



Briefing April 2013

# The Economic Impact of Ontario's Infrastructure Investment Program

## At a Glance

- ◆ Ontario's public infrastructure spending has important repercussions on the provincial economy, employment, and the income of its residents.
- ◆ As infrastructure projects are completed, they bolster the stock of physical capital and boost productivity in the private sector.
- ◆ Ontario's past and planned public infrastructure spending over 2006 to 2014 lifts the province's real productive capacity by 2.1 per cent by 2014 and adds \$1,044 (in constant 2012 dollars) to the average income per resident.

## INTRODUCTION

This briefing follows and updates an earlier study<sup>1</sup> to assess the contribution of Ontario's infrastructure investment program to the province's economy. Our findings suggest that the direct employment and purchases generated by public infrastructure spending have substantial impacts on the economy. However, the long-term benefits are just as important. Evidence from research conducted in Canada, the United States, and other jurisdictions suggests that there is a robust link between the stock of public infrastructure and the level of income in an economy. As infrastructure projects are completed, they bolster the stock of physical capital and boost potential output.

<sup>1</sup> Antunes, Beckman, and Johnson, *The Economic Impact of Public Infrastructure in Ontario*.

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And, more importantly, there is a high degree of interdependence between the quality and quantity of public infrastructure and the performance (productivity) of an economy's business sector. Thus, we utilize findings from the literature to quantify the impact of Ontario's past and planned infrastructure spending on the province's potential output and the income of its residents.

It is important to note that we assess only the benefits of Ontario's past and planned infrastructure spending on the economy. We do not attempt to quantify the potential benefits of additional public savings (should the funds not have been spent) or of alternate spending.

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**While the direct employment and purchases generated by public infrastructure spending have substantial impacts on the economy, the long-term benefits are as important.**

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First, we present results of the economic impact stemming from the construction and purchases generated by Ontario's infrastructure spending. The following section looks at the long-term benefits of the same spending on the productive capacity of Ontario's economy. The final section concludes.

### THE ECONOMIC IMPACT OF ONTARIO'S INFRASTRUCTURE SPENDING

In this section, we rely on the Conference Board's proprietary model of the Ontario economy to quantify the economic impact of infrastructure spending. The analysis captures not only the effects of direct spending on construction and machinery, but also supply chain and other impacts related to the employment and purchases generated by Ontario's public infrastructure spending program. In effect, we assess the impacts associated with increased economic activity directly related to the construction phase of the infrastructure spending program. But because infrastructure spending builds assets whose economic useful life will extend beyond the construction phase, in the next section we quantify the long-term impact that the increased stock of public capital has on Ontario's potential output and the income of its residents.

### DATA

The Ontario Ministry of Infrastructure provided the Conference Board with past and planned public capital investment expenditures over the fiscal years running from 2005–06 to 2014–15, as shown in Table 1.

The data were converted to a calendar-year basis, resulting in data spanning a period of nine years from 2006 to 2014. Because there are large differences between the economic impacts obtained from labour-intensive construction and those obtained from machinery and equipment (M&E) investment (because of higher import content), it was necessary to break out the capital investment spending by type of asset. We relied on historical data from Statistics Canada's Private and Public Investment Intentions Survey to split the public capital investment data between construction (or what is termed "structures") and M&E investment, depending on the broad sectors to which the funds were allotted. The investment spending categories were transportation, education, health, and "other" (a combination of sectors such as water, the environment, municipal and local infrastructure, and justice). Furthermore, the government construction and M&E deflators from Statistics Canada's Provincial and Territorial Economic Accounts were used to convert nominal capital expenditures displayed in Table 1 into real terms—that is, adjusted for inflation.

### KEY ASSUMPTIONS AND METHODOLOGY

Aggregate infrastructure investment data were used to "shock" the Conference Board's provincial economic model of Ontario—that is, show the effect that infrastructure spending has had on Ontario's economy. The model simulations were performed over 2006 to 2014.

The shock to the Conference Board's Ontario economic model was to real public construction investment and real public machinery and equipment (M&E) capital outlays. The government construction and M&E deflators from Statistics Canada's Provincial and Territorial Economic Accounts were used to deflate the public investment data provided by the Ministry of Infrastructure in 2002 dollars. (Deflators are used to convert nominal capital expenditures into real terms—that is, adjusted for inflation.) As a point of interest, the two government capital investment deflators have very different trends over history. From 2006 to 2011, M&E prices remained relatively

**Table 1**  
Annual Gross Infrastructure Expenditure  
(\$ millions)

Sector	Actual							Planned		
	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Transportation <sup>1</sup>	3,272	3,126	4,020	3,012	4,235	4,430	4,754	5,753		
Health	461	558	1,340	2,525	2,860	3,064	3,043	3,247		
Education <sup>2</sup>	1,524	1,806	2,324	1,690	2,001	2,163	2,368	2,405	2,363	1,672
Other	1,349	1,617	3,115	1,763	1,870	1,955	2,520	2,492	1,735	1,057
Stimulus investments	n.a.	n.a.	n.a.	n.a.	1,616	3,598	n.a.	n.a.	n.a.	n.a.
<b>Subtotal</b>	<b>6,606</b>	<b>7,107</b>	<b>10,798</b>	<b>8,991</b>	<b>12,582</b>	<b>15,209</b>	<b>12,685</b>	<b>13,897</b>	<b>13,611</b>	<b>11,994</b>
Less: Other partner funding <sup>3</sup>	n.a.	n.a.	441	531	620	597	1,268	1,018	707	638
<b>Total excluding partner funding</b>	<b>n.a.</b>	<b>n.a.</b>	<b>10,357</b>	<b>8,459</b>	<b>11,961</b>	<b>14,612</b>	<b>11,417</b>	<b>12,879</b>	<b>12,904</b>	<b>11,356</b>
Less: Flow-throughs <sup>4</sup>	244	246	273	221	1,133	340	438	335	416	196
<b>Total provincial expenditure</b>	<b>6,362</b>	<b>6,861</b>	<b>10,525</b>	<b>8,238</b>	<b>10,829</b>	<b>14,272</b>	<b>10,979</b>	<b>12,544</b>	<b>12,488</b>	<b>11,159</b>

1 Transportation includes planning activities, property acquisition, highway service centres, and other infrastructure programs (e.g., municipal/local roads/remote airports).

2 Figures include updates since Quarterly Finances, August 2012.

3 Third-party contributions to capital investment in the consolidated sectors (schools, colleges, and hospitals).

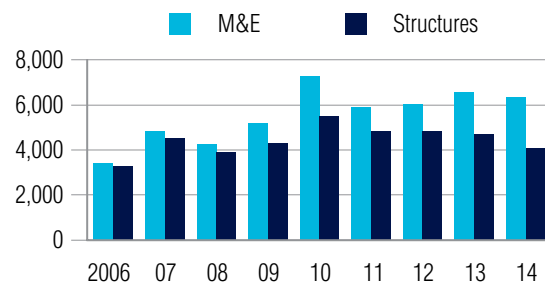
4 Mostly federal government transfers for capital investments. Reported only as a footnote in FES for 2005-06, 2006-07, and 2007-08.

Source: Ontario Ministry of Infrastructure.

flat, partly because a robust Canadian dollar made imported M&E cheaper. On the other hand, construction prices advanced by nearly 25 per cent over the same period due to rising construction material costs and wage pressures.

Data from the Conference Board's latest provincial forecast were used to extend the deflators over the 2012 to 2014 period. The decline in M&E prices suggests that the government purchasing power for this type of capital grew more strongly over 2006 to 2011 (a trend that should continue through to 2014) and that in inflation-adjusted terms, a larger share of infrastructure spending is allotted to M&E than to structures. (See Chart 1.)

**Chart 1**  
Real Provincial Infrastructure Spending: Machinery and Equipment, and Structures  
(2002 \$ millions)



Sources: Infrastructure Ontario; Statistics Canada; The Conference Board of Canada.

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The Conference Board's macroeconomic model of the Ontario economy was used to quantify the impact of the real capital investment streams estimated for 2006 to 2014. The analysis evaluates the combined direct, indirect, and induced economic impacts, where:

- ◆ **Direct impact** measures the value-added<sup>2</sup> on the economy of the increased public capital spending on those firms that would either build structures or manufacture equipment. Because demand for M&E has a high import content, the direct effect on the Ontario economy is muted. Nonetheless, the increased demand will generate domestic activity in the transportation sector.
- ◆ **Indirect impact** (or supply chain impact) measures the value-added that the "direct impact firms" generate economically through their demand for intermediate inputs or other support services. For example, increased construction activity will lift demand for utilities, transportation, financial, and insurance services.
- ◆ **Induced impacts** are derived when employees of the aforementioned industries spend their earnings and owners spend their profits. These purchases lead to more employment, wages, income, and tax revenues, and can be felt across a wide range of industries.

Thus, increased investment in infrastructure will not only have direct impacts on the economy (on construction, for example) but will also spread through the economy through a series of multiplier effects. Supply chain effects are first felt on demand for industries that are direct suppliers. Second-round induced effects produce a widespread impact (albeit usually smaller) on all sectors of the economy, largely through a general increase in consumer spending. The overall economic multiplier is calculated as the sum of all value-added impacts (direct, indirect, and induced) divided by the initial spending on infrastructure (in constant dollars).

It is important to note that the initial constant dollar value of the public capital investment does not result in a one-to-one increase in real GDP. This is because a significant portion of the investment is assumed to go

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2 Value-added, or net output, is the difference between total revenue and the sum of expenses on parts, materials, and services used in the production process. Summing the value-added across all industries in a region will yield the GDP in that region.

toward the purchase of M&E, much of which is imported. Moreover, even as demand is lifted for M&E produced in Ontario, the lift in demand for manufactured goods will require intermediate inputs purchased from suppliers that may be outside the provincial boundaries. This dependence of the supply chain on imported components will determine the level of leakages and the extent to which the overall economic multiplier is reduced.

The Conference Board's provincial forecasting model captures the sum of the direct, indirect, and induced impacts on Ontario's economy, based on its estimated historical relationships. The model incorporates a detailed modelling of prices, households, and businesses. It also provides economic impact results for a wide range of economic indicators.

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Some key points and assumptions about the methodology are worth mentioning. The Conference Board's Ontario forecasting model contains only a partial accounting of government revenues (including direct and indirect tax revenues). In addition, government accounts in the Conference Board's Ontario models are based on national accounts data and not on the public accounts. In principle, one can assume that the impact of the shock on a national account and public account basis would be similar. Finally, although the shock has only small effects on costs and prices, these variables do move in response to a change in economic activity. Price effects are assumed to be too small to have an impact on monetary policy or the value of the currency.

#### **FINDINGS**

Cumulative infrastructure spending will total an estimated \$96.7 billion, in current dollars, from 2006 to 2014. In real 2002 dollars, the cumulative value of the past and planned investment will be \$89.7 billion, with \$39.9 billion toward structures and \$49.8 billion toward

machinery and equipment. Table 2 summarizes the impact of Ontario's infrastructure investment program on key economic indicators.

Not surprisingly, the investment spending will have widespread impacts on the Ontario economy. From 2006 to 2014, the average contribution to real GDP—including direct, indirect, and induced impacts—is about \$11.3 billion per year, helping to support roughly 167,000 jobs per year. It is interesting to note that the increase in Ontario's economic activity associated with infrastructure spending has a positive impact on net interprovincial migration. The result is an increase in population and a boost to housing starts and residential construction.

The increase in employment lifts up personal income in current dollars by an annual average of \$7.4 billion from 2006 to 2014, while corporate profits are up by \$2.2 billion per year on average. Increases in personal income and corporate profits help push up total income (GDP in current dollars) in Ontario by an average of \$12.6 billion per year from 2006 to 2014.

A sizable benefit accrues back to federal and provincial governments. The boost to personal income results in an average annual increase of \$1.6 billion in personal income tax collection, while increases in profits yield an average increase of \$583 million per year in corporate income taxes over 2006 to 2014 for federal and

**Table 2**  
Total Public Infrastructure Investment—Economic Impact in Ontario  
(key economic indicators)\*

	2006	2007	2008	2009	2010	2011	2012	2013	2014	Annual average
<b>Investments</b>										
Total investment generated (\$ millions)	6,736	9,609	8,810	10,181	13,411	11,802	12,152	12,502	11,491	10,744
Total investment generated (2002 \$ millions)	6,673	9,375	8,174	9,460	12,755	10,743	10,865	11,241	10,378	9,963
Structures (2002 \$ millions)	3,282	4,545	3,921	4,273	5,498	4,848	4,808	4,685	4,050	4,434
Machinery and equipment (2002 \$ millions)	3,391	4,831	4,253	5,188	7,257	5,895	6,056	6,556	6,327	5,528
<b>Effects</b>										
Real GDP at market prices (2002 \$ millions)	7,546	10,796	8,525	9,308	14,071	12,390	12,847	13,440	13,041	11,329
GDP at market prices (\$ millions)	7,966	11,643	8,875	10,333	15,748	13,742	14,533	15,332	14,927	12,567
Personal income (\$ millions)	4,268	6,251	5,451	6,141	9,205	8,340	8,660	9,250	9,424	7,443
Corporate profits (\$ millions)	1,288	1,790	170	1,556	3,075	1,947	2,865	3,652	3,804	2,239
Population of labour force age	8,555	15,697	23,580	31,533	41,457	51,892	62,140	72,532	82,310	43,300
Employment	107,016	152,049	129,474	142,289	208,423	185,181	188,310	194,756	191,563	166,562
Unemployment rate (level difference in rate)	-0.65	-0.91	-0.76	-0.83	-1.20	-1.05	-1.06	-1.08	-1.05	
Retail sales (\$ millions)	3,553	5,066	5,343	4,671	5,809	6,677	7,054	7,428	7,951	5,950
Housing starts	2,584	5,998	4,308	3,301	7,575	6,666	6,592	6,964	7,139	5,681
Personal income tax collections (\$ millions)	996	1,476	1,255	1,341	1,906	1,725	1,779	1,883	1,870	1,581
Corporate income tax collections (\$ millions)	450	601	49	570	877	437	625	792	846	583
Total indirect taxes (\$ millions)	761	1,209	1,262	951	1,348	1,790	1,963	2,156	2,530	1,552

\*level difference = shock minus control, except where otherwise indicated

Sources: Ontario Ministry of Infrastructure; The Conference Board of Canada.

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provincial governments. Indirect taxes (which consist largely of sales taxes) are boosted by the lift to income and consumer spending, up on average by \$1.6 billion per year over the simulation period. It is interesting to note that the provincial government recoups roughly \$16.7 billion in cumulative personal and corporate income taxes and indirect taxes over the 2006 to 2014 period. This compares with the cumulative \$96.7 billion spent on the province's infrastructure program.

Table 3 shows the impact of increased infrastructure spending on the components of real GDP by spending category. The direct impact of the shock shows up in real government fixed capital formation, averaging a lift of just under \$10 billion per year. The increase in public investment and associated boost to economic activity results in a sizable lift to private investment—up about \$3.6 billion per year. As we will see in the following section, there is an important relationship between infrastructure spending and private sector productivity. This \$3.6 billion can be spent on various investments, including improving existing capital and acquiring new

technologies. It also reflects the induced aspects of higher household income leading to increased residential spending.

However, the import content associated with the private and public sectors' lift to M&E investment represents a leakage that offsets the overall impact on Ontario's economy. Additional imports are required to meet the extra demand for consumer goods resulting from increased employment and income. As a result of this extra demand, imports increase by an average of \$10.5 billion per year from 2006 to 2014, dampening the total impact on real GDP. Export volumes are unaffected by the shock, given stable external demand and our assumption that the simulation has no impact on the exchange rate. Real government spending on goods and services is also generally unaffected by the simulation assumptions.

The economic impact results on real GDP by industry are presented in Table 4. The largest impact is on the construction industry, which increases by an average of \$3 billion per year. Manufacturing industries also

**Table 3**

Total Public Infrastructure Investment—Economic Impact in Ontario  
(real GDP expenditure-based)

2002 \$ millions (market prices)*	2006	2007	2008	2009	2010	2011	2012	2013	2014	Annual average
<b>Final domestic demand</b>	<b>13,632</b>	<b>19,310</b>	<b>17,342</b>	<b>17,966</b>	<b>24,550</b>	<b>23,042</b>	<b>23,454</b>	<b>24,014</b>	<b>23,417</b>	<b>20,747</b>
Consumer expenditures	4,392	6,464	6,023	5,311	7,808	8,233	8,638	9,031	9,756	7,295
Government spending on goods and services	0	2	4	5	5	8	10	13	16	7
Gross fixed capital formation	9,478	13,202	11,617	12,944	17,158	15,145	15,153	15,332	13,977	13,778
Government	6,851	9,570	8,317	9,488	12,640	10,782	10,837	11,031	10,036	9,950
Private	2,492	3,420	3,146	3,237	4,213	4,179	4,125	4,097	3,818	3,636
Residential construction	88	130	119	139	205	186	192	202	205	163
Non-residential structures	976	1,333	1,190	1,267	1,607	1,494	1,486	1,450	1,291	1,344
Machinery and equipment	1,518	2,095	1,979	1,944	2,582	2,753	2,669	2,668	2,548	2,306
<b>Net exports</b>	<b>-6,673</b>	<b>-9,411</b>	<b>-9,817</b>	<b>-9,606</b>	<b>-11,643</b>	<b>-11,885</b>	<b>-11,824</b>	<b>-11,769</b>	<b>-11,531</b>	<b>-10,462</b>
Exports	0	0	0	0	0	0	0	0	0	0
Imports	6,673	9,411	9,818	9,606	11,643	11,885	11,824	11,769	11,531	10,462
<b>Gross domestic product at market prices</b>	<b>7,546</b>	<b>10,796</b>	<b>8,525</b>	<b>9,308</b>	<b>14,071</b>	<b>12,390</b>	<b>12,847</b>	<b>13,440</b>	<b>13,041</b>	<b>11,329</b>

\*level difference = shock minus control, except where otherwise indicated  
Source: The Conference Board of Canada.

**Table 4**  
Total Public Infrastructure Investment—Economic Impact in Ontario  
(real GDP by industry)\*

	2006	2007	2008	2009	2010	2011	2012	2013	2014	Annual average
<b>Real GDP at basic prices (2002 \$ millions)</b>	<b>7,529</b>	<b>10,757</b>	<b>8,187</b>	<b>9,154</b>	<b>14,452</b>	<b>12,386</b>	<b>12,855</b>	<b>13,698</b>	<b>13,409</b>	<b>11,381</b>
<b>Total goods</b>	<b>4,044</b>	<b>5,705</b>	<b>4,216</b>	<b>4,818</b>	<b>7,481</b>	<b>6,184</b>	<b>6,340</b>	<b>6,673</b>	<b>6,270</b>	<b>5,748</b>
Primary sector	266	386	197	310	582	368	399	457	418	376
Manufacturing	1,495	2,150	1,291	1,543	3,016	2,358	2,489	2,815	2,837	2,222
Construction	2,175	3,009	2,609	2,836	3,664	3,267	3,249	3,179	2,786	2,975
Utilities	107	160	120	129	218	191	204	222	229	176
<b>Business services</b>	<b>3,486</b>	<b>5,052</b>	<b>3,969</b>	<b>4,334</b>	<b>6,969</b>	<b>6,199</b>	<b>6,512</b>	<b>7,021</b>	<b>7,134</b>	<b>5,631</b>
Transportation, storage, and communication	328	479	306	391	712	554	596	668	669	523
Wholesale and retail trade	1,546	2,236	1,870	1,868	2,901	2,631	2,719	2,889	2,972	2,404
Finance, insurance, and real estate	579	847	653	736	1,221	1,179	1,267	1,368	1,408	1,029
Community, business, and personal services	1,033	1,489	1,140	1,338	2,135	1,835	1,930	2,095	2,085	1,676
<b>Public administration and defence</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>2</b>

\*level difference = shock minus control except where otherwise indicated  
Source: The Conference Board of Canada.

experience a sizable boost, with sectors such as the fabricated metals industry and the electrical equipment and component manufacturing industry benefiting from the investment. Business services industries also experience an increase in demand for services that include architecture, engineering, and computer system design. The services sector also benefits from the induced impacts, where higher employment and wages bolster household spending. In total, output in business services increases by an average of \$5.6 billion per year over 2006 to 2014.

The overall economic multiplier is calculated as the total change in real GDP divided by the initial constant-dollar increase in infrastructure spending. Our estimates indicate that for every \$100 million (inflation-adjusted) invested in public infrastructure, real GDP is boosted by \$114 million and roughly 1,670 person-years of employment are created or supported. In other words, for each \$100 million of public infrastructure investment, about 1,670 jobs will be created for one year.

Table 5 breaks down the employment gains by industry. Construction employment is up sharply—nearly 49,000 construction jobs are supported annually by Ontario's infrastructure program. Business services employment is up by more than 88,400 jobs annually, encompassing a wide range of sectors that include, for example, transportation, financial services, wholesale and retail, and others. The job creation stimulated by the infrastructure spending will have helped keep Ontarians in the province, lowering the outflow of interprovincial migrants and boosting population. This, along with an increase in labour force participation and a reduction in the number of unemployed, helps meet the demand for workers. Overall, the number of unemployed people is reduced by about 62,500 per year, lowering the unemployment rate by just under 1 percentage point.

**Table 5**Total Public Infrastructure Investment—Economic Impact in Ontario  
(employment by industry)\*

	2006	2007	2008	2009	2010	2011	2012	2013	2014	Annual average
<b>Total employment</b>	<b>107,016</b>	<b>152,049</b>	<b>129,474</b>	<b>142,289</b>	<b>208,423</b>	<b>185,181</b>	<b>188,310</b>	<b>194,756</b>	<b>191,563</b>	<b>166,562</b>
Primary sector	3,281	4,537	2,439	4,749	9,659	5,192	5,952	6,822	6,164	5,422
Manufacturing	15,960	21,844	14,605	16,910	29,437	24,847	25,564	27,808	27,970	22,772
Construction	31,672	44,866	46,455	48,097	58,085	56,805	54,508	51,827	48,267	48,953
Utilities	515	885	725	736	1,237	1,016	1,127	1,178	1,214	959
Business services	55,587	79,910	65,235	71,777	109,982	97,287	101,117	107,070	107,884	88,428
Public administration and defence	2	7	16	21	23	34	41	53	65	29
<b>Unemployment</b>	<b>-41,029</b>	<b>-58,384</b>	<b>-49,535</b>	<b>-52,068</b>	<b>-77,038</b>	<b>-69,141</b>	<b>-70,282</b>	<b>-72,724</b>	<b>-72,327</b>	<b>-62,503</b>
Unemployment rate (level difference in rate)	-0.65	-0.91	-0.76	-0.83	-1.20	-1.05	-1.06	-1.08	-1.05	

\*level difference = shock minus control, except where otherwise indicated  
Source: The Conference Board of Canada.

## PUBLIC CAPITAL'S CONTRIBUTION TO PRIVATE SECTOR PRODUCTION

In our 2010 study,<sup>3</sup> we reported on the widespread benefits of public infrastructure spending. Public capital includes schools, hospitals, utilities, and transportation, as well as recreational and cultural infrastructure. We noted that public capital helps private sector production by providing an educated and healthy population as well as transportation and other infrastructure relied on by businesses. In essence, public capital provides the environment that businesses need to operate, and by doing so helps boost private sector productivity. As we saw in the previous section, infrastructure investments can also lead to private sector investments in new technologies and capital.

Specifically, we found that public capital had contributed significantly to labour productivity over the past 30 years and that the contribution had strengthened over the 2000s in comparison with the previous two decades due to an increasing contribution of public capital to the overall growth in capital stock in Ontario. We found that,

3 Antunes, Beckman, and Johnson, *The Economic Impact of Public Infrastructure in Ontario*.

from 2000 to 2008, public capital contributed 0.23 percentage points per year to labour productivity's growth of 0.93 per cent per year—or that public capital was responsible for roughly a quarter of overall labour productivity growth in recent years.

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### Public capital provides the environment that businesses need to operate—thereby boosting private sector productivity.

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In this section, we update our 2010 findings by quantifying the potential benefits that public capital has brought to private sector production. We assess the potential benefit that Ontario's infrastructure program, over the 2006 to 2014 period, has on the economy and on the level of income that Ontarians earn today.

The methodology relies on simplifying the complex production that occurs in the economy to a single equation, where total output is a function of capital, labour, and total factor productivity. Total factor productivity (TFP) captures the efficiency with which capital and labour mix to create output, and is essentially the motor of



economic prosperity. Positive TFP growth contributes, one for one, to overall GDP growth and labour productivity. Moreover, it remains the key long-term driver of competitiveness and real per capita income. Note that in the production function approach, public capital is not captured explicitly, but is instead nestled in the TFP variable. Therefore, public capital is a component of TFP that is estimated and split out from TFP.

According to our framework,<sup>4</sup> TFP is influenced by the stock of public capital through the following formulation:

$$\text{Equation 1: } \Delta \ln(\text{TFP}_t) = \Delta \ln(\text{TFP}^*_t) + \beta_g \Delta \ln(G_t)$$

Where TFP\* is TFP excluding public capital,  $G_t$  is the real stock of public capital, and  $\beta_g$  is the output elasticity of public capital. The subscript  $t$  denotes time. The equation simply states that for a 1 per cent change in the stock of public capital, TFP would rise by  $\beta_g$  per cent. The difficulty is that  $\beta_g$  is unknown and not directly measurable, since we do not know the market price of public capital. However, Macdonald<sup>5</sup> estimates  $\beta_g$  for Canadian infrastructure to be around 0.1, with warnings that there is considerable range around the estimate. We use this estimate, and a margin around it, to estimate the contribution that Ontario's past and planned investments in infrastructure have had on Ontario's residents today.

## FINDINGS

Using the same infrastructure spending estimates as in the previous section, we find that Ontario's past and planned public infrastructure spending over 2006 to 2014 provides a significant and permanent boost to the province's overall potential output. In addition to the economic activity generated by the construction phase of projects, the cumulative increase in the stock of public capital helped boost the province's real productive capacity by 1.9 per cent in 2012 and, accounting for future planned investments, increases to 2.1 per cent by 2014. This represents an increase in the average income of Ontario residents of \$902 per person in

2012, increasing to \$1,044 per resident by 2014 (in constant 2012 dollars). These estimates are based on Macdonald's national estimate ( $\beta_g$  of 0.1) for the output elasticity of public capital.

This increase in real income per capita is due to the impact of increased infrastructure investment on Ontario's potential output as projects are completed. For example, income gains can come in the form of reduced time spent in traffic after transportation infrastructure is completed. These longer-term benefits come in addition to the economic impacts associated with the construction phase discussed above.

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### **Ontario's past and planned public infrastructure spending over 2006 to 2014 provides a significant and permanent boost to the province's overall potential output.**

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It is important to note that the methodology on which these results are based relies on an approximated relationship between production, labour, and capital inputs. The theoretical foundation for the "production function" used is common in the literature and is useful for capturing effects of overall public infrastructure on the economy. However, this does not mean that the mathematical relationship between public infrastructure investment and productivity will hold equally for all public investment projects. Some infrastructure projects may have more direct impacts on productivity than others. Consider, for example, transportation infrastructure versus recreational or cultural infrastructure: while both provide benefits to society, they will likely contribute very differently to private sector productivity. In Table 6 we provide a wide range of estimates that bound some of this variation in different types of public capital and their benefits to productivity.

The impact of past and planned infrastructure spending under various assumptions about the strength of the link between public capital and TFP is displayed in Table 6. The range of increases in real productivity capacity lies between 1.1 and 2.6 per cent in 2012, with the range increasing to between 1.2 to 3.0 per cent in 2014. At a minimum, the average Ontarian is earning \$536 more

4 The derivation of the impact of public capital on total factor productivity is developed in the technical notes to this briefing. See text box "Technical Notes."

5 Macdonald, "An Examination of Public Capital's Role in Production."

**Table 6**

Change in Productive Capacity Associated With Ontario's Public Infrastructure Spending From 2006 to 2014 (in constant 2012 \$)

	Alternate values for output elasticity of capital		
	<i>Bg</i> = 0.06	<i>Bg</i> = 0.10	<i>Bg</i> = 0.14
Percentage change in real productivity capacity in 2012	1.1	1.9	2.6
Percentage change in real productivity capacity in 2014	1.2	2.1	3.0
Change in income per Ontario resident in 2012	536	902	1,274
Change in income per Ontario resident in 2014	620	1,044	1,477

Source: The Conference Board of Canada.

per year today because of investments in infrastructure that occurred over 2006 to 2012. And if investments progress as planned through to 2014, the minimum benefit grows to \$620 per person in 2014 (in constant 2012 dollars).

## CONCLUSION

In this briefing, we examine the benefits of Ontario's infrastructure spending program on the provincial economy. We look at the economic impacts associated with the direct employment and purchases generated by public infrastructure spending. In addition, we quantify the benefits of the same infrastructure spending on the province's potential output and the income of its residents.

Past and planned infrastructure spending will total an estimated \$96.7 billion, in current dollars, from 2006 to 2014. Not surprisingly, the investment spending will have widespread impacts on the Canadian economy. From 2006 to 2014, the average contribution to real GDP—including direct, indirect, and induced impacts—is about \$11.3 billion per year, helping to support roughly 167,000 jobs per year. The complementary nature of public and private capital investments is reflected in the analysis: the \$10-billion annual increase in public investment results in an average annual boost to private sector investment of \$3.6 billion. A sizable benefit accrues back to the federal and provincial governments. The lift to income and profits helps generate nearly \$3.7 billion per year in taxes over 2006 to 2014. It is interesting to note that the provincial government recoups roughly

\$16.7 billion in cumulative personal and corporate income taxes and indirect taxes over the 2006 to 2014 period. This compares with the cumulative \$96.7 billion spent on the province's infrastructure program.

The economic multiplier associated with infrastructure spending is calculated as the total change in real GDP divided by the initial constant dollar increase in infrastructure spending. Our estimates indicate that for every \$100 million (inflation-adjusted) invested in public infrastructure, real GDP is boosted by \$114 million and roughly 1,670 person-years of employment are supported. In other words, for each \$100 million of public infrastructure investment, about 1,670 jobs will be created for one year.

Moreover, as infrastructure projects are completed, they bolster the stock of physical capital and boost the productive capacity of the economy over the long term. There is strong evidence in the literature about the link between public capital and private sector productivity; however, the strength of the relationship is difficult to establish with certainty. Thus, we quantify the impact of past and planned infrastructure spending using various assumptions about the strength of the link between public capital and productivity. The mid-point among these assumptions suggests that, in addition to the economic activity generated by the construction phase of projects, Ontario's past and planned public infrastructure spending over 2006 to 2014 lifts the province's real productive capacity by 2.1 per cent by 2014. This represents an increase in the average income of Ontarians of \$1,044 per person by 2014 (in constant 2012 dollars).

### Technical Notes

Here we develop the framework that allows us to isolate the impact of public capital on total factor productivity.

We start with an aggregate production function of Ontario's economy. We use the standard Cobb-Douglas production function:

$$(1) \quad GDP_t = (TFP_t) * (L_t^{\beta_l}) * (K_t^{\beta_k})$$

Here,  $GDP$  is total output generated in the business sector,  $TFP$  is total factor productivity, and  $L$  and  $K$  are measures for labour composition and capital stock in the business sector.  $\beta_l$  and  $\beta_k$  represent the elasticities of labour and capital—in other words, the responsiveness of output to changes in labour or capital. The year is denoted by the subscript  $t$ .

First, we estimate the elasticity of labour ( $\beta_l$ ) as the proportion of nominal labour income in the business sector out of total income in the business-sector economy. From there, we take the standard economic assumptions of competitive markets and constant returns to scale to generate ( $\beta_l + \beta_k = 1$ ).

Second, we take the logarithmic difference of (1) and get:

$$(2) \quad \Delta \ln(GDP_t) = \Delta \ln(TFP_t) + \beta_l \Delta \ln(L_t) + \beta_k \Delta \ln(K_t)$$

Total factor productivity is the only unknown variable in the equation, so it is calculated as the residual when all other changes in GDP are accounted for by labour and capital.

Third, to estimate the contribution to labour productivity, we subtract the change in hours worked from the change in GDP in equation (2) to get:

$$(3) \quad \Delta \ln \left( \frac{GDP_t}{Hrs_t} \right) = \Delta \ln(TFP_t) + \beta_l \Delta \ln \left( \frac{L_t}{Hrs_t} \right) + \beta_k \Delta \ln \left( \frac{K_t}{Hrs_t} \right)$$

This equation shows the relationship between labour productivity in the business sector (on the left-hand side) and the components that contribute to this productivity (TFP, labour composition, and business sector capital).

Note that public capital is not included in equation (3). Because TFP is calculated as a residual, public capital has been lumped in with it. Therefore, we separate out public capital from TFP:

$$(4) \quad \Delta \ln(TFP_t) = \Delta \ln(TFP^*_t) + \beta_g \Delta \ln(G_t)$$

... where  $G_t$  is the public capital stock and  $\beta_g$  is the output elasticity of public capital.

The unknown variable in equation (4) is the output elasticity of public capital,  $\beta_g$ . Measuring this is a challenging exercise because we do not know the market price of public capital and there are no close proxies where private companies have created public infrastructure in Ontario that would yield a market price. Macdonald points out that estimates of TFP and the elasticity of public capital are statistically very hard to disentangle in the traditional production function approach because both track trend GDP in a similar fashion.<sup>1</sup> Macdonald estimates  $\beta_g$  for Canadian infrastructure<sup>2</sup> to be around 0.1 and warns there is a considerable range around the estimate. We use this estimate for the output elasticity of public capital in this analysis, but we also provide estimates for  $\beta_g = 0.06$  and  $\beta_g = 0.14$  to assess the sensitivity of results under different assumptions.

The analysis was based on the infrastructure investment data provided by the Ontario Ministry of Infrastructure over the 2006 to 2014 period. We utilized a modified version of our model's potential output block that separates the contribution of public and private capital based on the output elasticities presented here.

1 Macdonald. "An Examination of Public Capital's Role in Production."

2 Macdonald's 2008 paper includes all investments made by the public administration sector defined as the North American Industry Classification System (NAICS) 91 industry in his definition of public capital. Our study uses a broader definition that includes schools and hospitals.

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## The Economic Impact of Ontario's Infrastructure Investment Program

by *Pedro Antunes and Jacqueline Palladini*

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