and evaluation would be based on a transparent and open process, and driven by clearly defined merit-based criteria. This process would be designed to enhance the allocative efficiency of infrastructure resources.

³² Edward Gramlich, "Infrastructure Investment: A Review Essay," *Journal of Economic Literature*, Vol. XXXII, September 1994, pp. 1176-1196.

³³ We purposely stray from a discussion of the federal role in infrastructure spending. Some evidence suggests transportation infrastructure spillover effects are not significant across state boundaries for road and highway transportation, implying that provincial rather than state level grants are more appropriate to consider (E. Gramlich, "Infrastructure Investment: A Review Essay," *Journal of Economic Literature*, Vol. XXXII, September 1994, pp. 1176-1196). In a companion paper, B. Dahlby and E. Jackson focus on inter-governmental grants in "An Analysis of Federal Infrastructure Programs," forthcoming 2015.

This process would also aim to identify and work to minimize the allocation of capital based on short-term political incentives.

As such, these new provincial institutions would have some ability to further lower the borrowing cost of municipal projects which contribute to efficiency. However, the mandate might allow for the extension of additional borrowing incentives for both public and private projects which can be shown to offer the potential for significant positive externalities, or contribute to social or environmental development goals. It is often impossible to fully monetize the benefit streams accruing to projects that generate positive spillovers, and though these projects may offer significant public benefits over and above the monetary return on investment, they may not be developed based on less competitive private returns to capital investment. As such, there can be underinvestment in these types of socially valuable projects which offer positive externalities but may not offer the most competitive return among a portfolio of competing investments. In this case, a provincial institution might be justified in lowering the cost of capital for a private project, subsidizing some degree of the borrowing cost, in effect increasing the project's return to investment such that it is competitive from an investment standpoint. Though this role is not a central or necessary function of the institution we propose, such a role in subsidizing capital projects that can be shown to offer significant positive externalities would be justified on the grounds of economic efficiency, in that the total public return to the investment (subsidy for the project) would produce public benefits over and above the costs incurred.

To restate the central function of the proposed provincial institution, at the most basic level it would consider municipal project proposals in contrast to one another, and in relation to larger development and economic principles established at the provincial level. Through this process, it would assess the degree to which projects competing for investment capital satisfy criteria for economic efficiency and optimal resource allocation, and should thus be given priority access to financing. Further additional financing incentives might be offered to incent design criteria such as utilization of user pay, rather than tax financing. Finally, as mentioned above, the mandate might be expanded to offer some degree of subsidy for private projects which include substantial social, environmental or development goals. This subsidy could potentially include simply passing on the province's preferential borrowing cost for some degree of the project's financing, effectively lowering borrowing cost and thus increasing the rate of return on the project.

We note that this evaluative body for public infrastructure could operate as a non-profit corporation. It would not have a banking function unless governments enabled the corporation to provide loans from public and private funding as well as financial surpluses generated by the corporation. Consumer pricing as discussed above would best create such financial surpluses. Outright privatization should also be pursued if the need for public ownership cannot be demonstrated.

PROJECT SELECTION AND EVALUATION AT THE PROVINCIAL AND FEDERAL LEVEL

Though the type of institution discussed above would be designed in the context of capital financing for municipalities, much as the current capital finance authorities are, aspects of institution and its intended mandate would be equally suited to contribute to more effective provincial and federal project evaluation. As described above, provincial and federal

governments can already directly access debt financing on preferential terms, and thus this aspect of the provincial-municipal institution is not relevant for provincial and federal projects. However, we would argue that provincial and federal governments could produce more effective infrastructure outcomes in Canada if similar federal and provincial institutions with mandates to undertake arm's-length, criteria-based evaluation of large-scale capital projects and competing financing proposals were implemented. These institutions would be organized around a common process for project evaluation and would play an active role in the evaluation and prioritization of competing infrastructure priorities, embedded in an institution at arm's length from government. They would function according to the same mandate described above and help Canada's federal and provincial governments approach a more optimal level and distribution of infrastructure resources.

The institution would also retain a staff with the inbuilt capacity to evaluate and aid in the development of large-scale infrastructure projects from the perspectives of design, engineering, financing and economics. Project evaluation would be based on a common approach to a transparent and arm's-length process driven by clearly defined criteria and based on project merit. This process would be designed to enhance the allocative efficiency of infrastructure resources, and would also aim to identify and work to minimize the allocation of capital based on political influence and incentives.

The federal government continues to administer important infrastructure projects such as border facilities (Windsor bridge, ports, etc.), as do the provincial governments (highway networks, health, education). So a body at the federal level makes sense just as at the provincial level.

CONCLUSIONS

In undertaking an analysis of the determinants of adequate public capital stock, or optimal public capital spending, it is necessary to consider both the degree to which governments have undertaken the privatization of core public infrastructure, and the degree to which they may privatize further. If governments in Canada wish to advance the quality of core public infrastructure, at present the greatest potential to do so may well be to accelerate the trend which has been witnessed in the past 35 years, and re-examine areas of core public infrastructure which might be shifted from public to private supply by the implementation of user pricing.

In this paper we have developed and presented a rule for determining the optimal level of public infrastructure. This rule suggests that the optimum is achieved when the marginal return to infrastructure investments is equal to the cost of debt finance, accounting for the economic cost of taxation. We wish to note here that the economic cost of taxation is (or should be) a non-trivial concern for governments, and that where possible, governments would benefit their constituents by implementing user-pay models of finance for public capital, rather than relying on indirect income taxation that reduces the returns to productive activity.

Looking at the Canadian experience over the past 20-25 years, we must conclude that it is highly likely declining levels of investment into the late 1990s saw Canada underinvest in its public capital stock. However, at present, Canada is one of the largest spenders on infrastructure among the OECD countries, and this effort to renew Canada's capital stock has tangibly reduced the

average age of infrastructure. In addition, Canada has made a significant shift from public to private infrastructure for certain services, particularly communications and broadband, where public infrastructure is now a very small portion of total infrastructure spending.

Finally, we have presented two possible avenues that we urge policy makers to consider as they work to address Canada's infrastructure needs in the coming years. Most essential is simply a move away from tax financing, in favour of a greater reliance on direct consumer pricing for infrastructure. In addition, we advocate for the development of a more transparent approach to measuring the cost-benefit returns to public infrastructure spending, through the adoption of public bodies that evaluate and prioritize projects independent of the political incentives and vote-getting of priorities which often shape capital budgets.

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Philip Bazel is a research associate at The School of Public Policy and specializes in tax and infrastructure policy.

Jack M. Mintz is the President's Fellow of the School of Public Policy at the University of Calgary after serving as the Palmer Chair and Director since 2008.

He also serves on the boards of Imperial Oil Limited, Morneau Shepell and is chair and Vice-President of the Social Sciences and Humanities Research Council of Canada.

Widely published in the field of public economics, he was touted in a 2004 UK magazine publication as one of the world's most influential tax experts. He serves as an Associate Editor of *International Tax and Public Finance* and the *Canadian Tax Journal*, and is a research fellow of CESifo, Munich, Germany, and the Centre for Business Taxation Institute, Oxford University.

Dr. Mintz has consulted widely with the World Bank, the International Monetary Fund, the Organization for Economic Co-operation and Development, federal and provincial governments in Canada, and various businesses and non-profit organizations. In 2015, he received the Order of Canada.

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