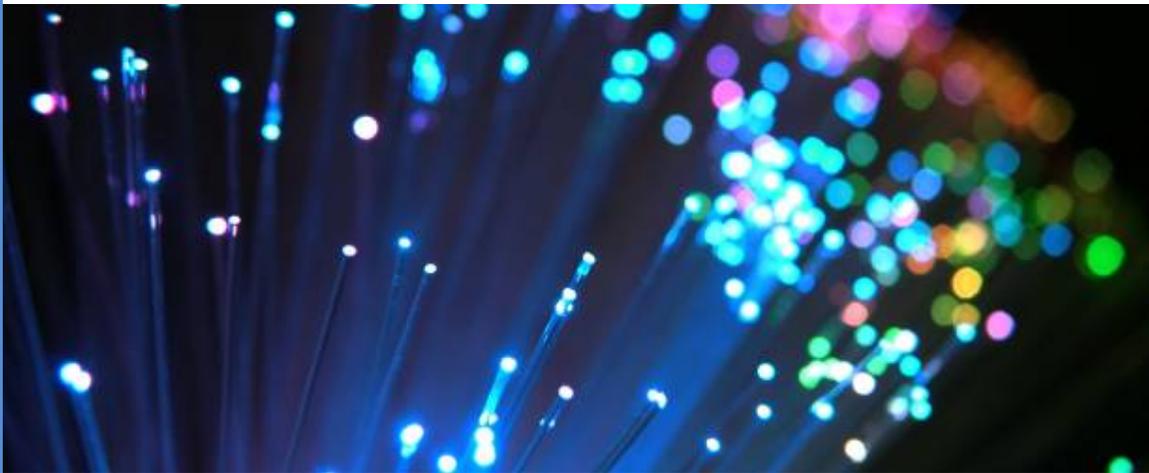


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Policy Brief:

The Economic Impact of the CRTC's Decision to Unbundle Fibre-to-the-Premises Networks

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Abstract

Abstract

In July 2015, the Canadian Radio-television and Telecommunications Commission (CRTC) expanded its unbundling obligations to cover fibre-to-the-premises (FTTP) networks. The telecom regulator takes comfort in the belief that the regulated wholesale rate for accessing an incumbent's FTTP network can be chosen in such a way as to not deter investment by Canadian Internet service providers. Yet regulators around the globe with the same stated intension have largely failed in that mission. Drawing from a literature review and original empirical analysis, this Policy Brief seeks to estimate the economic impact of the CRTC's expanded unbundling mandate on planned FTTP investment in Ontario and Quebec. To arrive at an estimate of the likely short-run investment loss, I multiply the expected decline in incumbent investment against Bell Canada's planned FTTP deployments in those two provinces. Next, I translate that expected investment decline into employment and output effects using traditional multipliers and estimated spillover effects. According to these estimates, the CRTC's 2015 Decision could discourage between \$72 and \$384 million in FTTP investment per year in Ontario and Quebec, leading to between 2,880 and 15,360 lost jobs, and between \$225 million and \$1.2 billion in lost economic output per year. The CRTC has offered no estimate of offsetting benefits to its FTTP unbundling plan.

Introduction

I. Introduction

Mandatory unbundling is a prescription for when a country experiences insufficient retail competition for the provision of Internet access services. Canada fails to satisfy this criterion. By 2013, 15 percent of Canadian homes were covered by “fibre to the premises” (FTTP),¹ 58 percent were passed by telco-based “fibre to the node” (FTTN)²—an intermediate fibre technology that stops short of bringing fibre to the subscriber’s home—and 95 percent of all homes were passed by cable-based fibre to the node (aka DOCSIS 3.x).³

Broadband competition requires at least two facilities-based providers offering comparable services.⁴ As of 2013, approximately 80 percent of the nation was covered by two wireline technologies (cable modem and DSL) capable of delivering download speeds

of at least 5 Mbps.⁵ Even more impressive, nearly 60 percent of Canadian households had access to two or more providers capable of achieving speeds of 25 Mbps down;⁶ this percentage would tend to increase as Canadian telco-based Internet service providers (ISPs) extend their next-generation networks. By comparison, by some estimates, only 25 percent of U.S. households had access to two or more providers capable of delivering speeds of 25 Mbps down as of December 2013.⁷

In the two years following the window of study in the last Canadian Radio-television and Telecommunications (CRTC) Monitoring Report (2014 and 2015), Canadian ISPs have expanded their fibre footprints to cover an even greater share of households. For example, Bell Aliant, which alongside Bell Canada comprises Bell’s ISPs, extended its FibreOP coverage to more than 325,000 premises across Nova Scotia and represents an investment of \$121 million since 2010; and

1. CRTC, Communications Monitoring Report 2014, Figure 5.1.5 (equal to 2 million homes divided by 13.3 million nationwide homes). As of 2013, there were approximately 520,000 FTTP connections in Canada. *See also* RVA Market Research, at slide 6.

2. CRTC, Communications Monitoring Report 2014, Figure 5.1.5 (equal to 7.8 million homes divided by 13.3 million nationwide homes).

3. *Id.* (equal to 12.6 million homes divided by 13.3 million nationwide homes).

4. *See, e.g.*, Scott Wallsten & Colleen Mallahan, Residential Broadband Competition in the United States, BE Press Working Paper, March 2010, at 32, Table 7 (finding that cable modem prices declined between \$1.25 (cable speed tier 6) and \$4.84 (cable speed tier 5) per month when cable modem providers faced an overbuilder).

5. CRTC, Communications Monitoring Report 2014, Figure 5.3.15 (assuming the DSL and cable modem footprints overlap).

6. *Id.* Table 5.3.12 (equal to the sum of 53% with two and 5% with three providers).

7. *See, e.g.*, Prepared Remarks of FCC Chairman Tom Wheeler, The Facts and Future of Broadband Competition, 1776 Headquarters, Washington, D.C. September 4, 2014 (citing NTIA State Broadband Initiative), *available at* http://transition.fcc.gov/Daily_Releases/Daily_Business/2014/db0904/DOC-329161A1.pdf.

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FibreOP is available to nearly one million homes and businesses in more than 70 communities across Atlantic Canada and Ontario.⁸ Greater Sudbury actually became the first community in Ontario with the next generation of FTTP communications delivered citywide.⁹ A planned FTTP deployment in Toronto by Bell Canada beginning in 2015 aims to deliver fibre to 1.1 million homes and businesses throughout Toronto, which would constitute the largest fibre deployment ever in Canada.¹⁰ This followed on the heels of Bell Canada launching its next-generation Bell Fibe service in Québec City in 2012 (which was presumably captured in the CRTC's latest report).¹¹

Broadband investment has been linked to greater employment¹² and economic growth.¹³ In addition to attracting human capital¹⁴ and potentially raising property values,¹⁵ enhanced broadband capabilities

8. Bruce Erskine, *Bell Aliant bolsters fibre optic system*, HERALD BUSINESS, May 7, 2014, available at <http://thechronicleherald.ca/business/1205963-bell-aliant-bolsters-fibre-optic-system>.

9. Bell Aliant expands FibreOP™ technology to Greater Sudbury, Ontario, Feb. 2, 2012, available at <http://www.newswire.ca/news-releases/bell-aliant-expands-fibreop-technology-to-greater-sudbury-ontario-509567841.html>.

10. Bell Gigabit Fibe bringing the fastest Internet to Toronto residents with a billion-dollar+ network investment, creation of 2,400 direct jobs, June 25, 2015, available at <http://www.bce.ca/news-and-media/releases/show/Bell-Gigabit-Fibe-bringing-the-fastest-Internet-to-Toronto-residents-with-a-billion-dollar-network-investment-creation-of-2-400-direct-jobs-1>.

11. Québec innovation and investment: Bell turns on broadband Fibe network throughout Québec City, Mar. 12, 2012, available at <http://www.bce.ca/news-and-media/releases/show/quebec-innovation-and-investment-bell-turns-on-broadband-fibe-network-throughout-quebec-city>.

12. See David Shideler, Narine Badasyan, and Laura Taylor, *The Economic Impact of Broadband Deployment in Kentucky*, Federal Reserve Bank of St. Louis Regional Economic Development, 3(2), 88-118, available at <https://research.stlouisfed.org/publications/red/2007/02/Shideler.pdf> (showing that broadband deployment contributes from 0.14 to 5.32 percent to total employment growth depending on the industry being studied). See also Robert Crandall, William Lehr and Robert Litan, *The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of U.S. Data*, 6 Issues in Economic Policy, Brookings (July 2007), available at <http://www.brookings.edu/views/papers/crandall/200706litan.pdf> (showing that for every one percentage point increase in broadband penetration in a state, employment increases by 0.2 to 0.3 percent per year.).

13. See David Sosa, *Early Evidence Suggests Gigabit Broadband Drives GDP*, Sept. 2014, available at <http://www.analysisgroup.com/article.aspx?id=15613> (showing that 14 gigabit broadband communities exhibited a per capita GDP approximately 1.1 percent higher than the 41 similar communities with little to no availability of gigabit services, leading to \$1.4 billion in added output).

14. A 2014 study about broadband investment in rural Minnesota communities revealed that over 30 percent of households say that they would definitely (19.6%) or very likely (21%) relocate to another community in order to receive broadband services, suggesting that "communities that can offer reliable broadband access tend to be relatively more attractive to businesses and residents." Strategic Networks Group, Inc. *The Return from Investment in Broadband Infrastructure and Utilization Initiatives*, for Blandin Foundation (Jan. 2014), available at http://blandinfoundation.org/_uls/resources/SNG--ROI-from-Broadband-Infrastructure-and-Utilization-01-31-14.pdf.

15. Gabor Molnar, Scott Savage & Douglas Sicker, *The Impact of High-speed Broadband Availability on Real Es-*

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can spawn new applications, which in turn support local economic growth. For example, Google Fiber partnered with University of Kansas Medical Center to develop a gigabit medical application that will allow patients to consult with physicians without leaving their homes;¹⁶ Google's investment has been credited with inducing several tech startups to relocate to Kansas City.¹⁷

Some meaningful portion of the benefits from continued broadband investment is now at risk thanks to a sharp course correction by the CRTC. In July 2015, the CRTC decided to expand its unbundling mandate—

albeit in a modified form—to include fibre-to-the-premises (FTTP) networks (the “2015 CRTC Decision”).¹⁸ In a prior decision from 2010, the CRTC limited its intervention to mandate access to “aggregated wholesale high-speed access”¹⁹ services to telco fibre-to-the-node (FTTN) and cableco DOCSIS 3.0 facilities, thereby exempting FTTP from mandatory unbundling.²⁰ The CRTC decided to implement the expanded unbundling regime in phases, starting with Ontario and Quebec (both of which are part of Bell Canada's footprint).²¹

* * *

The purpose of this *Policy Brief* is to estimate the potential forgone benefits in terms of employment and economic output that can be attributed to the CRTC's 2015 Decision to mandate unbundling of FTTP networks. The

tate Values: Evidence from the United States Property Markets, Preliminary Results (Aug. 2013), available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2241926. The authors determined that the presence of fibre-based broadband was associated with a positive effect on property values. See also RVA Market Research, The State of North American FTTH, presented at FTTH 2013 Conference & Expo, Sept. 30, 2013, slide 47 (showing that a FTTH connection increases the value of a \$300,000 home by between \$5,300 and \$6,400).

16. Sam Gustin, *After Austin: Five Reasons You'll Want Google Fiber in Your City*, TIME, Apr. 11, 2013, available at <http://business.time.com/2013/04/11/after-austin-five-reasons-youll-want-google-fiber-in-your-city/>.

17. See, e.g., Cerner Enters Into Agreement to Purchase Former Bannister Mall Site, Cerner, Aug. 1, 2013, available at http://www.cerner.com/Cerner_Enters_Into_Agreement_to_Purchase_Former_Bannister_Mall_Site/; Cecilia Kang, Google Fiber provides faster Internet and, cities hope, business growth, WASHINGTON POST, Jan. 25, 2013, available at http://www.washingtonpost.com/business/technology/google-fiber-provides-faster-internet-and-cities-hope-business-growth/2013/01/25/08b466fc-6028-11e2-b05a-605528f6b712_story.html.

18. CRTC, Telecom Regulatory Policy 2015-326, Review of wholesale wireline services and associated policies, July 22, 2015, available at <http://www.crtc.gc.ca/eng/archive/2015/2015-326.pdf> [hereafter *CRTC Decision*].

19. This path to market entry includes an access component, a transport component, and the interface component. The mandate from the 2015 decision includes an access component and the interface component (omitting the transport component).

20. CRTC, Telecom Regulatory Policy 2010-632, Wholesale high-speed access services proceeding, Aug. 30, 2010, ¶ 121, available at <http://www.crtc.gc.ca/eng/archive/2010/2010-632.htm> (“In the case of the ILECs, the facilities that are subject to wholesale obligations include FTTN and, in the case of the cable carriers, DOCSIS 3.0 facilities.”).

21 *Id.* ¶152.

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Policy Brief is organized as follows: In Part II, I develop a range of investment effects associated with mandatory unbundling. Because Telus (which operates in Alberta) will be largely shielded from the mandates in the short run, I focus on the impact on Bell Canada's investment.²² Then based on original analysis and evidence from existing economics literature, I estimate that the likely short-run decline in Bell Canada's FTTP investment will be between 6 and 32 percent.

In Part III, I estimate Bell Canada's planned FTTP investments, which were announced before the CRTC issued its 2015 Decision, by applying the percentage decline in investment (from Part II) against this base of planned investment. This gives the expected reduction in investment in dollar terms attributable to the CRTC's 2015 Decision. According to my estimates, Bell Canada was expected to invest \$1.2 billion in fibre per year *in the absence of an FTTP unbundling obligation* over the coming years, which implies

that the expected annual investment loss attributable to the CRTC's unbundling obligation in Ontario and Quebec would be between \$72 million (a 6 percent decline) and \$384 million (a 32 percent decline).

In Part IV, I estimate the number of jobs and economic output in the two provinces that could be sacrificed as a result of the CRTC's 2015 Decision. Before considering spillover effects, the CRTC's 2015 rules could eliminate between 1,440 jobs (associated with a 6 percent investment decline) and 7,680 jobs (associated with a 32 percent investment decline) in Ontario and Quebec through the "total multiplier," which accounts for direct, indirect, and induced job effects. In addition there is likely to be spillover effects, which have been estimated to generate one additional job loss for every job loss created through the multiplier effect. Including spillover effects, the CRTC's 2015 Decision could lead to a reduction of between 2,880 and 15,360 jobs in the two provinces. Finally, in terms of output effects, the CRTC's 2015 Decision could lead to a reduction of between \$225 million and \$1.2 billion in gross domestic product.

22. That Telus recently announced its intention to deploy fibre in Vancouver is not informative of the impact of the rule, as (1) Telus is largely shielded from the rule in the short-run, and (2) the effect of the rule will manifest at the *margin*—that is, the difference between realized investment and but-for investment. See, e.g., [Sean Buckley](#), *Telus commits \$762M to build Vancouver FTTP network*, FIERCE WIRELESS, Oct. 5, 2015. The model presented here does not predict that fibre investment will disappear in the presence of unbundling. Thus, evidence of continued investment in the presence of unbundling is largely uninformative of the incremental effect.

Impact of Unbundling on Investment

II. The Impact of Mandatory Unbundling on Incumbent Investment

In this section, I rely on original analysis and evidence from the existing economic literature to develop a range of likely investment effects that could be induced by the CRTC's 2015 Decision. In theory, mandated (as opposed to voluntary)²³ unbundling reduces an incumbent's expected return, and thus should reduce incumbent investment. The question is by how much. While there is no direct analogy to the Canadian experiment, there is information from previous mandated access regimes that can be used to inform the magnitude. I begin by studying a natural experiment in Canada, in which the telecom regulator afforded asymmetric treatment to FTTN and FTTP technologies. Next, I exploit a second natural experiment involving asymmetric regulation, this time in the United States (DSL versus cable modem service). I then turn to the economic literature to refine my estimate of the likely investment ef-

23. A rational network owner would charge an access price that makes it indifferent between acting as a wholesaler and as a vertically integrated retailer. The purpose of mandatory access (as opposed to voluntary access) is to push the access price *below* the rate that would fully compensate the network owner for its forgone retail margin. Thus, the CRTC's assurance in its 2015 decision that ISPs will be fully compensated via the access-pricing regime (nonsensically) implies that there is no need for regulation. In reality, the mandated access rate will reduce the ISP's return relative to a world in which it could set its own access rate.

fects of mandatory unbundling on incumbent investment.

A. A Natural Experiment in Canada: Fibre-to-the-Node Versus Fiber-to-the-Premises

Recall from the introduction that the CRTC initially exempted FTTP from its unbundling mandate in 2010; the access technologies that were subject to unbundling were DSL, cable modem, and FTTN. The CRTC's disparate treatment of FTTN and FTTP from 2010 through 2015 represents a natural experiment that can be exploited to infer the incremental effect of unbundling on incumbent investment. In the absence of disparate treatment, one would expect investment in the two fibre-based access technologies to grow at the same rate; even if one technology were more popular than the other, the difference should manifest in the *levels* of investment as opposed to the growth. To avoid confusion, I refer to FTTN as "Node" and FTTP as "Premises" in this discussion.

Bell Canada has produced to me a decomposition of its fibre-based investment by year by technology. Figures 1 and 2 show the annual investment by Bell Aliant (which operates in Atlantic Canada as well as various communities in Northern Ontario), and Bell Canada (which serves the remainder of Bell Canada's footprint), respectively, in Node and Premises technologies from 2009

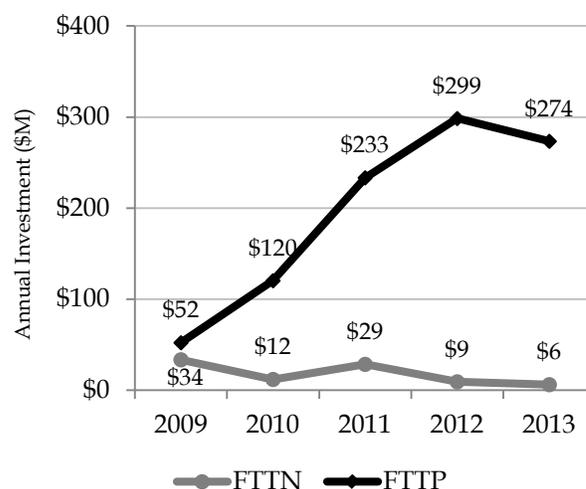
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through 2013, the latest available data on Bell Canada’s fibre-based deployment.

If mandatory unbundling has no impact on investment, then one would not expect to see a rapid shift in investment from a mature yet non-ubiquitous technology (Node) to a new, riskier, and more expensive technology (Premises). As Figures 1 and 2 show, however, Bell Canada shifted its investments dramatically from Node to Premises over this time period, presumably in part to avoid the unbundling mandate. Indeed, Bell Canada’s Premises investment overtook its Node investment in 2013 (\$493 million versus \$425 million). For Bell Aliant, the cumulative average growth rate (CAGR) for Node investment over this period was -34.2 percent versus 51.2 percent for Premises; for Bell Canada, the CAGR for Node investment was 3.6 versus 72.9 percent for Premises.

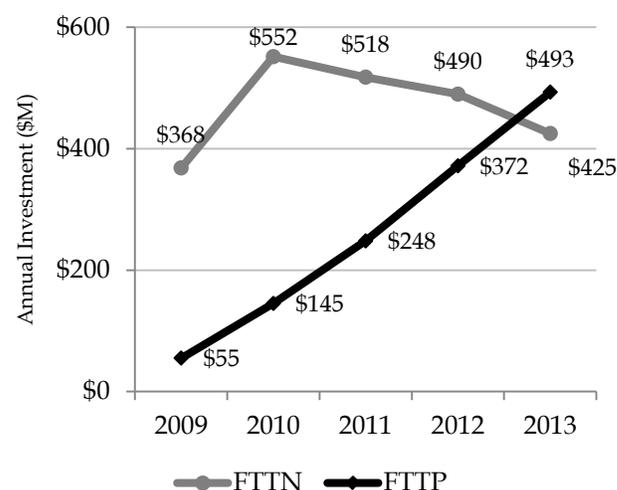
Economists often employ difference-in-differences (“DID”) analysis because it allows one to control for factors influencing a variable of interest (here, investment), which may have changed over time.²⁴ In this scenario, by including Premises investment as

Figure 1
Bell Aliant Investment by Technology



Source: Bell Canada.

Figure 2
Bell Canada Investment by Technology



Source: Bell Canada.

24. See, e.g., David Card & Alan Krueger, *Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania*, 84 AMERICAN ECONOMIC REVIEW 772-793 (1994) (employing a DID model to estimate the impact of New Jersey’s increase in minimum wages on employment in the fast food industry).

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a control in a DID model, changes in common factors influencing the investment decisions in both access technologies are controlled for even when these variables are not directly observable. Using the change in Premises investment as a proxy for what should have happened to Node investment in the absence of unbundling, shows that the 2010 unbundling rules are associated with a \$248.5 million decrease in Node investment by Bell Aliant, and with a \$381.3 million decrease in Node investment by Bell Canada (a combined decrease of \$629.8 million). That is, annual Node investment should have increased by \$660 million as indicated by the increase in Premises investment, but instead increased by a mere \$30 million.

To be sure, some of this decline can be attributed to substitution from the mature to the new access technology. Node is a cheaper access technology and therefore fits some environments better than Premises.²⁵ When

Node is saddled with a regulatory requirement, however, the relative benefits of Node disappear, which may result in no investment in certain neighborhoods. In particular, for certain “marginal” Canadian neighborhoods where the expected penetration was modest, Premises investment was not a viable alternative for Node. This implies that there was at least some “leakage” of capital expenditures from the Canadian Internet ecosystem.

Consider the following illustrative example: A marginal (as opposed to the typical) neighborhood is served only by DSL and cable modem; the deployment cost per home for Node and Premises are \$500 and \$1000,²⁶

25. See, e.g., Stefaan Vanhastel and Wim Van Daele, *Mining Tactics for Migration to Fiber*, OSP, available at <http://www.ospmag.com/issue/article/vdsl2-turning-copper-gold> (“Typically, in brownfield situations, an FTTH deployment will be three times cheaper than an FTTH architecture because the copper between the street cabinet and the subscriber is being re-used. . . . All in all, in competitive environments where time and money are the major determining factors (in other words, pretty much everywhere), FTTH (as well as FTTC/B, for that matter) permits a less capital-intensive, and faster, deployment than FTTH.”); Richard Clarke, FTTH/VDSL2 Broadband Networks, AT&T, Apr. 18,

2008, at Slide 19 (“Cost per subscriber [for FTTH] is about half PON FTTH cost of ~US\$2000.”).
26. See, e.g., ICT Regulation Toolkit, Cost Analysis for FTTH, available at <http://www.ictregulationtoolkit.org/en/toolkit/notes/PracticeNote/2974> (Figure 4) (showing cost per home of FTTH in urban areas of \$500, rising to \$1000 in suburban areas); CSMG, FTTH Deployment Assessment, Oct. 13, 2009, available at http://www.neofiber.net/Articles/FTTH_Assessment_of_Costs.pdf (Slide 4) (showing Verizon FiOS cost per home for FTTH of \$1350 as of 2009); *Fiber cheaper than DSL?*, Fastnews.com, July 14, 2009, available at <http://fastnetnews.com/fiber-news/175-d/1902-fiber-cheaper-than-dsl> (“This is very similar to Verizon’s current costs of about \$670/home. That compares to costs of ‘less than \$300’ for FTTH/DSL from remote terminals . . .”); Richard Clarke, FTTH/VDSL2 Broadband Networks, AT&T, Apr. 18, 2008, Slide 17 (“Success-based costs (NID, STB, install) [for FTTH] in US\$600-\$700 range.”); RBC Telecom Scenario Report Fibre-to-the-home: Playing the long game, Aug. 19, 2015, at 24 (showing average cost per premise for FTTH for BCE of

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respectively; a subscriber is worth \$4,000 in present discounted value; and the expected penetration rate in this underserved neighborhood is 25 percent due to less-than-average household income. Under these assumptions, deploying Premises is *not* profitable (an expected gain is $\$0 = 0.25 \times \$4,000 - \$1,000$), whereas deploying Node is profitable (an expected gain of $\$500 = 0.25 \times \$4,000 - \$500$). In this scenario, decreasing the present discount value from the Node deployment through unbundling (from \$4,000 to say \$2,000), as the CRTC did in 2010, means that no investment occurs (the new expected gain from Node investment is $\$0 = 0.25 \times \$2,000 - \$500$). There is no substitution to Premises because Premises is also not profitable in this scenario (its costs are too high), and the neighborhood goes without fibre entirely.

Moreover, even in neighborhoods that received Premises investment (due solely to the regulatory distortion), because Premises is more expensive on a per home basis, fewer homes were covered in that neighborhood for any given level of expenditure. Given that we observe Premises investment, the expected return on Premises investment for the neighborhood clearly exceeded the provider's cost of capital. To the extent that the

expected return on Node investment *would have been even higher* in the absence of Node unbundling, more homes would be wired with fibre. Continuing the prior example, an investment of \$1 million in Node will cover 2,000 homes (equal to \$1 million divided by \$500 per home), but that same investment will provide coverage for only 1,000 homes (equal to \$1 million divided by \$1,000) if it is diverted to Premises. Accordingly, Node unbundling in Canada likely resulted in lower fibre penetration through some combination of diminished investment and diminished coverage per dollar invested.

This simple illustration is consistent with the experience of fibre deployment in the United States. Using Node technology, AT&T passed significantly more homes in the United States than did Verizon using Premises technology.²⁷ Accordingly, it is reasonable to infer that a non-trivial share of the combined \$629.8 million implied decrease in Node investment leaked from the Canadian ecosys-

\$1,060); Scotiabank, *Converging Networks*, Aug. 31, 2015, Exhibit 2 (showing cost per home passed for FTTH of \$700).

27. Mark Lowenstein, *What should AT&T do now that it owns DirecTV?*, FIERCE WIRELESS, July 29, 2015, available at <http://www.fiercewireless.com/story/lowensteins-view-what-should-att-do-now-it-owns-directv/2015-07-29> (estimating "about 30 million homes 'passed' with U-Verse, compared with 17 million for Verizon FiOS"); AT&T U-Verse Catches FiOS, available at <http://www.lightreading.com/broadband/fttx/atandt-u-verse-catches-fios/d/d-id/703508> ("With that increase, AT&T boasts 9.1 million U-Verse Internet subscribers, far more than Verizon's total of 5.8 million subs for FiOS Internet."). This comparison does not control for difference in the size of ISPs' territories.

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tem or was diverted to a higher-cost technology, resulting in fewer homes having access to fibre. Even a modest five percent leakage implies that some 63,000 Canadian homes (equal to \$31.5 million divided by \$500 per home) are not covered by fibre to the node due to the CRTC's 2010 unbundling mandate. This conclusion is consistent with Bell Canada's comments in the proceeding.²⁸

B. A Natural Experiment in the United States: DSL Versus Cable Modem

Like the CRTC's asymmetric treatment of FTTN and FTTP from 2010 to 2015, the FCC similarly treated telco-based ISPs differently from cable-based ISPs from 1998 through 2005. This gives rise to another natural experiment of sorts, which allows one to develop a prediction of the likely investment effect of the CRTC's 2015 Decision. Unlike Canada's natural experiment, which permitted telcos to substitute from one technology (FTTN) to another (FTTP) to avoid the unbundling obligation, short of becoming cable operators, U.S. telcos in the early 2000s had no alternative but to wait for (unregulated)

fibre-based technology to evolve. The mandated-unbundling-induced leakage was 100 percent.

Following the 1996 Telecom Act, the FCC imposed classic common-carrier obligations on telcos, including mandatory unbundling. For example, in 1999, the FCC required telcos to share a portion of their lines with resellers of DSL service at regulated rates ("line sharing"). The two access technologies did not achieve regulatory parity until August 2005, when DSL was reclassified as an information service.²⁹

Unlike DSL service, cable modem service was classified as an information service from its inception, and was never subject to the FCC's unbundling regime. Thus, the natural control group to measure the impact of unbundling on telco investment is cable operators. Here, by including cable as a control in a DID model, changes in common factors influencing the investment decisions of both

28. Bell Canada Final Comments ¶ 5 ("Our experience also shows that after the CRTC mandated wholesale access to services enabled by FTTN facilities in 2010, our broadband networks were rolled out to *approximately 400,000 fewer homes than we had originally planned* over the two subsequent years. For Bell Canada, FTTP is between 33% and 186% more expensive than FTTN, so the impact of mandated access on FTTP investment is much more dramatic.") (emphasis added).

29. *FCC Classified DSL as Information Service*, TECH LAW JOURNAL, Aug. 5, 2005, available at <http://www.techlawjournal.com/topstories/2005/20050805a.asp>. The appellate courts partially dismantled the common-carrier regime before 2005. For example, the D.C. Circuit Court of Appeals vacated the FCC's Line Sharing Order in May 2002. *USAT v. FCC*, 290 F. 3d 415 (D.C. Cir. 2002). The FCC eliminated line sharing as an unbundled network element in August 2003. Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers, CC Docket No. 01-338, Report and Order on Remand and Further Notice of Proposed Rulemaking, FCC 03-36 (rel. Aug. 21, 2003).

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telcos and cable companies are controlled for even when these variables are not directly observable.

So what does the DID model tell us about the effect of unbundling on telco investment? First, we need to estimate the growth in cable capex over the relevant period, which will serve as a benchmark for how telco capex should have grown in the absence of the unbundling obligation. Next, we can compare the actual growth in telco investment against this benchmark. The difference in the differences gives a measure of the impact of unbundling on incumbent investment. According to a report by the Columbia Institute for Tele-Information (CITI),³⁰ cable capital capex had reached \$15.9 billion by 2008 (the earliest date in the CITI sample), and the “major telco wireline” capex (excluding wireless) reached \$26.3 billion. In 1996, cable capex was \$6.7 billion, per the Telecommunications Industry Association (TIA), and telco capex (as measured by the capex of the local exchange carriers) was \$18.1 billion.³¹ Thus, over the interven-

ing period where telcos were uniquely subject to unbundling (at least through 2005), cable capex increased by \$9.2 billion for a CAGR of 7.5 percent, but telco capex increased by only \$8.2 billion for a CAGR of 3.2 percent.

Using these data (a combination of CITI and TIA), the simple DID model suggests that unbundling was responsible for *slowing* telco investment by roughly \$1 billion per year (equal to the \$10.4 billion difference between the two groups in 2008 less the \$11.4 billion difference in 1996). A \$1 billion decline represents a 5.5 percent decline relative to the telcos’ 1996 capex. Moreover, the growth rate of cable capex was double that of regulated telcos over this period (7.5 percent versus 3.2 percent).

The advantage of using CITI and TIA capex data is that it is public and replicable. The disadvantage is that it comes from two different sources, which potentially raises measurement issues. Using USTelecom’s proprietary data for cable and telco broadband-related capex paints a more dramatic picture. (USTelecom makes total ISP wireline investment available on its website.³²) The difference in the differences in

30. Robert Atkinson & Ivy Schultz, *Broadband in America: Where Is It and Where Is It Going?* Preliminary Report Prepared for the Staff of the FCC’s Omnibus Broadband Initiative, Nov. 2009, available at <http://www8.gsb.columbia.edu/rfiles/citi/91a20123-2501-0000-0080-984f56e8d343.pdf>.

31. TIA, *Investment, Capital Spending And Service Quality In U.S. Telecommunications Networks: A Symbiotic Relationship*, Nov. 2002, available at

http://www.tiaonline.org/policy_/publications/filings/documents/Nov13-2002_CapEx_QoS_Final.pdf.

32. USTelecom, *Historical Broadband Provider Capex*, available at <http://www.ustelecom.org/broadband->

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capex between 2008 and 1996 (for comparison with the first estimate) is \$10.6 billion, an implied decline of 38.7 percent attributable to the difference in regulatory treatment. The difference in the differences between 2005 and 1996 (the relevant window) is \$10.2 billion, an implied decline of 37.2 percent.

C. Review of Economic Literature

The DID results—that unbundling decreased ISP investment by between 5.5 percent (based on CITI and TIA data) and 37.2 percent (based on USTelecom data)—is corroborated by a 2014 paper by Kevin Hassett and Robert Shapiro, which similarly attempts to estimate the impact of unbundling obligations on telco-based ISPs. The authors exploit the FCC’s asymmetric treatment of wireless and wireline investment: Like cable-based Internet service, wireless broadband service was regulated under a light-touch approach (as opposed to common-carrier regulation).³³ Hassett and Shapiro estimate the share of (regulated) wireline investment that can be explained by movements in (the relatively deregulated) wire-

less investment. The portion that cannot be explained this way serves as an estimate of the “constrained” wireline investment subject to unbundling, which allows one to infer the relative impacts of the different forms of regulation. They estimate that the more stringent rules were associated with a reduction in telco wireline investment between 17.8 percent and 31.7 percent per year.³⁴ A supplemental 2015 study by the same authors estimates that a movement from the (formerly) light-touch U.S. regulatory regime to a European-style unbundling regime is predicted to reduce investment by 36 percent.³⁵

There has been limited economic research on the impact of unbundling on incumbent investment for countries outside the United States. Most of the research focuses on the effect of unbundling on broadband penetration, which is a proxy for investment (as there cannot be adoption without investment). For example, Wallsten and Hausladen (2009) test the effects of unbun-

[industry-stats/investment/historical-broadband-provider-capex](#). A breakdown by technology was provided to the author.

33. Kevin A. Hassett & Robert J. Shapiro, *The Impact of Title II Regulation of Internet Providers On Their Capital Investments*, Sonecon, November 2014, available at http://www.sonecon.com/docs/studies/Impact_of_Title_II_Reg_on_Investment-Hassett-Shapiro-Nov-14-2014.pdf.

34. *Id.*

35. Kevin A. Hassett & Robert J. Shapiro, *Regulation and Investment: A Note on Policy Evaluation Under Uncertainty: With an Application to FCC Title II Regulation of the Internet*, July 2015, at 18-19, available at http://cbpp.georgetown.edu/wp-content/uploads/HassettShapiro_Policy-EvaluationUnderUncertainty.pdf.

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dling on fibre connections per capita.³⁶ Using a regression model that controlled for income, population, and other demographic variables, they examined the link between fibre connections and unbundled lines from 27 European countries between 2002 and 2007. The authors find that “countries with more broadband connections per capita provided through local loop or bitstream unbundling have fewer fiber connections . . . per capita provided by the incumbent and entrants.”³⁷ In particular, for every unbundled line per capita in a country, they estimate that the number of fibre connections per capita declines by 0.041.³⁸

To compare this result to the percentage investment effects described above, consider the following scenario: If a country increased its share of unbundled lines from 5 to 10 percent of the population by extending its unbundling obligation to fibre—as did France and the UK³⁹—the number of fibre

connections would fall by 8.2 percent according to this model;⁴⁰ increasing the share of unbundled lines from 5 to 20 percent would lead to a 16.4 percent reduction in (per capita) fibre lines.⁴¹ To the extent that a decrease in fibre connections is a reasonable proxy for a decrease in fibre investment, this model further corroborates the finding of the DID model discussed earlier.

This range of likely investment effects from mandatory unbundling is modest compared to the findings from an earlier experiment in Europe that took place in the late 1990s. Grajek and Röller (2009) estimated the effect of unbundling in 20 EU member states⁴² on incumbents’ and entrants’ investment deci-

36. Scott Wallsten and Stephanie Hausladen, Net Neutrality, Unbundling, and their Effects on International Investment in Next-Generation Networks, *Review of Network Economics*, Vol. 8, Issue 1 (March 2009), 90-112, available at https://www.techpolicyinstitute.org/files/wallsten_unbundling_march_2009.pdf.

37. *Id.* at 102 (emphasis added).

38. *Id.* Table 3a.

39. *European Commission highlights regulatory approach for fiber to the home*, MUNIWIRELESS, June 21, 2009, available at <http://www.muniwireless.com/2009/06/21/european-commission-approach-for-fiber-to-the-home/> (“Access to other passive elements (unbundling of the fibre loop

or access to active elements – service based competition (“bitstream”) – should also be mandated, according to the draft Recommendation. The Commission wants its final recommendations to be applied by all European NRAs before the end of 2009. Several countries as Portugal, France, UK or Germany have already adopted obligations concerning FTTH or FTTN networks build out. In France ARCEP is supposed to announce new dispositions next week.”). *See also* Wallsten & Hausladen, *supra*, Figure 4.

40. The predicted share of fibre lines per capita given a 10 percent share of unbundled lines is 4.59% (equal to 5% less $0.41 \times 10\%$).

41. The predicted share of fibre lines per capita given a 20 percent share of unbundled lines is 4.18% (equal to 5% less $0.41 \times 20\%$).

42. The following EU countries are included in the study (EU 15): Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Portugal, Sweden, and the United Kingdom. The study also includes the following EU 12 countries (new member states after the 2004 and 2007 accession): Bulgaria, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, and Slovenia.

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sions between 1997 and 2006.⁴³ The authors used an index of access regulation to measure regulatory intensity, which includes full unbundling, line sharing, bitstream access, and subloop unbundling. After controlling for the presence of entrants and GDP per capita, among other things, the authors found that increasing regulatory intensity by the average change in the regulatory regime in the EU 15 between 1997 and 2002 reduced incumbents' infrastructure stock by an estimated 48.7 percent in the short-term.⁴⁴ In the long-term, the effect is quite similar (47 percent).⁴⁵ Grajek and Röller's estimate is significantly higher than the upper bound implied by the DID model.

D. Summary of Findings

Table 1 summarizes these findings in the context of the economics literature. To be fair, there are some unpublished discussion

papers that are not able to detect a statistically significant impact of access regulation on incumbent investment.⁴⁶ Yet even those authors reached a different conclusion during subsequent research that was ultimately published.⁴⁷ Accordingly, based on original

43. Michal Grajek & Lars-Hendrik Röller, *Regulation and Investment in Network Industries: Evidence from European Telecoms*, 55(1) JOURNAL OF LAW AND ECONOMICS 189-216, available at <https://www.esmt.org/regulation-and-investment-network-industries-evidence-european-telecoms-0>.

44. *Id.* at 16. The estimate is equal to the product of 0.5 (the average change in the regulatory regime in EU 15 between 1997 and 2002) and -0.975, the estimated coefficient on the key explanatory variable (Regulation). *Id.* Table 4.

45. *Id.* ("Taking this into account, we find that increasing the regulation index by 0.5 reduces incumbents' infrastructure stock by approximately 47 percent over the long term. In other words, the negative impact of regulation on incumbent's investment incentive is only partially compensated by strategic complementarity.").

46. See, e.g., Hans Friederiszick, Michal Grajek, & Lars-Hendrik Röller, *Analyzing the Relationship between Regulation and Investment in the Telecom Sector*, March 2008, at Table 3, available at http://www.researchgate.net/profile/Michal_Grajek/publication/228353806_Analyzing_the_relationship_between_regulation_and_investment_in_the_telecom_sector/links/0a85e52d517c7aa099000000.pdf (showing a negative yet statistically insignificant effect on incumbent investment). See also Wolfgang Briglauer, Klaus Gugler, & Adhurim Haxhimusa, *Facility- and service-based competition and investment in fixed broadband networks: Lessons from a decade of access regulations in the European Union member states*, ZEW Discussion Papers, No. 15-048, available at <http://www.econstor.eu/bitstream/10419/112761/1/832562270.pdf> (finding no statistically significant effect between access regulation and incumbent capex).

47. Michal Grajek & Lars-Hendrik Röller, *Regulation and Investment in Network Industries: Evidence from European Telecoms*, 55(1) JOURNAL OF LAW AND ECONOMICS 189-216 (finding that increasing regulatory intensity by the average change in the regulatory regime in the EU 15 between 1997 and 2002 reduced incumbents' infrastructure stock by an estimated 48.7 percent in the short-term). Similarly, in a subsequent published paper, Briglauer & Gugler found a negative effect of access regulation on fibre deployment, suggesting that the measure of the dependent variable (capex generally versus fibre investment in particular) is critical. See Wolfgang Briglauer & Klaus Gugler, *The Deployment and Penetration of High-Speed Fiber Networks and Services: Why are European Member States Lagging Behind?* 37 TELECOMMUNICATIONS POLICY 819-835, at 832 (2013) ("However, in line with the literature cited in Section 2, our qualitative analysis shows that the strict cost-based mandatory access regime underlying the EU regulatory framework is at odds with achieving the goals of the Digital Agenda. An international cross-sectional comparison indicates

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analysis and the economics literature, the estimated impact of unbundling on incumbent investment appears to range from approximately 6 to 49 percent. To be conservative, I use the range of 6 to 32 percent (effectively omitting Grajek and Röller, as well as the upper-bound estimate from the DID result), to gauge the likely impact of the CRTC's unbundling on planned FTTP investment in Ontario and Quebec.



Accordingly, based on my original analysis and the economics literature, the estimated impact of unbundling on incumbent investment appears to range from approximately 6 to 49 percent.

strong reluctance of European incumbent operators to undertake FTTH/B deployment. . .”).

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Table 1
Summary of Incumbent Investment Effects of Unbundling

Study	Sample	Methodology	Lower Bound (%)	Upper Bound (%)
Singer (2015)	USA	DID	5.5	37.2
Hassett & Shapiro (2014)	USA	Regression	17.8	31.7
Wallsten & Hausladen (2009)	European Union	Regression	8.2	16.4
Grajek & Röller (2009)	European Union	Regression	NA	48.7

Planned FTTP Investment

III. Planned FTTP Investment in the Absence of the 2015 Unbundling Rules

Before the CRTC's 2015 Decision, Bell Canada and TELUS announced several fibre-based broadband investment initiatives across Canada. For example, TELUS intended to invest \$4.2 billion over the next three years in "new infrastructure facilities" across Alberta.⁴⁸ In Edmonton, TELUS planned to invest \$1 billion over three years to connect more than 90 percent of the homes and businesses to their fibre-optic network.⁴⁹ Because Telus will be shielded from the immediate effects of the expanded unbundling obligation, I conservatively omit these planned investments in my calculations. I also omit any planned investment by Manitoba Telecom, which appears to have scaled back its 2010 FTTP investment plan.⁵⁰

48. TELUS will invest \$4.2 billion across Alberta through 2018, Media Releases, available at https://about.telus.com/community/english/news_centre/news_releases/blog/2015/04/06/telus-will-invest-42-billion-across-alberta-through-2018.

49. New TELUS fibre optic network will help spur the next wave of social and economic opportunity in Edmonton, Media releases, available at https://about.telus.com/community/english/news_centre/news_releases/blog/2015/06/19/test.

50. RBC Telecom Scenario Report Fibre-to-the-home: Playing the long game, Aug. 19, 2015, at 22 ("Manitoba Telecom reaching the end of a largely unfinished 5-year plan - In 2010, Manitoba Telecom announced that by the end of 2015, the company intended to deploy FTTH to 120,000 premises in 20 communities. By the end of 2014,

Bell Canada intended to invest \$20 billion over the next five years, "ensuring Canada remains competitive at a global level in next-generation broadband communications."⁵¹ Bell Canada announced capital expenditures of \$827 million in the first quarter of 2015, up 13.4 percent over the prior year, which "reflected continued deployment of broadband fibre, including expansion of our fibre to the home (FTTH) footprint . . ."⁵² In June 2015 (prior to the CRTC's 2015 Decision), Bell Canada announced plans to invest \$1.14 billion in Canada's biggest gigabit infrastructure project in Toronto.⁵³ In addition, in Atlantic Canada, Bell planned \$2.1 billion in capital investment over the next five years in broadband wireline and wireless networks.⁵⁴ As one analyst projects, the deployment of

FTTH had reached 35k premises, increasing to 42k by Q2/15.") (emphasis added).

51. BCE reports first quarter 2015 results, News Releases, available at <http://www.bce.ca/news-and-media/releases/show/BCE-reports-first-quarter-2015-results?page=2&month=&year>.

52. *Id.*

53. Bell Gigabit Fibe bringing the fastest Internet to Toronto residents with a billion-dollar+ network investment, creation of 2,400 direct jobs, June 25, 2015, available at <http://www.bce.ca/news-and-media/releases/show/Bell-Gigabit-Fibe-bringing-the-fastest-Internet-to-Toronto-residents-with-a-billion-dollar-network-investment-creation-of-2-400-direct-jobs-1>.

54. *Bell Boosts Broadband in Atlantic Canada with Acquisition, Investment, Privatization Plans*, MEDIACASTER, Jul. 23, 2014, available at <http://www.mediacastermagazine.com/news/bell-boosts-broadband-in-atlantic-canada-with-acquisition-investment-privatization-plans/1003171114/?&er=NA>.

Planned FTTP Investment

FTTP to 75 percent of their total footprints would require investment outlays of \$9 billion for Bell Canada, \$5 billion for TELUS, and \$500 million for Manitoba Telecom.⁵⁵

These planned investments include non-fibre deployments, including mobile broadband. To arrive at a fibre-specific investment plan, I computed the ratio of fibre investment to total capital expenditures in 2013 for Bell Canada based on the fibre data presented in Figures 1 and 2 (equal to \$1.198 billion divided by \$3.571 billion or 33.5 percent).⁵⁶ I also computed the ratio of Bell Canada's total FTTP investments in 2014 (which excludes FTTN) to the sum of wireline and wireless capex (equal to \$751 million divided by \$2.725 billion or 27.5 percent). It is therefore reasonable to infer that fibre-based investments will account for roughly 30 percent of Bell's capex over the coming years.

Next, I impose that share of 30 percent on the total planned annual investment for Bell Canada (\$4.0 billion)⁵⁷ over the coming years, which yields a predicted fibre investment *in the absence of unbundling* of \$1.2 billion. Using the investment effects estimated in Part II, I estimate that Bell Canada's FTTP investment will decline by between \$72 million (equal to 6 percent of \$1.2 billion) and \$384 million (equal to 32 percent of \$1.2 billion) in the presence of the FTTP unbundling obligation.

55. RBC Telecom Scenario Report Fibre-to-the-home: Playing the long game, Aug. 19, 2015, at 24.

56. BCE Inc. 2013 Annual Report, at 77 (showing total capex). This does not imply that prior FTTN and FTTP investment projects were fungible; indeed, given that FTTN investments effectively disappeared for Bell Aliant, this assumption has no bearing. Even with respect to Bell Canada, which invested a non-trivial amount in FTTN in 2013, the company has announced its intentions to shift future investment activities to FTTP. See, e.g., RBC Telecom Scenario Report Fibre-to-the-home: Playing the long game, Aug. 19, 2015, at 9 ("In early 2015, BCE formally announced a shift from FTTN to FTTH deployment with "virtually all" incremental fibre investment being FTTH.").

57. BCE reports first quarter 2015 results, News Releases, available at <http://www.bce.ca/news-and-media/releases/show/BCE-reports-first-quarter-2015-results?page=2&month=&year> (equal to \$20 billion over five years).

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IV. Impact of CRTC's 2015 Unbundling Rules on Employment and Output

So what happens to an economy when this much capex is removed from the system? As in other industries, broadband capital expenditures have a multiplicative effect on job creation and economic output if the economy is at less than full employment.⁵⁸ According to Statistics Canada, Canada slipped into a recession in the first half of 2015,⁵⁹ indicating that Canada is well below full employment. In this section, I trace the impact of the removal of broadband capex on jobs and output using traditional multipliers as well as estimates of spillover effects.

A. Job Impact

The analysis of employment effects from the CRTC's 2015 Decision is divided into two parts: (1) "total multiplier effects," which es-

timates the number of jobs directly and indirectly created by spending activities in upstream (input) industries, plus induced jobs from greater household income; and (2) "spillover effects," which accounts for additional spending by related and new downstream industries that benefit indirectly from additional broadband investment and penetration.

1. Total Multiplier Effects

The employment effects of capital expenditures in the telecom industry extend beyond the company's direct employees. "Direct effects" are jobs generated from activities such as installing fibre, while "indirect effects" are job gains associated with communication equipment suppliers. "Induced effects" are the jobs created when the employees of an input provider use their additional income to purchase more goods and services in the local economy. These three effects (direct, indirect, and induced)—collectively referred to as the "total multiplier"—are considered to be the key elements of a traditional analysis of economic impact. Four papers in the literature inform my estimate of the total multiplier for fibre-based broadband investment.

Using the Bureau of Economic Analysis job and output multipliers, along with slated broadband investment schedules from the Columbia Institute for Tele-Information,

58. The multiplier is a standard principle in the macroeconomics literature. See, e.g., RUDIGER DORNBUSCH & STANLEY FISCHER, *MACROECONOMICS* 66 (McGraw Hill 6th ed. 1994). Richard Kahn first introduced the multiplier concept as an "employment multiplier." See Richard F. Kahn, *The Relation of Home Investment To Employment*, 41 *ECON. J.* 173, 173-98 (1931). John Maynard Keynes expanded upon this concept by introducing the "investment multiplier." See JOHN MAYNARD KEYNES, *A GENERAL THEORY OF EMPLOYMENT, INTEREST, AND MONEY* 115 (Harcourt Brace & Co. 1964) (1936).

59. Canada officially enters recession, AFP, Aug. 31, 2015, available at <http://news.yahoo.com/canada-officially-recession-first-half-2015-131114485.html> (showing the economy contracted 0.5 percent in the second quarter after retreating 0.8 percent in the first quarter of 2015).

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Crandall and Singer (2010) projected an average of 509,546 jobs in the United States would be sustained from 2010 to 2015 as a result of approximately \$30.4 billion of annual broadband investments relative to a world without such investments,⁶⁰ implying a weighted-average multiplier (across all broadband technologies) of 16.8 jobs for every million dollars of broadband investment.

Katz and Callorda (2014) studied the effects of repealing a sales tax exemption in Minnesota on the telecommunications industry.⁶¹ Based on an input-output analysis, they estimate that a \$154 million reduction in broadband investment would destroy 3,323 jobs in the state, implying a total job multiplier of 21.6 jobs per million dollars of broadband investment.⁶² Indirect and induced effects contribute a substantial proportion of that total multiplier.⁶³

Sosa and Audenrode (2012) estimated that the effects of reassigning 300 MHz of additional spectrum to mobile broadband would trigger \$15.075 billion in new capital spending per year (although the study pertains to mobile broadband, the authors rely on job multipliers derived from wireline services.)⁶⁴ The authors apply BEA Type II RIMS multipliers to calculate a weighted average of Construction (56%) and Broadcast and Communications Equipment (44%), implying 20.4 jobs for every \$1 million invested.⁶⁵

Finally, using the latest multipliers for telephone apparatus manufacturing (11.8), broadcast and wireless communications equipment (13.8), fibre-optic cable manufacturing (14.4), and construction (26.7),⁶⁶ Eisenach, Singer and West (2009) estimated separate multipliers for different types of broadband spending by applying weights to each of the industry multipliers based on the allocation of broadband capital spending to

60. Robert W. Crandall & Hal J. Singer, *The Economic Impact of Broadband Investment*, Prepared for Broadband for America, Feb. 2010, available at http://internetinnovation.org/files/special-reports/Economic_Impact_of_Broadband_Investment_Broadband_for_America.pdf.

61. Raul Katz & Fernando Callorda, *Assessment of the Economic Impact of the Repeal of the Tax Exemption on Telecommunication Investment in Minnesota* (Feb. 2014), available at <http://www.mncca.com/doc/minnesota-study-final-version.pdf>.

62. *Id.* at 24.

63. *Id.*

64. David Sosa and Marc Van Audenrode, *Private Sector Investment and Employment Impacts of Reassigning Spectrum to Mobile Broadband in the United States*, Analysis Group (August 2011), available at http://www.analysisgroup.com/uploadedFiles/News_and_Events/News/Sosa_Audenrode_SpectrumImpactsStudy_Aug2011.pdf.

65. *Id.* at 5.

66. U.S. DEPARTMENT OF COMMERCE, BUREAU OF ECONOMIC ANALYSIS, *Regional Input-Output Modeling System (RIMS II)*, Table 1.5 (2008). Multipliers are based on the 1997 Benchmark Input-Output Table for the Nation and 2006 regional data.

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each industry.⁶⁷ They estimated the weighted average employment multipliers for fibre-based technologies of 19.7 jobs per million dollars of FTTH investment.⁶⁸

Table 2 summarizes the relevant literature on the total multiplier effects from broadband investment.

Given the consistency with which various researchers have used a multiplier of approximately 20 jobs per million of investment, I adopt that figure here to estimate the initial job impact associated with the CRTC's 2015 Decision. Table 3 shows that before considering spillover effects, the CRTC's 2015 rules could eliminate between 1,440 and 7,680 jobs in Canada.

Table 2
Summary of Total Multipliers from Broadband Investment

Study	Annual Investment (billions)	Projected Total Jobs (000s)	Total Multiplier	Method
Crandall & Singer (2010)	\$30.4	509.5	16.8	Multiplier
Sosa & Audenrode (2012)	\$15.1	307.6	20.4	Multiplier
Katz & Callorda (2014)	\$0.2	3.3	21.6	Input-Output
Singer & West (2010)	\$12.7	250.4	19.7	Multiplier

Notes: Total multiplier is the sum of direct, indirect, and induced effects.

67. Jeffrey A. Eisenach, Hal J. Singer, & Jeffrey D. West, *Economic Effects of Tax Incentives for Broadband Infrastructure Deployment*, Fiber-to-the-Home Council (2008) at 8.

68. *Id.* Table 2 at 8. FTTH weights are 30 percent for telephone apparatus manufacturing, 20 percent for fibre optic cable manufacturing, and 50 percent for construction.

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Table 3
Direct, Indirect, Induced Job Loss from
CRTC’s 2015 Decision

	Annual Investment Loss (\$M)	Total Multiplier
Lower end (6% decline)	\$72	1,440
Upper end (32% decline)	\$384	7,680

Source: Author’s calculations.

2. Spillover Effects

The total-multiplier-based jobs estimate does not account for additional spending in related downstream industries except for those industries that directly benefit from increased spending by broadband input providers. Yet broadband investment and higher broadband penetration have been shown to create additional, or “spillover” effects in myriad downstream industries, including in healthcare,⁶⁹ education,⁷⁰ and energy,⁷¹

69. M. Meyer, R. Kobb, & R. Ryan, *Virtually healthy: Chronic disease management in the home*, 5 DISEASE MANAGEMENT 87-94 (2002).

70. Working Party on Communication Infrastructures and Services Policy, Network Developments in Support of Innovation and User Needs, Organization for Economic Cooperation and Development Dec. 2009 at 5 (Broadband is having a significant impact on education and e-learning by improving access to digital learning resources; encouraging communication among schools, teachers and pupils; promoting professional education for teachers; and linking local, regional, and national databases for administrative purposes or supervision.)

whose ability to enrich and enhance their service offerings is increased by greater availability of broadband internet access.⁷² Broadband spillover effects tend to concentrate in service industries such as financial services and healthcare, yet some have identified an effect in manufacturing as well.⁷³

In light of the recognized limitations of the multiplier approach for capturing the full economic effect of investment activities,

available at [http://www.oelis.oecd.org/olis/2009doc.nsf/LinkTo/NTO000889E/\\$FILE/JT03275973.PDF](http://www.oelis.oecd.org/olis/2009doc.nsf/LinkTo/NTO000889E/$FILE/JT03275973.PDF).

71. See, e.g., Justin Horner, *Telework: Saving Gas and Reducing Traffic from the Comfort of your Home*, Mobility Choice, available at <http://www.mobilitychoice.org/MCtelecommuting.pdf> (“By taking more than 4.7 million cars off the road every day, telecommuting already has a positive effect on congestion.”); Ted Balaker, *The Quiet Success: Telecommuting’s Impact on Transportation and Beyond*, Reason, Nov. 2005, available at <http://reason.org/files/853263d6e320c39bfcedde642d1e16fe.pdf> (“In fact, an analysis of Washington D.C. commuting by George Mason University’s Laurie Schintler found that traffic delays would drop by 10 percent for every 3 percent of commuters who work at home.”); Joseph Fuhr and Stephen Pociask, *Broadband and Telecommuting: Helping the U.S. Environment and the Economy*, Low Carbon Economy, 2011, 41-47, available at <http://file.scirp.org/Html/4227.html> (“Studies show that telecommuters reduce daily trips on days that they telecommute by up to 51% and automobile travel by up to 77%. ”).

72. For example, using online help-wanted ads as a guide to the location of app-related jobs, Mandel and Scherer estimated the number of app-related jobs per U.S. state as of April 2012. Mike Mandel & Judith Scherer, *The Geography of the App Economy*, Sept. 2012 (prepared for CTIA), available at http://files.ctia.org/pdf/The_Geography_of_the_App_Economy.pdf.

73. Crandall, Lehr, & Litan, *supra*.

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economists have developed alternative methods and tools to estimate the full effects of broadband investment and use. Four studies inform my estimate of the spillover effect here.

Crandall and Singer (2010) estimate spillover effects by examining how added spending in related upstream markets could impact employment.⁷⁴ Using industry-specific employment multipliers and an assumed five percent increase in capital expenditure, they estimate an additional 452,081 jobs on top of the 509,546 jobs created via the total multiplier, implying a spillover multiplier of 0.89.

Katz and Suter (2009) describe how “network-effect-driven” job gains flow from three trends: innovation leading to the creation of new services, attraction of jobs (from either other U.S. regions or overseas), and productivity enhancement.⁷⁵ They calculate the impact of innovation on the professional services sector, by applying the ratio of productivity gains to the creation of new employment, and applying this effect to the economy of the states with the lowest rela-

tive broadband penetration. The underlying assumption of this estimate is that “the economy can generate enough jobs through innovation in a rate comparable to productivity gains.”⁷⁶ From these gains, they subtract: (1) the net jobs lost due to accelerated outsourcing from increased broadband penetration, and (2) the jobs lost due to more efficient processes enabled by broadband. They estimate that this (net) spillover multiplier can range from 0.07 to 7.28 of the direct effects, with a mid-point estimate of 3.65.⁷⁷ Expressed as a multiple of the total multiplier effect (direct, indirect, and induced effects combined), their midpoint estimate is slightly above one.

Atkinson, Castro and Ezell (2009) also examine the impact of spillover effects.⁷⁸ They explain how broadband investment facilitates: (1) innovative applications such as telemedicine, e-commerce, online education and social networking; (2) new forms of commerce and financial intermediation; (3) mass customization of products; and (4) marketing of excess inventories and optimization of supply chains. They explain that network externalities should not decline with the build out

74. Robert W. Crandall & Hal J. Singer, *The Economic Impact of Broadband Investment*, Prepared for Broadband for America, Feb. 2010, available at http://internetinnovation.org/files/special-reports/Economic_Impact_of_Broadband_Investment_Broadband_for_America.pdf.

75. Raul Katz & Stephan Suter, *Estimating the Economic Impact of the Broadband Stimulus Plan*, at 20.

76. *Id.* at 21.

77. *Id.* at 26.

78. Robert D. Atkinson, Daniel Castro and Stephen J. Ezell, *The Digital Road to Recovery: A Stimulus Plan to Create Jobs, Boost Productivity and Revitalize America*, INFO. TECH. & INNOV. FOUND. (Jan. 2009), available at <http://www.itif.org/files/roadtorecovery.pdf>.

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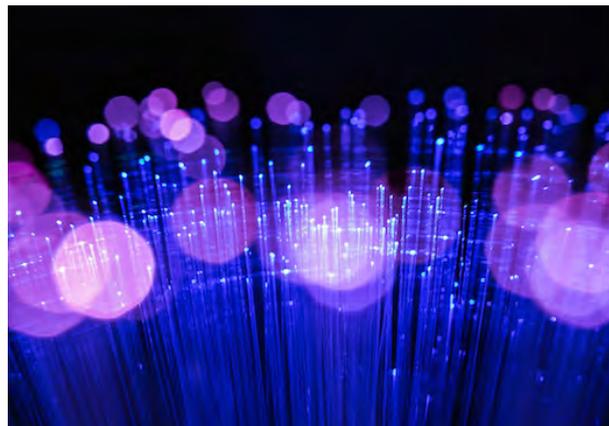
of networks and maturing technology over time, because penetration has not reached 100 percent and because faster connections should permit a new round of application innovation. Based on a \$10 billion broadband investment program, they estimate 268,480 jobs via spillover effects, implying a spillover multiplier of 1.17.

Finally, a 2013 study by The Wireless Infrastructure Association (PCIA) explained how new technologies have been made possible as wireless broadband exceeded a critical threshold where innovators and users of new technologies “can move forward with their business plans with the knowledge that the underlying infrastructure will be there to serve them.”⁷⁹ For example, the technology for mobile payments has been growing due to the pervasiveness of wireless broadband infrastructure.⁸⁰ The study estimates that projected mobile broadband investments of roughly \$35.5 billion per year will increase GDP by 1.6 percent to 2.2 percent, and will create 303,740 jobs in the first year of the study. Although their study focuses on the

impact of wireless broadband investments, it nevertheless offers another application of the spillover effect.

Table 4 summarizes the relevant economic literature on spillover effects.

Given the consistency with which various researchers have used a spillover multiplier of slightly over one additional network-induced job per every job created via the total multiplier, I adopt the spillover estimate of one. Table 5 shows the results from combining the job losses from total multiplier and spillover effects.



79. Alan Perce, Richard Carlson, and Michael Pagano, *Wireless Broadband Infrastructure: A Catalyst for GDP and Job Growth 2013-2017*, PCIA (Sep. 2013), 9, available at http://www.pcia.com/images/IAE_Infrastructure_and_Economy_Fall_2013.PDF.

80. Gartner, *Gartner Says Worldwide Mobile Payment Transaction Value to Surpass \$171.5 Billion*, Press Release, May 29, 2012, available at <http://www.gartner.com/newsroom/id/2028315>.

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Table 4
Summary of Spillover Effects from Broadband Investment

Study	Projected Total Jobs (000s)	Spillover Jobs (Spillover Multiplier) (000s)
Crandall and Singer (2010)	961.0 ^A	452.0 (0.89)
PCIA (2013)	303.7 ^B	194.9 (1.79)
Katz and Suter (2009)	263.9 ^C	136.1 (1.06)
Atkinson, Castro, and Ezell (2009)	498.0 ^D	268.5 (1.17)

Notes: Spillover jobs are the jobs created above and beyond those created by direct, indirect, and induced effects. The spillover multiplier is defined here as the ratio of spillover jobs to direct, indirect, and induced jobs.

^A Equal to 509,000 direct jobs plus 452,000 spillover jobs.

^B Equal to 26,777 direct jobs plus 82,027 indirect and induced jobs plus 194,937 spillover jobs.

^C Equal to 37,300 direct jobs plus 31,000 indirect jobs and 59,500 induced jobs plus 136,100 spillover jobs.

^D Equal to 64,000 direct jobs plus 166,000 indirect and induced jobs plus 268,500 spillover jobs.

Table 5
Total Job Loss from CRTC's 2015 Decision

	Annual Investment Loss (\$M)	Total Multiplier	Spillover Jobs	Total Job Loss
Lower end (6% decline)	\$72	1,440	1,440	2,880
Upper end (32% decline)	\$384	7,680	7,680	15,360

Impact on Jobs and Output of CRTC Decision

C. Economic Output

Finally, one can measure the multiplicative effect of broadband investment on economic output. This occurs because higher expenditures on broadband equipment—equivalent to higher demand for the products of equipment manufacturers—cause equipment manufacturers to hire more employees to meet the increased demand. The equipment manufacturers’ incomes increase as well due to the increased expenditures, which, according to the consumption function, will increase their consumption as well. The increased consumption of equipment manufacturers will in turn increase the income and employment of their suppliers. The income and employment of those suppliers will then increase, triggering another round of spending.

Eisenach, Singer, and West estimate the weighted average output multipliers for FTTP investment (3.1293).⁸¹ They arrive at this figure by using a weighted average of multipliers for three inputs used in the production of FTTP: telephone apparatus manufacturing, fiber-optic cable manufacturing, and construction. The weights for the three inputs were based on estimates of the capital mix used in FTTP, cable modem, and DSL deployments. Because FTTP relies more

heavily on the burying of new infrastructure in the ground, the construction multiplier was given a larger weight when computing the FTTH-specific multiplier (50 percent), compared to the DSL and cable-modem multipliers (20 percent).

I apply these multipliers to my annual broadband investment estimates in Table 6. The CRTC’s 2015 Decision could reduce economic output in Canada by between \$225 million and \$1.2 billion per year.

Table 6
Total Output Loss from CRTC’s 2015 Decision

	Annual Investment Loss (\$M)	Total Output Loss (\$M)
Lower end (6% decline)	\$72	\$225
Upper end (32% decline)	\$384	\$1,201

Source: Author’s calculations.

81. Eisenach, Singer, West, *supra*, at 8.

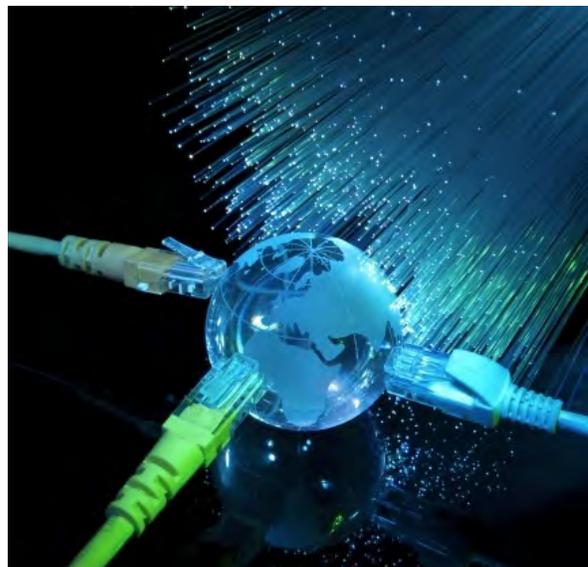
Conclusion

V. Conclusion

The CRTC's extension of the unbundling rules to cover FTTP networks will likely impose significant costs on the Canadian economy. The CRTC's 2015 Decision could discourage between \$72 and \$384 million in FTTP investment per year in Quebec and Ontario alone, leading to between 2,880 and 15,360 lost jobs, and between \$225 million and \$1.2 billion in lost economic output per year.

On the other side of the ledger, the CRTC has offered no evidence that there would be a significant enhancement in competition, implying negligible benefits associated with its rule. Although the CRTC indicated that there are investment benefits associated with "competitor investment in alternative transport facilities,"⁸² these modest investments will pale in comparison to the significant decline in FTTP investment. Competitors have little incentive to increase investment in transport when there are significant facilities in place that they can already lease and normal (competitive) returns.

To the extent that doing nothing, or pursuing alternative policies to enhance competition generates the same level of benefits as FTTP unbundling, these options are strictly superior from an efficiency perspective. Accordingly, the CRTC should refrain from extending its unbundling obligations to FTTP.



82. *CRTC Decision* ¶ 139 ("Moreover, a disaggregated wholesale HSA service could encourage competitor investment in alternate transport facilities, thereby serving to develop a more robust telecommunications system.").