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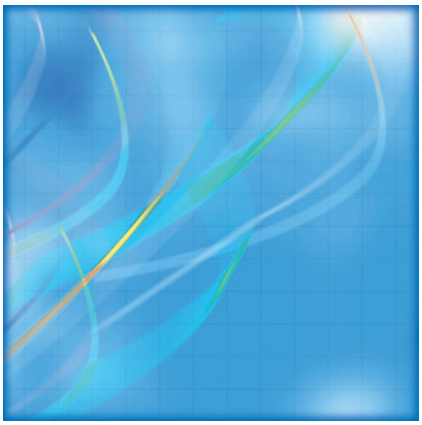
Public infrastructure in Canada: Where do we stand?



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'The third and last duty of the sovereign or commonwealth is that erecting those public institutions and those public works, which, though they may be in the highest degree advantageous to a great society, are, however, of such a nature that the profit could never repay the expense to any individual or small number of individuals.'

Adam Smith, The Wealth of Nations

Abstract

Roads, railways, bridges, water systems, power plants, telecommunication facilities, ports and airports are components of the infrastructure that are vital to the economic activity. Recently, the notion of infrastructure has become an important item of the Canadian public policy debate. This study sheds some light on four main questions: a) How large is public infrastructure in Canada b) What are the main components of that infrastructure? c) How has that infrastructure evolved over the last forty years in Canada? and d) To what extent has public infrastructure contributed to the growth of Canada's standard of living and the performance of Canadian businesses?

1. Public infrastructure in perspective

Government can try to improve living conditions in various ways: it can stimulate private and foreign investment, spend more on education and health programs in order to enhance human capital, preserve the environment, or it can add to the stock of public capital. The past few years have witnessed growing awareness that the stock of public capital has been neglected by many OECD countries.[1]

Almost everyone has experienced the frustration and delay of congestion on overburdened motorways. The deteriorating quality of roads, bridges, and sewer systems can lead to serious economic problems—from congested streets and highways, bursting water mains, crowded public schools, and an overburdened criminal justice system. The debate on macroeconomic consequences of the declining stock of public capital has been quite vigorous in the United States where it has become an important topic on the political agenda. Recently, the issue of inadequate public investment has come to the forefront in Canada.

Despite the favourable economic news of the second half of the 1990s—low unemployment, low inflation, a budget surplus, and a healthy economic growth—concerns about an "infrastructure crisis," which first arose during the early 1990s, have persisted. And there is reason to be concerned. Economic growth has pressed the capacity of Canada's public capital infrastructure, because public capital investment has not kept pace with the growing economy.

[1] The ratio of public investment to GDP declined in the majority of OECD countries, with the exception of Spain and Portugal. In order to become more competitive with the European Union, these two countries undertook extensive programs of upgrading their stock of public capital.

At the same time, budget concerns have shifted from how to get rid of the federal deficit to what to do with the surplus. Should we pay down the national debt, cut taxes, or restore funding to some of the many spending programs that were cut in order to balance the budget?

Public infrastructure has contributed substantially to the Canadian economic development over the last century.[2] Public investment in canals, highways, and airports has supported the transportation sector, while public investment in roads, sewers, and water treatment facilitated urban expansion.

Some recent studies have indicated that expenditures on public investment have more of an impact on productivity than do expenditures on private investment. But even if the impact of public and private investment on economic growth is roughly comparable, the recent trends should provide ground for concern, since we have seen a decline in public investment with no offsetting rise on the private side. This shortfall raises questions about whether Canada will have the appropriate infrastructure to support its living standards.

2. What do we mean by public infrastructure?

Before describing trends in public capital outlays, it is necessary to define the concept of investment. More details are also available in the methodological box below.

Statistics Canada defines investments as expenditures on goods intended to be used as capital goods in the production process. In general, these are goods with an expected lifespan of more than one year and involve new fixed capital formation as well as replacement investments. All expenditures on capital goods of the government are classified as investment of public administration, subdivided into federal, provincial and territorial and local governments. Capital outlays of publicly-owned enterprises are not counted as part of public administration capital spending. Public utility firms engaged in activities such electric generation, gas distribution and water supply are excluded. In the Canadian System of National Accounts (CSNA), all such firms come under the heading of the business sector.

Furthermore, investment in military equipment is classified as being for public consumption and therefore does not fall under the CSNA's coverage of public investment. Public purchases of land are also excluded by definition.

[2] Firestone (1959, 118) summarized the situation as follows: 'In the direct field the most important developmental projects were concerned with transportation. Railway tracks were laid linking the Pacific with the Atlantic Ocean and supplementary feeder lines were constructed. Harbour facilities were expanded, particularly in Eastern Canada, to encourage overseas trade. Canals were built, principally in the Great Lakes-St. Lawrence region, to help provide low cost inland transportation. The guiding principle behind these federal investment projects was to raise the efficiency of the national economy. But assistance was also given to private venture [....]. As agriculture in the Prairie Provinces became a major factor in export trade, private interests built substantial storage and related facilities, particularly grain elevators, and the federal government aided the transhipment of grain by adapting railway and harbour facilities to the needs of transporting large quantities of bulk commodities.'

Methodology

A specific terminology is used by economist statisticians to describe capital stock estimates and their construction. Relevant methodologies and concepts are presented in this box to facilitate subsequent exposition.

Capital stock is a measure of the amount of capital in existence at a particular point of time, e.g. December 31, 2002. Investment, a flow concept, is a measure of the additions to capital stock over a particular time period, e.g. from January 1, 2002 through December 31, 2002.

An asset must be durable to be classified as capital. The convention is that any asset expected to be in service for at least one year is categorized as capital, if an asset is expected to be in service for less than one year it is categorized as a consumption good. Exceptions to this rule exist. For example, consumer durables, such as cars and refrigerators, are classified as consumption in the Canadian System of National Accounts, but are treated as capital in the construction of the Canadian Balance Sheet Accounts and the capital input employed in the Canadian Productivity Accounts. A similar treatment is performed by other statistical offices around the world.

Estimates of Canadian public capital stock include fixed tangible assets and intangibles such as software capital. Fixed assets are non-financial produced assets which are used in a production process. Fixed tangible assets are best defined by example as the adjective "tangible" is not sufficiently definitive. Tangible assets include dwellings, other buildings and structures, machinery and equipment.

Capital stocks are measured by the census method or by the perpetual inventory method. Under the census method, capital stock is counted. The sheer magnitude of the enumeration task makes this an unattractive option. The task is further complicated by the need to devise a methodology sufficient to count or aggregate heterogeneous assets. Virtually all statistical offices who have constructed estimates of public capital stock have used the perpetual inventory system.

To construct net capital stocks with the perpetual inventory method, information on investment and asset deterioration is needed at a minimum. Expenditures on public assets are investments. Since assets frequently last for many years and expenditures are often not available over the entire time period, a benchmark or starting point for the capital stock, is also commonly needed. Gross capital stock is calculated by simply adding up investment or expenditure on public capital and deducting retirements or assets withdrawn from service. Net capital stock, which is the stock concept used in the present study, requires that gross capital stock be reduced by the amount of wear and tear on the asset as it ages and asset retirements. Depreciation captures the effect of wear and tear on the productive capacity of the asset.

The data on public infrastructure used in this paper are from Statistics Canada's Investment and Capital Stock Division (see Statistics Canada 2001). The remaining data are from the balance sheet accounts and income and expenditures accounts.

Public investment is generally subdivided into the following categories:

- Public expenditures for the construction and renovation of government buildings;
- Public expenditures to carry out civil engineering works (infrastructure);
- Public expenditures on machinery and equipment used by the public administration.

Investments in health and education are maintained separately from those made by the public administration.

Table 1 shows the structure of the overall public investment (public administration, health and education) in Canada by main category of asset. Overall public investment reached a high of

$30.6 billion in 2002 of which public administration was responsible for 57.9%, compared to 25.8% for health care and social assistance and 16.4% for educational services. Although public administration still accounts for the bulk of the overall public investment, its share has declined since 1961 when it represented 63.3%. During the same period, public investment in infrastructures lost significant ground (from 69.2% in 1961 to 48.6% in 2002) primarily to the benefit of machinery and equipment (from 10.7% to 32.2%), reflecting large commitments that governments made to assets related to information technology.

Table 1. The structure of overall public investment in Canada (current prices)

		Educational Services				Health care and social assistance				Public administration				
	Total	Total components		Building construction	Machinery and equipment	Total components		Building construction	Machinery and equipment	Total components		Building construction	Engineering construction	Machinery and equipment
	$B	$B	%	$B		$B	%	$B		$B	%	$B		
1961	2.0	0.4	18.2	0.3	0.0	0.4	18.5	0.3	0.1	1.3	63.3	0.3	0.9	0.1
1973	4.7	0.7	15.9	0.6	0.1	0.7	15.0	0.5	0.2	3.3	69.1	0.6	2.3	0.4
1979	7.8	0.9	12.1	0.7	0.2	1.3	16.0	1.0	0.3	5.6	71.8	0.9	3.9	0.7
1988	17.3	2.3	13.2	1.6	0.7	3.5	20.4	2.1	1.4	11.5	66.4	2.0	6.5	3.0
2002	30.6	5.0	16.4	3.5	1.5	7.9	25.8	4.7	3.2	17.7	57.9	3.4	8.6	5.7

Note: The portion of the private sector in health and education was excluded.

3. How large is public infrastructure capital in Canada?

The stock of public capital in Canada is very large,—$227.5 billion in 2002 (Table 2) or about 20% the size of the business sector capital stock. About half of that public capital stock is held by local government, compared to 1/3 for the provincial and territorial governments and slightly less than 1/5 for the federal government. This contrasts markedly with 1961 when public capital was worth $13.6 billion, representing 30% of the business sector capital stock. In 1961 the federal government owned 39.1% of that capital, compared to 35% for its provincial counterpart and 25.9% for the local government. Over the last forty years, the share of federal government in total public capital experienced a steady decline, while local government almost doubled its share during this period.

Table 2. Capital stock of public administrations in Canada

	Total	Federal		Provincial		Local	
	$Billion	$Billion	%	$Billion	%	$Billion	%
1961	13.6	5.3	39.1	4.8	35.0	3.5	25.9
1973	39.0	10.2	26.1	16.5	42.3	12.3	31.6
1979	83.5	17.7	21.2	37.4	44.8	28.4	33.9
1988	153.1	29.6	19.3	63.7	41.6	59.8	39.1
2000	219.1	38.0	17.3	78.2	35.7	102.9	47.0
2002	227.5	40.1	17.6	77.9	34.3	109.5	48.1

Note: Net of linear depreciation

In 2002, public infrastructure (civil engineering works) capital stock was worth $157.3 billion, representing almost 70% of the overall public capital stock, virtually unchanged since 1961 (Table 3). Local government accounted for about half of total public infrastructure capital, compared to 40.8% for the provincial government and a modest 6.8% for the federal government. Since the early 1960s, the bulk of public infrastructure capital stock was under the ownership of the provincial and local governments (respectively 45.3% and 30.9%), compared to about ¼ for the federal government.

Table 3. Infrastructure capital stock of public administrations in Canada

	Total		Federal			Provincial			Local		
	$Billion	Share of Total Capital Stock of Pubic Administrations (%)	$Billion	Share of Federal Infrastructure Capital in the Public Administration Infrastructure Capital (%)	Share of Federal Infrastructure Capital Stock in the Federal Total Capital Stock (%)	$Billion	Share of Provincial Infrastructure Capital in the Public Administration Infrastructure Capital (%)	Share of Provincial Infrastructure Capital Stock in the Provincial Total Capital Stock (%)	$Billion	Share of Local Infrastructure Capital in the Public Administration Infrastructure Capital (%)	Share of Local Infrastructure Capital Stock in the Local Total Capital Stock (%)
1961	9.3	68.4	2.2	23.9	41.7	4.2	45.3	88.5	2.9	30.9	81.5
1973	29.2	74.9	4.4	15.1	43.3	14.6	50.1	88.7	10.2	34.8	82.5
1979	64.4	77.2	7.7	12.0	43.4	33.2	51.5	88.7	23.6	36.6	83.1
1988	113.7	74.3	10.9	9.6	36.8	54.4	47.8	85.3	48.5	42.6	81.0
2000	155.2	70.9	11.2	7.2	29.5	65.1	41.9	83.3	78.9	50.9	76.7
2002	157.3	69.1	10.6	6.8	26.5	64.3	40.8	82.4	82.4	52.4	75.3

Note: Net of linear depreciation

In 2002, federal public capital infrastructure represented only 1/4 of the overall federal public capital, a sharp decline since 1961 when this proportion was 41.7%. By contrast, ¾ of local public capital is accounted for by infrastructure, compared to about 80% at the provincial level. Both provincial and local public capital infrastructure saw their share decline slightly since 1961 (respectively, from 88.5% to 82.4% and from 81.5% to 75.3%).

Public capital infrastructure consists of different categories of assets that ultimately reflect the variety of 'services' that public infrastructure capital provides to the population. These assets, listed in Table 4, range from parking lots, bridges, communication towers, electric power construction, canals and waterways, sewage systems, waste disposal facilities, historical sites to roads and highways.

Table 4. The structure of public infrastructure capital stock by asset (current prices)

	1961		1973		1979		1988		2000	
	$Billion	%	$Billion	%	$Billion	%	$Billion	%	$Billion	%
	Local public infrastructure capital stock									
Highways and roads	1.4	47.9	5.0	48.8	11.1	47.0	20.8	42.9	35.5	45.0
Sewage treatment	0.3	11.2	1.2	11.4	2.8	11.9	6.3	13.0	9.6	12.2
Sanitary sewers	0.4	12.8	1.3	13.1	3.3	13.8	7.5	15.5	13.7	17.3
Bridges	0.1	4.2	0.4	4.0	1.0	4.3	2.2	4.6	3.5	4.4
Canals and waterways	0.1	3.9	0.5	4.5	1.2	5.1	3.0	6.2	4.5	5.7
Outdoor recreational	0.1	4.7	0.4	4.3	1.1	4.6	2.2	4.6	3.2	4.0
Waste disposal facilities	0.1	2.9	0.3	2.5	0.6	2.6	1.2	2.4	1.5	1.9
Irrigation facilities	0.1	5.2	0.5	5.0	1.0	4.4	2.2	4.5	2.9	3.7
Other	0.2	7.1	0.7	6.4	1.5	6.4	3.1	6.3	4.5	5.7
Total	**2.9**	**100.0**	**10.2**	**100.0**	**23.6**	**100.0**	**48.5**	**100.0**	**78.9**	**100.0**
	Provincial public infrastructure capital stock									
Highways and roads	2.9	68.4	10.2	69.4	22.6	68.1	34.9	64.2	44.7	68.7
Bridges	0.3	7.7	1.1	7.3	2.6	7.9	5.0	9.2	6.2	9.5
Sewage treatment	0.2	4.2	0.6	4.2	1.5	4.4	2.7	5.1	2.5	3.9
Sanitary sewers	0.2	4.3	0.6	4.4	1.5	4.7	3.0	5.5	3.1	4.7
Canals and waterways	0.1	2.0	0.3	2.2	0.9	2.6	1.8	3.4	2.1	3.2
Reservoirs	0.1	1.5	0.2	1.5	0.5	1.4	0.8	1.5	0.9	1.4
Outdoor recreational	0.1	2.4	0.3	2.2	0.8	2.3	1.3	2.3	1.1	1.6
Irrigation facilities	0.1	2.1	0.3	2.0	0.6	1.8	1.1	2.0	1.1	1.7
Other	0.3	7.5	1.0	6.8	2.3	6.8	3.7	6.8	3.4	5.2
Total	**4.2**	**100.0**	**14.6**	**100.0**	**33.2**	**100.0**	**54.4**	**100.0**	**65.1**	**100.0**
	Federal public infrastructure capital stock									
Highways and roads	0.4	18.6	0.9	19.6	1.5	19.9	2.0	18.1	2.1	18.9
Trunk and distribution mains	0.2	7.4	0.3	7.7	0.6	8.0	1.0	8.9	1.1	9.4
Docks, wharfs, piers, terminals	0.2	10.8	0.5	11.6	1.0	12.7	1.6	14.8	1.4	12.6
Sewage treatment	0.1	5.9	0.3	6.1	0.5	6.3	0.8	7.0	0.8	7.0
Sanitary sewers	0.2	9.0	0.4	9.6	0.8	10.0	1.2	11.4	1.3	11.8
Runways	0.1	4.3	0.2	3.9	0.3	3.6	0.3	3.0	0.3	3.1
Rail track	0.1	2.3	0.1	2.6	0.2	2.5	0.2	1.9	0.3	2.8
Bridges	0.0	2.1	0.1	2.2	0.2	2.4	0.3	2.6	0.3	2.8
Electric power construction	0.2	8.5	0.3	7.8	0.5	6.9	0.6	5.9	0.4	3.8
Communication towers	0.1	2.4	0.1	2.0	0.1	1.5	0.1	0.6	0.1	1.3
Other Communication	0.1	2.7	0.1	2.0	0.1	1.5	0.1	0.6	0.1	1.2
Canals and waterways	0.0	1.2	0.1	1.5	0.1	1.7	0.2	2.2	0.3	2.5
Reservoirs	0.1	2.3	0.1	2.6	0.2	2.6	0.3	2.6	0.2	2.2
Outdoor recreational	0.0	1.6	0.1	1.5	0.1	1.6	0.2	1.6	0.3	2.4
Irrigation facilities	0.0	1.8	0.1	2.0	0.2	2.0	0.2	2.1	0.2	1.8
Other	0.4	19.0	0.8	17.5	1.3	17.0	1.8	16.7	1.8	16.3
Total	**2.2**	**100.0**	**4.4**	**100.0**	**7.7**	**100.0**	**10.9**	**100.0**	**11.2**	**100.0**

Although the structure of public capital infrastructure by asset type varies considerably for each level of government, provincial and local public infrastructure capital are concentrated in highways and roads. In 2000, this capital asset accounted for 69% of the provincial infrastructure capital, compared to almost 50% for its local counterpart—unchanged since 1961. Far behind highways and roads, bridges represented the second largest asset in the composition of the provincial public infrastructure capital, accounting for a modest 10%. In contrast, sewer facilities is the second largest asset for local public capital infrastructure, accounting for almost one third of the local government capital infrastructure.

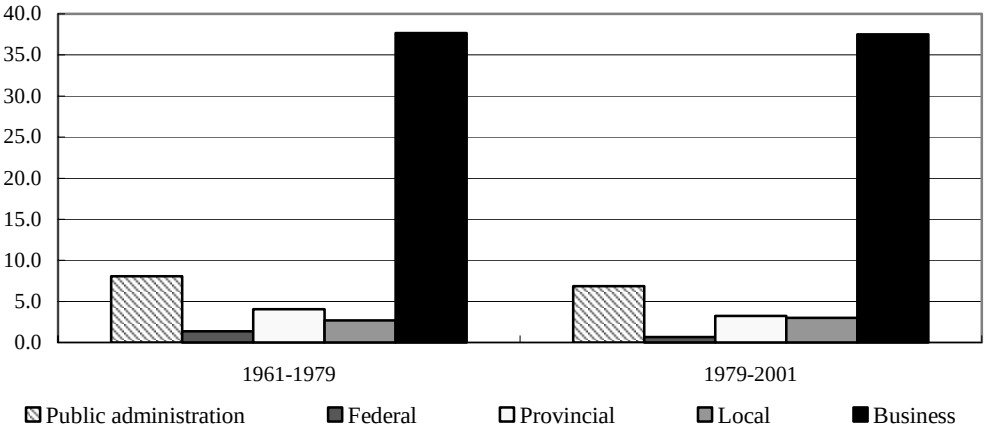
Although highways and roads is still the largest asset in the composition of the federal government infrastructure capital stock, it accounted for slightly less than 1/5 of the federal government capital infrastructure, followed closely by assets such as sewer facilities and docks and wharfs.

4. Historical trends of public infrastructure

Canada, like many other countries, invests heavily in its public infrastructure capital stock. Such capital formation is needed for a strong, flexible, and vibrant economy. Workers need to ride the subway or drive their car to get to work; companies need to ship goods; manufacturers need to use water and dispose of waste.

Yet over the past three decades the ratio of public infrastructure capital has slipped in Canada in comparison to the overall tangible produced capital stock—residential and non-residential structures, machinery and equipment, consumer durable goods and inventories. As Figure 1 indicates, it climbed as high as 8.1% in the 1960s and the 1970s, but dipped as low as 6.9% in the 1980s and 1990s and was only 5.5% in 2001. Meanwhile, the share of the business sector capital stock—equipment such as trucks, trains, and planes and structures such as office buildings, factories, and warehouses—in the overall tangible produced capital stock stood unchanged at 38%. This suggests that the business sector capital stock has increased the demands placed on the available public infrastructure facilities. This drop in public capital led to the concerns about an “infrastructure crisis” that were prevalent in policy discussions of the early 1990s.

Figure 1. Share of public infrastructure capital stock and business' sector capital stock in the national tangible produced capital stock (percentage)



Note: Tangible produced capital: Residential and non-residential structures, machinery and equipment, durables, consumer durables and inventories

This decline in the ratio of public capital infrastructure is largely attributable to the federal and provincial components which saw their share declining substantially (respectively by 46% and 20%). In contrast, the share of local government capital infrastructure in the national tangible produced assets increased slightly during the same period.

When capital stock is expressed as a ratio to the national tangible produced capital stocks, sewage facilities experienced a steady long-term increase from 0.57% to 0.88% between 1961 and 2001, albeit with moderate cyclical fluctuations (Figure 2a). Others like canals and waterways also increased until 1996 and fell off substantially in the subsequent period (Figure 2b).

Figure 2a. Share of the local government infrastructure capital stock by asset class in the national tangible produced capital stock (percentage)

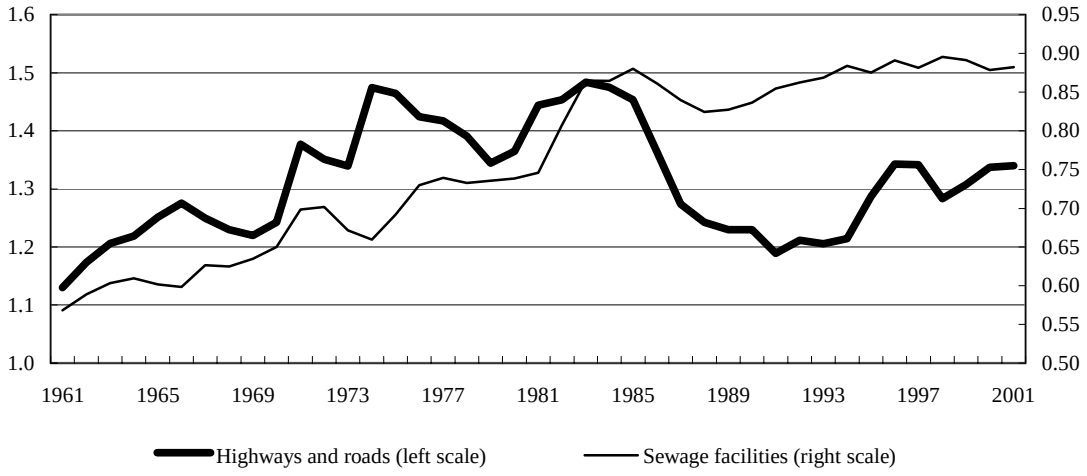
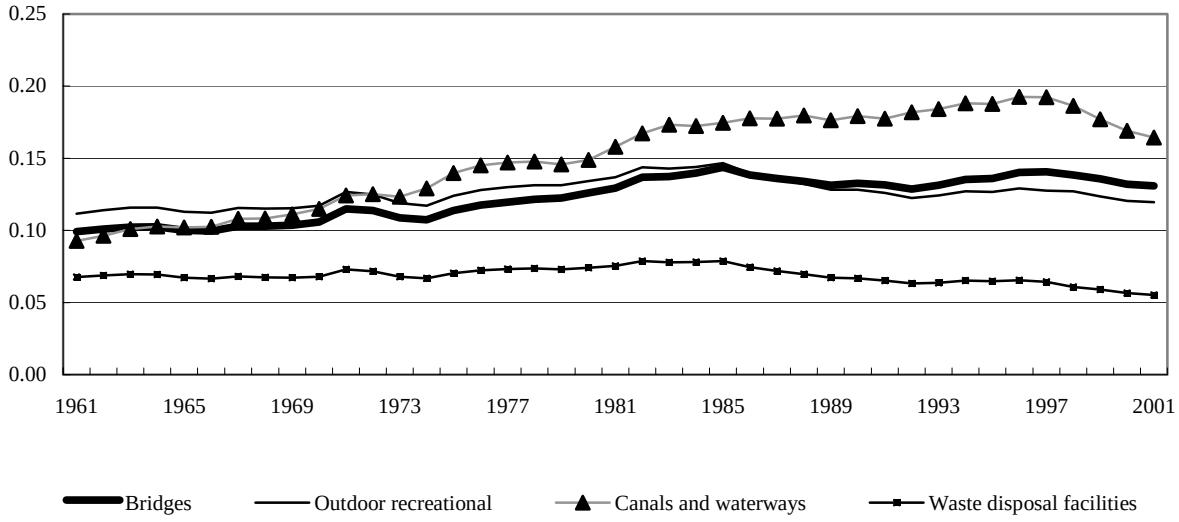
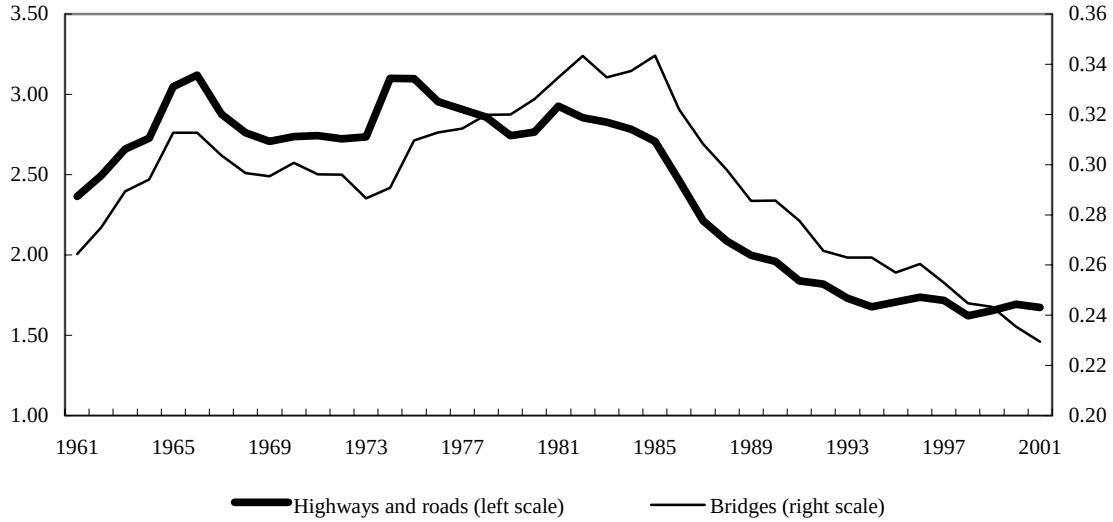


Figure 2b. Share of the local government infrastructure capital stock by asset class in the national tangible produced capital stock (percentage)



The other major local infrastructure capital assets like highways and roads, bridges, outdoor recreational facilities begun to decline in the early 1980s. Of these assets, though, only highways and roads started to recover in the second half of the 1990s, but their ratio to the national tangible produced capital stock still remains below the heights of the early 1980s. In contrast, its provincial counterpart experienced a steady decline.

Figure 3. Share of the provincial government infrastructure capital stock by asset class in the national tangible produced capital stock (percentage)



5. How valuable is public infrastructure?

Having documented the major trends of public infrastructure capital in Canada, we now turn to quantify its relevance in the Canadian economy both in terms of the following economic indicators: GDP per unit of public infrastructure capital stock, public infrastructure capital per person and the business sector's cost savings associated with the use of public infrastructure capital. Each of these indicators is discussed below.

Production activity combines not only labour and private capital but also public infrastructure capital to produce a variety of goods and services measured by real GDP. Labour productivity (GDP per unit of labour) and private capital productivity (GDP per unit of private capital) are partial productivity indicators that measure the extent to which the production process is becoming more efficient in terms of its use of each of these marketed inputs.

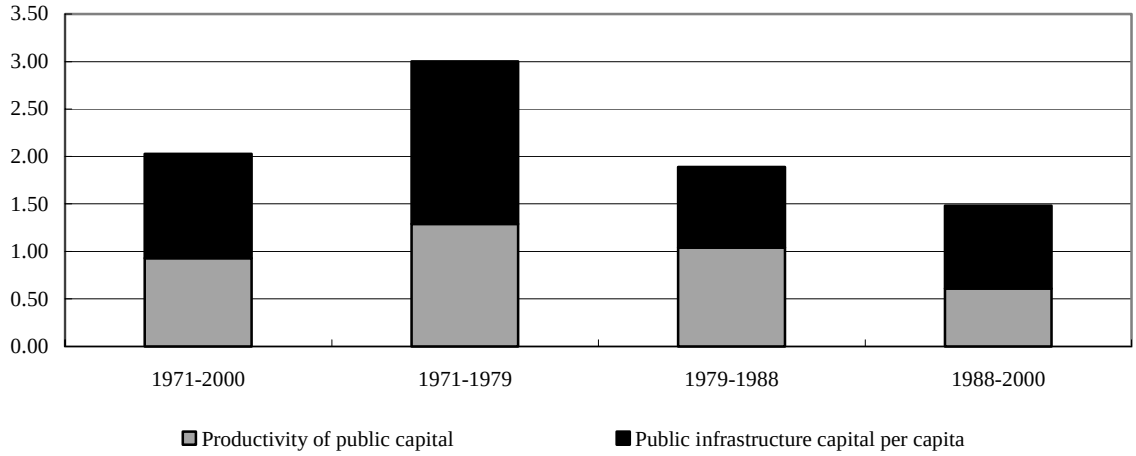
Likewise, GDP per unit of public infrastructure capital, or productivity of public infrastructure capital, can be taken as a partial productivity indicator that captures the extent to which the economic activity makes an efficient use of public infrastructure capital as a 'free' input. This partial productivity indicator is relatively easy to measure as it does not require estimates of the prices of public capital services which are not readily observable.

Partial productivity indicators should however be interpreted with caution, since what appears to be an efficient use of public capital infrastructure may only be the reflection of a substitution effect that may or may not be accompanied by an efficient use of other private inputs.

Figure 4 displays the trend of public infrastructure capital productivity over the 1971-2000 period and its sub-periods reflecting the last three business cycles—1971-1979, 1979-1988 and 1988-2000. Over the last thirty years, public infrastructure capital productivity advanced at 0.93% per year, compared to 1.4% for labour productivity. During the 1990s, public infrastructure capital productivity grew at 0.61% per year, down from 1.29% during the 1970s and 1.04% in the 1980s. In comparison, during the three consecutive business cycles, labour productivity advanced at 2.1%, 0.9% and 1.3% respectively.

Another useful indicator is public infrastructure capital per person which captures the demands placed by Canadians on the available public infrastructure capital. A lower growth rate suggests that, on average, Canadians have placed an added burden on public infrastructure capital. Figure 4 shows that over the 1971-2000 period, public infrastructure capital per capita grew at 1.10%. Between the 1970s and the subsequent two decades, the growth of public infrastructure capital experienced a steady slowdown—from 1.71% during the 1970s to 0.87% in the 1990s, unchanged from 0.85% during the 1980s.

Figure 4. Contribution of public infrastructure to Canada's standards of living (average annual growth rate in percentage)



The combination of these two partial indicators—productivity of public infrastructure capital and public infrastructure capital per capita—gives rise to the notion of GDP per capita, a crude measure of prosperity (measured by the height of the columns in Table 4).[3] Over the last thirty years, Canada's standard of living grew at 2.0% per year. Between 1971 and 1979, Canada's standards of living increased 3.02%. However, it slowed down markedly during the following two decades. The growth rate was only 1.9% during the 1980s and 1.5% during the 1990s.

5.1 Measuring the economic benefits of public infrastructure

Public infrastructure capital is a public good, and as a result, no market prices can be related to the services it provides. Nonetheless, the estimation of the shadow price or willingness to pay for these services and measured as the private production cost savings associated with the use of public infrastructure capital is important for policy making. The marginal benefit of public capital is quantified as the private cost reduction associated with the use of an additional unit of public capital. For example, a well-constructed highway allows a truck driver to avoid back roads and to transport goods to market in less time. The reduction in required time means that the producer incurs a lower cost and the truck experiences less wear and tear. Hence, public investment in a highway enables private companies to produce their products at lower total cost. The condition of the highway, of course, is just as important as its existence. Similar stories can be told for mass transit, water and sewer systems, and other components of public capital.

[3] That is $\frac{GDP}{Persons} = \frac{GDP}{Public\ Infrastructure\ Capital} \times \frac{Public\ Infrastructure\ Capital}{Persons}$, or in other words:

$$GDP\ per\ capita = Productivity\ of\ Public\ Infrastructure\ Capital \times Demands\ Placed\ on\ Public\ Capital\ Infrastructrue$$

Table 5 - Marginal Benefits of Public Capital (Mean Values, 1961-2000)

	$\frac{\partial \tilde{C}}{\partial G}$
Agricultural and related service	0.60
Fishing and trapping	0.00
Logging and forestry	0.05
Mining	0.14
Crude petroleum and natural gas	0.36
Quarry and sand pit	0.00
Services incidental to mineral extraction	0.02
Food	0.65
Beverage	0.09
Tobacco products industry	0.02
Rubber products	0.04
Plastic products	0.04
Leather and allied products	0.01
Primary textile	0.03
Textile products	0.02
Clothing	0.06
Wood	0.21
Furniture and fixture	0.02
Paper and allied products	0.34
Printing, publishing and allied	0.15
Primary metal	0.56
Fabricated metal products	0.38
Machinery ind. (except electrical mach)	0.24
Transportation equipment	1.29
Electrical and electronic products	0.02
Non-metallic mineral products	0.07
Refined petroleum and coal products	0.34
Chemical and chemical products	0.33
Other manufacturing	0.01
Construction	2.58
Transportation	2.56
Pipeline transport	0.07
Storage and warehousing	0.01
Communication	0.64
Other utility	0.81
Wholesale trade	2.11
Retail trade	2.56
Business Sector	17.44

Note: Marginal benefit of public capital is defined to be the negative of the partial derivative of the cost function with respect to public capital. This derivative can be interpreted as the marginal willingness to pay function.

Table 5 shows that for the Canadian business sector, the marginal benefit associated to public infrastructure capital is about 0.17. That is, a $1.00 increase in the net capital stock generates approximately 17 cents of 'cost saving' producer benefits per year.[4] For industries such as transportation, retail, wholesale, and other utility, the marginal benefits of a $1.00 increase in public capital is higher than 2 cents. These industries are probably the most intensive users of the public capital.

[4] These results are obtained from Harchaoui and Tarkhani (2003) using the parameter estimates of a cost function of the business sector. The cost elasticity estimate of public capital at the aggregate level lies within the following confidence intervals (at 5% level): -0.05981 and -0.071412.

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