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E-BRIEF

March 9, 2015

ECONOMIC GROWTH AND INNOVATION

# Tackling Traffic: The Economic Cost of Congestion in Metro Vancouver

by
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- Traffic congestion slows down traffic – that is the visible cost of congestion. But it also causes people to forgo trips that they otherwise would take. This is the hidden cost of congestion.
- When congestion causes people to not travel it stifles the key benefits of living in a city: learning face-to-face, finding better jobs, and sharing services and infrastructure.
- On top of the cost of congestion due to slower travel, these wider, hidden costs of congestion are between $500 million and $1.2 billion per year for the Metro Vancouver area.
- These hidden costs of congestion in Metro Vancouver are at least as large as the visible economic costs that the regional Mayors' Council has presented.

Voters in Metro Vancouver will soon decide whether to approve a transportation and transit plan financed with a region-wide 0.5 percentage point increase in the Provincial Sales Tax. In an upcoming plebiscite, voters across the 21 municipalities in Metro Vancouver, including such major

The report is published by the C.D. Howe Institute in collaboration with Clean Energy Canada and the Real Estate Foundation of British Columbia as a way to stimulate discussion of transit policy and does not represent the official positions of any of these organizations. The Institute maintained full editorial independence and is solely responsible for the paper's contents. The author wishes to thank the following individuals: Mark Krass, who provided excellent assistance on commuting distance data. Graeme Brown, Jock Finlayson, Carol Layton, Robin Lindsey, Todd Litman, Andy Manahan, Jeremy Moorhouse and C.D. Howe Institute staff provided very useful comments on an earlier draft. The author retains responsibility for any remaining errors.

communities as Surrey, Burnaby and Richmond, must consider how to deal with the bane of most metropolitan areas – growing congestion. They will need to weigh whether the economic costs of congestion are high enough that reducing them, through this plan, could be of sufficient benefit to warrant a sales tax increase.

What are the economic costs of congestion in Metro Vancouver? The regional Mayors' Council, which produced the plan, estimates that congestion currently costs residents about $500 million per year in excess vehicle crashes and wasted time in traffic. This will grow to $1 billion per year in 2045 if governments do nothing (HDR 2015). The Mayors' Council predicts its plan will avoid one-third of that cost.

However, congestion costs in Metro Vancouver include more than traffic delay, crashes and injuries. As I will show, there are also hidden and wider economic costs involved owing to trips forgone. Because of congestion, workers do not take jobs that are the best fit for them. Companies lose out, because the pool of workers they may draw from is shallower than otherwise. People lose opportunities to learn from others around them. Businesses with unique offerings do not have ready access to a broad market. As I will discuss below, my estimates indicate that the hidden costs of congestion in Metro Vancouver are at least as large as the visible economic costs that the Mayors' Council has presented.

My focus here is on the economic benefits of reducing the hidden costs. To do so, I calculate the wider economic benefits of the Mayors' Council plan to reduce congestion. If its plan for investment in transit and transportation infrastructure were in place today, the people of Metro Vancouver would have higher incomes of between $500 million and up to $1.2 billion annually, or $950 per worker in Metro Vancouver, per year. Those higher incomes, in turn, would boost provincial and federal income tax revenues by an estimated $150 million and $360 million per year – and those added revenues could partly finance the Mayors' Council plan.

As the referendum on whether to accept new taxes to finance transit infrastructure begins, both the visible and hidden costs of congestion should be taken into consideration.

## The Mayors' Council Investment Plan and Estimates of Congestion Costs

Under the Mayors' Council transportation infrastructure investment plan, the immediate financing strategy is for the province to charge an extra 0.5 percentage points on the Provincial Sales Tax (PST) to pay for the region's share of the plan. The Mayors' Council proposes that the PST increase, which would apply only to residents of the region, would amount to $125 per household per year, providing a total of $250 million per year for the investment plan. If approved, the tax would finance one-third of the proposed $750 million in annual transit spending over 10 years, with the remaining funds to be found through other means or other levels of government. The investments will include bridge and roadway improvements as well as major ferry, bus and rail transit expansions across the region.

### *Current Estimates of Economic Costs of Congestion*

When a driver enters a roadway, she bases her travel decision on the private cost (such as her time, parking and vehicle operating costs) of driving a car. She does not take into account that her choice may prevent others from using that road, or slow them down when they do. Other drivers on the road impose the same cost on her. The result is traffic congestion, which is a social and economic cost.

Most existing studies of the economic cost of congestion start with an estimate of how long it takes a traveller to make a trip, such as one to work. These are attempts to quantify the obvious costs of congestion that travelers experience when waiting in traffic. The studies then compare that current travel time to how long a similar trip

would take without congestion. Finally, the studies multiply the difference in time by a dollar amount that reflects the assumed value people place on their time.

To assess the cost of congestion, it is important that policymakers consider an appropriate target for the level of congestion. Drivers would prefer roads to be free flowing. Transit riders would prefer trains and buses operating below capacity, with plenty of open seats. But such an outcome would be the result of inefficient over-investment.

Transport Canada (2006a, 2006b) calculates the economic cost from longer travel times plus the cost of less reliable travel times. Less reliable travel times due to congestion mean that drivers must include contingency time. These combined costs amount to, in 2000 dollars, $927 million per year in the Metro Vancouver region – or $466 per person – and $5.2 billion overall in Canada's five largest urban areas (Lindsey 2009, cited in Dachis 2013). Transport Canada's (2006a) economic cost of congestion, however, uses the unrealistic baseline of a largely unutilized road, and uses baseline speeds at the posted speed limit, making its cost of congestion an overestimate.

HDR, Inc., an engineering consultancy, has studied the economic costs of congestion for Metro Vancouver (HDR 2015). It calculates two economic costs, but notes these costs of congestion have some overlap.[1] The first cost is based on the extra time and operating cost of vehicles for drivers and transit users. It also includes crash and emissions costs due to regular congestion. Those total costs amount to $487 million per year, growing to slightly over $1 billion by 2045, given population growth.

HDR also estimated a second economic cost of $340 million per year, mostly due to reduced business demand for workers because firms must pay workers more to induce them to waste time in traffic. That cost will grow to an additional $1 billion in 2045 if governments do not address Metro Vancouver's traffic issues.

Rather than compare current travel time to travel time on an unutilized road, HDR (2015) sets the optimal level of congestion as the speed at which the costs of reducing congestion are higher than the benefits of reducing congestion. That is an appropriate baseline. HDR (2015) explains that congestion occurs when demand for the road exceeds its capacity, and acknowledges that it is not economically worthwhile to eliminate congestion. HDR argues that the Mayors' Council's transportation plan will reduce, by between 33 and 40 percent, the extent to which congestion exceeds the optimal level.

## The Wider Economic Benefits of Reduced Congestion

When a person lives in an urban area, that person has a positive benefit on others living in the same region. This is known as a positive agglomeration externality. Publicly financed transportation infrastructure enables more people in an area to connect than otherwise, and enhances that agglomeration effect.

These externalities can be region-wide. For example, someone living in downtown Vancouver benefits from an investment in Coquitlam or Richmond if that investment enables someone in a suburb to travel downtown and create a connection that otherwise wouldn't have occurred. Modern economic research has described

1 HDR (2015) follows a methodology similar to that in Metrolinx (2008), which found a cost of congestion in Toronto of $6 billion per year. These studies do not include the economic costs of delayed commercial vehicles or freight outside of certain sectors, as well as noise and road damage. Arnold (2014) uses a different methodology to show that the congestion cost to commercial traffic in Metro Vancouver is as high as $2 billion per year.

## Box 1: Agglomeration Economies in Practice

Studies from around the world have found that doubling the size of an urban area tends to increase incomes between 3 and 8 percent (Rosenthal and Strange 2003). Here in Canada, Beckstead et al. (2010) and Dachis (2013) found from the 2001 and 2006 Censuses that doubling a surrounding population is related to an increase in income of between 1 and 5 percent. The evidence also conclusively shows that larger populations result in higher incomes, and not vice-versa (see online Appendix).

**Labour Market Pooling:** A larger labour market can benefit both firms and people. A larger labour market can enable a better match of a person's skills and interests to the specific needs of an employer. This allows greater specialization of employees, resulting in increased economic efficiency and growth. Akin to how workers can be more productive when they specialize in a factory or office setting, a larger city allows more opportunities for specialization. That makes residents more productive and richer. A second benefit is that a larger labour market can reduce risks for both employees and firms, allowing both to be less dependent on their existing relationships (Overman and Puga 2010; Duranton and Jayet 2011).

**Learning in Cities:** Knowledge dissemination is most effective in close proximity – as Marshall (1890) put it, having ideas 'in the air' is akin to a public good. People learn better face to face. Learning more, and in less time, means higher incomes. A potential example of this is that a given patent is more likely to be cited by another patent from the same city (Rosenthal and Strange 2003). Workers also accumulate more valuable experience in larger cities, leading to higher incomes (de la Roca and Puga 2012). These benefits only occur when workers can reach common work areas, such as a downtown.

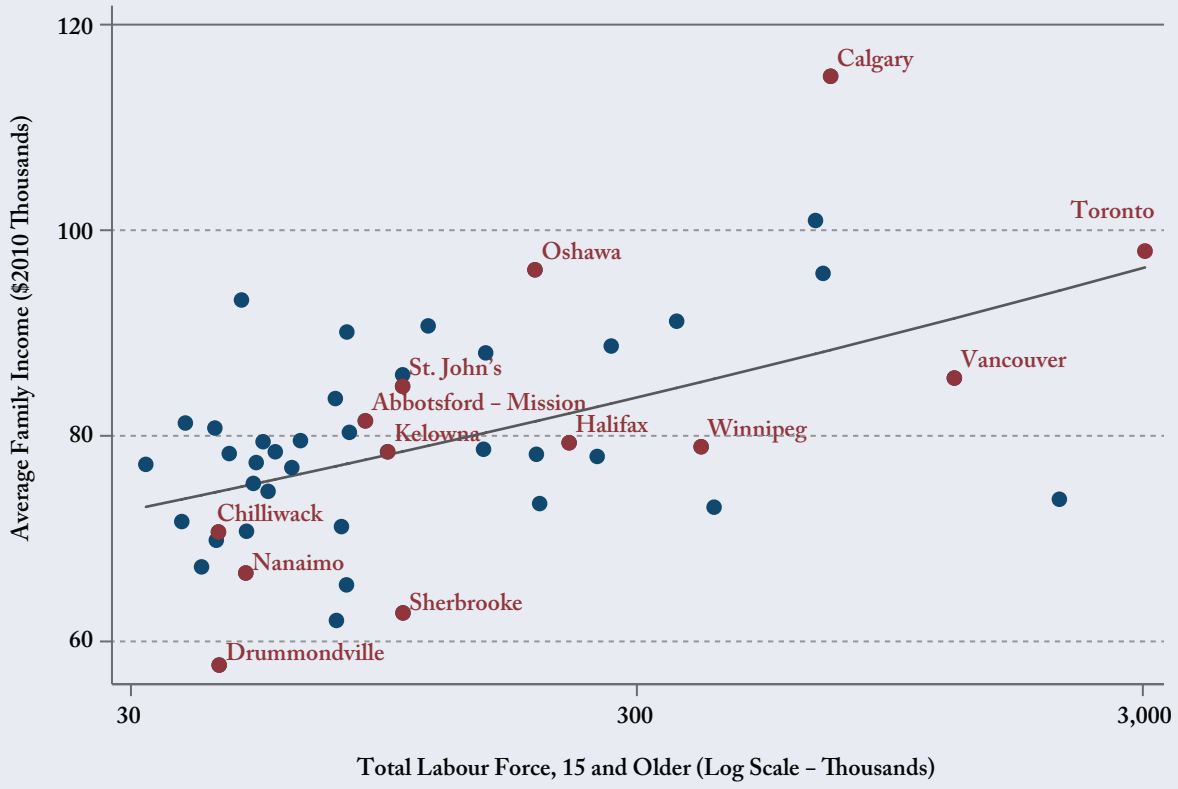
**Sharing in Cities:** In an urban area, firms and people can share inputs such as infrastructure, supplier networks or other services (Holmes 1999). Cities also provide cultural and consumer amenities – arts and sports venues or restaurants, for example – that would otherwise not be cost-effective in areas with less accessible populations. Even the customers already close to such amenities can be better off with less congestion or more transit because those extra customers that need transit or less congestion may be enough to make the sporting venue or the new restaurant viable. This is an example of how benefits can be region-wide and the potential beneficiaries of new transportation investments can be far away from the investment site.

the economic benefits of agglomeration through three effects: labour market pooling; the benefits of learning in person; and sharing in cities (see Box 1 for examples). If reduced congestion enabled people from West Vancouver or Surrey to reach parts of the region they otherwise would avoid travelling to, they could provide benefit to each other even if they never met.

I combine these economic benefits into a single measure of agglomeration effects at the Census Tract level and at the broader Census Metropolitan Area (CMA) level with 2011 National Household Survey data.[2] After

2 Census Tracts are small areas with between 2,500 and 8,000 residents and located in Census Metropolitan Areas. Census Metropolitan Areas are statistical boundaries that Statistics Canada uses to define effective labour markets with a total population of at least 100,000. For details, see http://www12.statcan.gc.ca/census-recensement/2011/ref/dict/geo009-eng.cfm.

**Figure 1: Income and Size of Labour Force by Census Metropolitan Area, 2011 NHS**




Source: Author's calculations from Statistics Canada.

controlling for the inherent characteristics of the population of a Census Tract – such as education levels, and the province of the CMA – I calculate that a doubling of population surrounding a Census Tract is associated with a 3 percent increase in nominal incomes (See online Appendix Table A-1).[3] Looking across Canadian CMAs, there is a clear, positive relationship between city size and income (Figure 1).

## Measuring the "Hidden" Economic Benefits of Transportation

Increased investment in transportation infrastructure, along with lower congestion, enables two wider economic benefits. If the travel time savings from the Mayors' Council's plan could be realized given today's population[4] and income levels, those benefits would be:

3 For a doubling of population size, I calculate this as $2^{0.0406}$ from column 4 in Table A-1.

4 Long-term migration changes and land use changes would be difficult to model.

- Region-wide agglomeration externalities, which may merit public support; and
- Higher incomes, because workers would have access to higher-paying jobs. These economic benefits accrue directly to the users of transportation, and are best captured by user fees.

The initial effect of the reduction in congestion will be faster travel times for commuters, saving people a few minutes on their commute every day. I have Metro Vancouver-wide estimates of increased travel speed and, for my purposes here, I assume all parts of Metro Vancouver experience that time savings.[5] The economic question is what people do with the time saved. The likely answer will be to travel more.

### *Economic Benefit 1: Region-wide Agglomeration Benefits*

Firstly, I estimate a pure agglomeration benefit, which is a catch-all estimate of the benefits I describe in Box 1. This agglomeration benefit puts a monetary value on the intangible benefits of better urban access. New transportation infrastructure and lower congestion allow current residents to access more of the region in the same amount of time as before. This broader access enables more connections than a person might otherwise have encountered, and that benefits others.

The magnitude of the all-encompassing agglomeration benefits for Metro Vancouver that I estimate in Table 1 will depend, first, on the strength of the agglomeration economic benefit of interpersonal connections[6] and, second, on the geographic size of the region benefitting from enhanced accessibility. The transportation investment plan will increase travel speeds, making it possible for commuters to travel a greater distance in the same amount of time. A larger travel area will mean more access and connections to other people, enhancing agglomeration economies.[7]

For each Census Tract in Metro Vancouver, I estimate a range of agglomeration benefits based on the Mayors' Council plan (see online Appendix). The annual agglomeration benefit ranges from an extra $257 million per year, or $209 per worker, to $512 million per year, or $411 per worker (Table 1). These are the outcomes that residents of Metro Vancouver are not enjoying because of excess congestion, which could be mitigated through transportation infrastructure investment.

### *Economic Benefit 2: Enhanced Commuting or Migration to Seek Higher Paying Jobs*

The second economic benefit I estimate relates to an increase in the ability of people to access new, higher paying jobs. This will result in an increase in incomes and Gross Domestic Product (GDP), but the longer commutes mean that people incur a higher travel cost and inconvenience when commuting a longer distance. Income is one part of how people think about their wellbeing, which economists call their social welfare. While new commuters would benefit from higher wages, were they to switch to a high-wage job requiring a longer

5 In fact, the increases in travel speed will vary by region based on the specific locations of investments.

6 I produce a low- and high-end range of agglomeration strengths of a one percent increase in population resulting in a 0.03 percent and 0.04 percent increase in incomes. These ranges are close to the low- and high-range estimates of the relationship of population and income from online Appendix Table 1. These are equivalent to a doubling of the population resulting in 2.1 to 2.8 percent higher incomes.

7 I create a high range and a low range of estimated change in travel patterns based on information I have received from TransLink and my own estimates of average commute distance from Statistics Canada. See online Appendix.

**Table 1: Yearly Agglomeration Benefits of Mayors' Council's Transportation Plan**

| Travel Pattern Change *(increase in travel distance)* | **Strength of Agglomeration Economies** *(increase in income from 1 percent increase in population)* | |
|---|---|---|
| | *Small (0.03 percent)* | *Large (0.04 percent)* |
| **Small (6.1 percent)** | $257 million ($209 per worker) | $343 million ($279 per worker) |
| **Large (8.8 percent)** | $384 million ($315 per worker) | $512 million ($411 per worker) |

Note: Total amounts inflated from $2010 from National Household Survey to $2015. Amount in parentheses are per capita amounts.

Source: Author's calculations from Statistics Canada.

commute, they would pay higher commuting costs or experience greater travel discomfort. The cost of housing would also increase because workers now able to access higher paying jobs would bid up the prices of the now more centrally located homes. The net change in their social welfare would be small, despite large increases in income and measureable GDP (see online Appendix).

I use the same range as in Table 1 of travel changes potentially associated with the Mayors' Council's plans, and a high- and low-end estimate of the wage premium for every additional commute kilometre (Table 2).[8] My estimate for the Metro Vancouver-wide increase in incomes, from access to better-paying jobs, ranges from $245 million, or $193 per worker, per year to up to $693 million, or $546 per worker, per year.

### *The Effect of Increased Tax Revenue*

As workers move from lower-wage jobs to higher-wage jobs, government income tax revenues increase. The effect on government revenues is a transfer of income from workers to governments, and is not an additional economic benefit. Using a marginal combined federal and provincial effective tax rate of 30 percent, the increase in government revenue would be between $150 and $360 million.[9] That provides some limited justification for federal or provincial support of local infrastructure projects. The largest beneficiaries of local transportation improvements, however, are local residents. The net result of reduced congestion from transportation infrastructure is an increase in values of properties of residents that benefit most. Property taxes can capture some of this increase in property value.

8 The average effect within Metro Vancouver is a 0.9 percent increase in income for every additional kilometre of commuting. I apply one standard deviation to this estimate to create an upper (1.1 percent) and lower (0.7 percent) bound estimate of the income benefit we can expect for each additional commuting kilometre.

9 I ignore the marginal cost of funds effect in this revenue discussion.

**Table 2: Yearly Income Increase of Access to New Jobs through Increased Travel Speed**

| Travel Pattern Change *(increase in travel distance)* | Wage Premium of Commuting to Job | |
|---|---|---|
| | *Small (0.7 percent per km)* | *Large (1.1 percent per km)* |
| **Small (6.1 percent)** | $245 million ($193 per worker) | $433 million ($341 per worker) |
| **Large (8.8 percent)** | $392 million ($308 per worker) | $693 million ($546 per worker) |

Note: Total amounts inflated from $2010 from National Household Survey to $2015. Amount in parentheses per capita amounts.

Source: Author's calculations from Statistics Canada.

### *What is the Total Cost of Congestion in Metro Vancouver?*

While HDR (2015) estimated the cost of visible traffic congestion, in this report I estimate the hidden costs of congestion.[10] The nature of separate studies means that the results cannot simply be added to one another. However, the different approaches are complementary.

If the one-third reduction in the cost of congestion as a result of the Mayors' Council's plan were in place today:

- The annual time savings would be worth approximately $163 million this year, and the business cost savings would be $140 million.
- Those estimates are of a similar order of magnitude to my estimates for the wider economic benefits of reduced congestion, which are between $500 million ($257 million in agglomeration benefits, and $245 million in higher incomes from commuting) and $1.2 billion ($512 million in agglomeration benefits plus $693 million in higher incomes from commuting).
- This implies that the hidden costs of congestion are similar to, and likely larger than, the visible costs of congestion.

### *Do the Total Benefits of Reduced Congestion Outweigh the Cost of New Taxes?*

What is the economic cost of the Mayors' Council plan? An increase in the PST, which is to be called the Metro Vancouver Congestion Improvement Tax, will be a cost for taxpayers and businesses. Taxes also have a wider economic cost: the marginal cost of funds. These are the costs to society of taxes because of transactions that

10 Further, the Mayors' Council's second estimate of economic benefits of reduced congestion assumes the increase in GDP comes from increased labour demand. My commuting benefit estimate is the effect of increased labour supply as a result of lower congestion.

people on the margin of making a purchase or working an extra hour no longer pursue due to higher taxes. Dahlby and Ferede (2011) find that when the province of British Columbia raises $1 of revenue from a sales tax, the social costs are $1.13. Applied to the estimated $250 million of PST revenue the province will collect, the social cost of the PST supplement is $283 million.

If the balance of the $750 million per year in investments is financed from other governments, the net cost-benefit analysis must include the social cost of the tax revenues they raise. If the federal government supplies $250 million, using Dahlby and Ferede's (2011) weighted average federal marginal cost of funds of 1.26, the economic cost would be $315 million. The remaining provincial share would cost society a further $283 million if financed by PST, but upwards of $458 million if financed by personal income tax and almost $3 billion if financed by corporate income taxes. A full cost-benefit analysis would need to take into account how long it would take for the benefits of transit to materialize after the investments were paid for, appropriate discount rates of the future savings, and much more.

If instead the balance of the $750 million per year is paid through user fees or congestion charges, this would have no broader economic cost. The revenues from any future congestion charges could be reinvested in transportation infrastructure. Indeed, the economic benefits I calculate above depend on an increase in average travel speeds the Mayors' Council estimates will result from congestion pricing.

Whether the benefits of the Mayors' Council's transportation plan passes a cost-benefit test depends on the additional revenue sources to finance the plan. Using congestion charges or sales taxes, and not income taxes, would keep the annual economic costs of the plan below $1 billion. But that figure would be over $3 billion if the province raised corporate income taxes.

## Conclusion

The economic costs of congestion – both the hidden and the visible costs – are large. Reducing the hidden costs alone would enable broader agglomeration economies, and new job opportunities, that could raise the incomes by up to $950 per worker per year. This increase in incomes is complementary to the visible savings from reduced congestion.

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This E-Brief is a publication of the C.D. Howe Institute.

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