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THE CONTRIBUTION OF BROADBAND TO THE ECONOMIC DEVELOPMENT OF FIRST NATIONS IN CANADA

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The Contribution of Broadband to the Economic Development of First Nations in Canada

Abstract

The faster access to information made possible by broadband Internet connectivity has had an important impact on the economy, transforming existing production processes and making new ones possible. The economic literature has shown that, in general, broadband has a statistically significant, positive effect on economic development. This report represents a first attempt at estimating the impact of broadband on economic development and job creation in First Nations reserves in Canada using econometric techniques. The report offers an up-to-date overview on the state of broadband availability in First Nations reserves, providing both national and provincial breakdowns of the data. It also details the main findings of the literature on the effect of broadband on economic development. Using a sample of 241 First Nations reserves and data from the 2001 and 2006 Aboriginal Population Profiles, we estimate the impact of broadband on average earnings and employment growth. Our econometric analysis failed to show a statistically significant impact of broadband on economic development. This finding, however, should be interpreted with caution, as severe data limitations might have affected the accuracy of the results. It is suggested that future econometric studies on the topic would benefit from more and better broadband data.

The Contribution of Broadband to the Economic Development of First Nations in Canada

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The Contribution of Broadband to the Economic Development of First Nations in Canada

Executive Summary

An increasing number of studies have identified a significant, positive impact of broadband on economic development and job creation. Broadband Internet connectivity is linked to better economic outcomes for both households – which can benefit from increased access to information on education, health care, and other topics – and businesses – which can reorganize their production processes, benefit from increased efficiency, take advantage of online sales opportunities, etc. To the best of our knowledge, however, no studies so far have tried to estimate the impact of broadband on the economic development of First Nations reserves in Canada using econometric techniques. This is the main objective of this report.

This executive summary is divided into five parts. The first part provides basic definitions used in this report – in particular, it defines broadband availability and broadband penetration, as well as discusses First Nations-related definitions. The second part offers an overview of broadband availability in First Nations in Canada. The third part summarizes the main conclusions of the literature on the impact of broadband on economic development. The fourth part presents the main findings of the report, while the last part concludes.

Definitions

Broadband

Broadband studies differentiate between *broadband availability* and *broadband penetration* (or use). Broadband availability has to do with whether an Internet Service Provider (ISP) offers broadband Internet services in a certain area. Broadband penetration, on the other hand, refers to actual broadband use. It is often defined as the number of broadband lines per 100 persons.

Overall, penetration data are preferred to availability data because, as mentioned above, they refer to actual broadband use, whereas the fact that broadband is available in an area does not necessarily imply that it is used by households and businesses in that area (nor does it capture how intensively it is used). This is particularly true for rural or remote areas, where broadband use might be limited by high prices, lack of information, insufficient training on computer use, and other factors. Unfortunately, penetration data are much harder to come by than availability data, especially in the case of small communities. Since detailed broadband penetration data were unavailable for First Nations reserves, this report makes use of broadband availability data.

In line with the benchmark currently in use by the Government of Canada, broadband connectivity is defined here as access to Internet services that support inbound (i.e. download) data transmission rates of 1.5 Mbps or more.

First Nations

For practical reasons, this report adopts the First Nations breakdown used by Aboriginal Affairs and Northern Development Canada (AANDC). Although the Assembly of First Nations' (AFN) breakdown is more up-to-date and inclusive than AANDC's, encompassing 630 (and over) First Nations versus only 617, AANDC's breakdown has the advantage of having two levels of granularity: the first is the band level; the second is the reserve level. In AANDC's definition, a band area can (potentially) contain several reserves. As an example, AANDC lists 19 reserves under the Lac La Ronge First Nation (SK). Although in general these reserves are fairly close to each other, this is not always the case. Thus, it is possible for broadband to be available for specific subareas (reserves) within a band area, but not for the band area as a whole. The greater granularity provided by reserve-level data makes it ideal for an analysis of the impacts of broadband on the economic development of First Nations in Canada.

The Aboriginal Community Population Profiles from the 2001 and 2006 Censuses provide both reserve-level and band-level data. A previous CSLS report (Tsiroulnitchenko and Hazell, 2011) matched the data from the Aboriginal Community Population Profiles to the AANDC's list of bands and reserves. The resulting database was used in this report to construct a detailed list of 1,012 reserves in 615 bands for which at least basic demographic data were available (either from the Aboriginal Community Population Profiles or from AANDC). Note that this is not a comprehensive list of reserves – reserves for which no demographic data were available were not included. This was done to avoid including reserves which did not have a permanent population. In general, data were usually available for the largest reserves in each band, but not necessarily for smaller communities.

An Overview of the State of Broadband Availability in First Nations Reserves in Canada

In 2011, broadband was available in 708 reserves out of 1,012 First Nations reserves for which we had data. Thus, at the national level, 70.0 per cent of First Nations reserves had access to the services of at least one broadband ISP. In contrast, Industry Canada estimated that 94 per cent of Canadian households had access to a minimum of 1.5 Mbps connectivity in 2009. This represents a significant digital divide between First Nations and non-First Nations communities.

At the provincial/territorial level, broadband availability varied significantly. In general, broadband was available for almost all reserves in the Maritimes with availability rates ranging

from 81.8 per cent in New Brunswick to 100.0 per cent in Nova Scotia and Prince Edward Island. The broadband availability rate in Newfoundland and Labrador was only 66.7 per cent, but this number is not particularly meaningful given the small number of reserves (only three). Central Canada provinces fared considerably worse, with availability rates of 63.3 per cent in Quebec and 60.4 per cent in Ontario. Western Canada had a mixed performance, with a high availability rate in Saskatchewan, where broadband was available to 81.4 per cent of the reserves, medium availability rates in Manitoba (63.0 per cent) and British Columbia (73.8 per cent), and low availability rates in Alberta (48.9 per cent). Regarding the Territories, broadband was available for most of the reserves in the Yukon (83.3 per cent), but availability rates were much lower for reserves in the Northwest Territories (56.0 per cent). Overall, the broadband availability patterns observed in our main sample of 241 reserves (for which both the 2001 and the 2006 Census Aboriginal Population Profiles had detailed economic data available) followed that of the total reserve population closely.

Focusing our attention only on our main sample from now on, we look at the relationship between broadband availability and remoteness. The majority of the 241 reserves in our main sample were situated in rural areas (50.2 per cent of the total). Next came reserves in urban areas (28.6 per cent of the total), followed by special access reserves (18.3 per cent of the total), and reserves in remote areas (2.9 per cent of the total). As expected, the likelihood of broadband availability varied according to the reserve's remoteness category. While 78.3 per cent of the reserves located in urban areas had access to broadband services, this number fell to 70.2 per cent in the case of reserves in rural areas, and 57.1 per cent in the case of reserves in remote areas. Perhaps surprisingly, the share of special access reserves that had access to broadband services was similar to that of rural reserves (70.5 per cent).

The majority of the reserves where broadband was available (110 reserves or 63.2 per cent of 174 reserves) were offered broadband services by a single internet service provider (ISP). A total of 31 reserves (17.8 per cent) had two broadband ISPs, 30 reserves (17.0 per cent) had three, and only 3 reserves (1.7 per cent) had four. Thus, in reserves where broadband was available, competition was limited at best and inexistent at worst. This can be indicative, *ceteris paribus*, of relatively high prices for broadband services in those markets, which can pose a problem to increasing broadband penetration rates.

Measuring the Impact of Broadband on Economic Development: Literature

The literature points to a significant impact of broadband use on economic development. It is important to acknowledge, however, that there are significant disagreements as to the magnitude of this impact and as to which economic variables are affected. Below, we summarize the main findings of the literature:

- In general, growth model studies have found a statistically significant, positive impact of broadband availability and penetration on employment growth, but not on GDP growth. This is a somewhat puzzling result, since one would expect employment growth to be accompanied by GDP growth. A possible reason for this result is data quality.

- Another possible reason refers to the fact that most (if not all) of the growth models seen in this section do not address endogeneity of broadband, i.e. broadband use can cause economic development, but economic development also induces broadband use. The failure to take this problem into account might have an impact on the overall quality of the estimated impact of broadband on economic development. Econometric techniques such as instrumental variables (IV) can be used to address this issue, producing more reliable estimates.

- Production function models have found a statistically significant, positive effect of broadband penetration on GDP growth and GDP per capita growth. The results of both Koutroumpis (2009) and LECG (2009) suggest that the economic benefits of broadband are a function of broadband penetration. Thus, the impact of broadband on economic growth is greatest once a certain "critical mass" has been reached. Conversely, if broadband penetration is low, the benefits of broadband might be modest at best.

- The case studies discussed show that broadband had a positive effect on the economic development of rural communities. Businesses that used broadband saw a significant increase in sales, GDP, employment, and the efficiency of their production processes. Households also reported benefitting from broadband use, in particular through reduced household expenses, although the mechanisms by which broadband might reduce expenses are not particularly clear.

An Empirical Assessment of the Economic Impact of Broadband on First Nations Reserves

The sample used in our econometric analysis was composed of 241 First Nations reserves for which both 2001 and 2006 Census Aboriginal Population Profiles data were available. Broadband was available for 174 out of the 241 reserves (72.2 per cent). Overall, reserves where broadband was available and reserves without broadband access had similar economic profiles. Both types of reserves had, for instance, average earnings around $15,500-15,600 in 2000 and $18,000 in 2005, as well as similar employment rates. Most of the small differences observed in their economic profiles were not statistically significant.

Our econometric analysis failed to show a meaningful impact of broadband availability on average earnings and employment growth. Although the broadband dummy had the expected

positive sign in all specifications, it was not statistically different from zero in any of them. Due to data limitations, however, these results must be interpreted with caution:

- The main data problem is the period mismatch between our dependent variables, which refer either to the 2000-2005 period or to the 2001-2006 period, and the broadband availability dummy, which refers to 2011. Ideally, the broadband availability data would refer to 2000 (or perhaps 2001).

- The broadband data used in our regressions refer to broadband availability instead of broadband penetration. Broadband penetration, measured as the number of broadband lines per 100 persons, is a better measure than broadband availability because it takes into consideration how many people are actually using broadband. Broadband availability, on the other hand, only tells us that at least one Internet Service Provider offers broadband services in the reserve area. High prices can severely limit broadband use, even if the service is available. In this sense, a statistically insignificant effect of broadband availability on employment or average earnings growth might just indicate a very low penetration rate.

- Another factor that can affect the overall economic impact of broadband is the number of years in which broadband had been available in a particular reserve. Reserves where broadband has just been made available will probably benefit from it only years ahead. On the other hand, in reserves where broadband has been available for a while now, it is possible that most of the economic benefits have already been accrued.

The issues discussed above remind us why our estimation results are by no means definitive. This report represents a first attempt at econometrically estimating the contribution of broadband to economic development in First Nations reserves. As such, its estimates should be understood as initial, "rough" estimates. A pre-requisite for improved estimates is more and better data. This includes not only broadband data (for example, data on broadband penetration and the year broadband became available), but also additional data on economic variables at the reserve level.

Conclusion

This report looked at the link between broadband and economic development in First Nations reserves in Canada. Although a growing literature points to an important role of broadband in promoting economic growth, our econometric analysis did not find a statistically significant impact of broadband availability on employment growth and average earnings growth in our sample of 241 First Nations reserves.

These results, however, should be interpreted with caution. Even though this report used the best data available, several data-related problems might have had a negative impact on the accuracy of our estimates. In particular: 1) there was a period mismatch between our dependent variables (from the 2001 and 2006 Censuses) and the broadband availability data (from 2011); 2) there were no reserve-level data on the year broadband became available for each reserve; and 3) reserve-level broadband data referred to availability instead of penetration, which is a better measure because it takes into account actual broadband use.

In light of these facts, we recommend that priority be given to collecting detailed reserve-level broadband data (for example, data on broadband penetration and the year broadband became available). The accuracy of future econometric studies can only be as good as the underlying estimates allow.

The Contribution of Broadband to the Economic Development of First Nations in Canada

I. Introduction

Living standards of on-reserve Aboriginal populations are significantly below that of Canada as a whole. Many reserves suffer from high poverty and unemployment rates, low average earnings, and many other socio-economic problems. Part of the multi-pronged approach to tackle this pressing issue is to guarantee that on-reserve populations have improved access to information through broadband Internet connectivity.

An increasing number of studies have identified a significant, positive impact of broadband use on economic development and job creation. Broadband Internet connectivity is linked to better economic outcomes for both households – which can benefit from increased access to information on education, health care, and other topics – and businesses – which can reorganize their production processes, benefit from increased efficiency, take advantage of online sales opportunities, etc. To the best of our knowledge, however, no studies so far have tried to estimate the impact of broadband on the economic development of First Nations reserves in Canada using econometric techniques. This is the main objective of this report.

The report is organized as follows.[1] Section two defines the broadband benchmark used in this report and discusses data sources. Section three offers an overview on the state of broadband availability in First Nations reserves in Canada. Section four provides a literature review on the relationship between broadband and economic development, looking both at econometric studies and at case studies. Special emphasis is given to the literature on the effects of broadband on rural/remote communities. Section five estimates the economic impact of broadband availability on a sample of First Nations reserves and discusses possible limitations of our estimation results. Section six looks at broadband policies in Canada and makes policy recommendations. Section seven suggests topics that would benefit from further research and section eight concludes.

[1] This report was prepared by Ricardo de Avillez, under the supervision of Andrew Sharpe. The CSLS would like to thank Karen Hunter and Judy Whiteduck from the Assembly of First Nations (AFN) for the opportunity to prepare this report. A draft of the report was presented at the annual meeting of the Canadian Economics Association at the University of Calgary in June 2012. The author would like to thank the discussant John Richards and session participants for comments; the author would also like to thank AFN officials for comments on the draft report, and the AFN ICT Working Group for the feedback given during the video conference on February 21, 2012 at the AFN office. Finally, the author would like to thank Adam Fiser for comments on the database and Tanya Bagai for copyediting

II. Definitions, Basic Concepts, and Data Sources

This section discusses definitions, basic concepts, and data sources used in this report. It is divided into four parts. The first part defines broadband connectivity, as well as the notions of broadband availability and broadband penetration. The second part analyses the reasons why broadband access matters for economic development. The third part clarifies some of the basic First Nations-related definitions used in this report, while the fourth part details our main data sources.

A. Definitions

An Internet connection is considered a broadband connection when certain thresholds for download and upload speeds are reached. There is no universal definition of what those thresholds are. In fact, countries and organizations often have different views as to what constitutes the minimum download and upload speeds in a broadband connection. Fiser (2010:8) notes, for instance, that

> The OECD (…) treats 256 Kilobits per second (Kbps) as its bottom end benchmark for statistical accounts of broadband access (…), while also acknowledging data transfer rates greater than 1 Megabits per second (Mbps) for representative broadband applications (…). Yet there is no broadband deployment standard among OECD members.

To make matters even more complicated, the rapid rate of technological progress has made it a necessity for broadband benchmarks to be updated frequently, under the risk of becoming obsolete. Connections that five or ten years ago were considered broadband connections may no longer make the cut today.

In line with Fiser (2010), this report adopts the benchmark currently in use by the Government of Canada, which defines broadband connectivity as access to Internet services that support inbound (i.e. download) data transmission rates of 1.5 Mbps or more.[2] Our choice is driven by data availability. More specifically, this definition of broadband is the one used by Broadband Canada,[3] which is the main source for broadband data used in this report (more details can be found in the next subsection).

[2] It is important to note that many organizations adopt significantly higher standards. See, for instance, CCPA (2012).

[3] As part of Canada's Economic Action Plan, Industry Canada was assigned $225 million to extend broadband coverage in Canada during the 2009-2012 period. The most important component of Industry Canada's strategy is the Broadband Canada: Connecting Rural Canadians program, which (as the name implies) focuses on bringing broadband to unserved or underserved rural areas.

Before moving forward, it is important to have in mind two different measures of broadband connectivity. Broadband studies differentiate between *broadband availability* and *broadband penetration* (or *use*). Broadband availability has to do with whether an Internet Service Provider (ISP) offers broadband Internet services in a certain area. Broadband penetration, on the other hand, refers to actual broadband use. It is often defined as the number of broadband lines per 100 persons.

Overall, penetration data are preferred to availability data because, as mentioned above, they refer to actual broadband use, whereas the fact that broadband is available in an area does not necessarily imply that it is used by households and businesses in that area (nor does it capture how intensively it is used). This is particularly true for rural or remote areas, where broadband use might be limited by high prices, lack of information, insufficient training on computer use, and other factors. Unfortunately, penetration data are much harder to come by than availability data, especially in the case of small communities. Since detailed broadband penetration data were unavailable for First Nations reserves, this report makes use of broadband availability data.

B. Why Does Broadband Matter?

Chapter 8 of the 2006 Telecommunications Policy Review Panel report entitled "Connectivity: Completing the Job" provides an excellent summary of the different contributions broadband access can make to economic and social well-being in unserved areas (the following is taken directly from TPRP, 2006:8-4-8-5).

- **Improved primary and secondary education and new opportunities for post-secondary education, training and lifelong learning**: Broadband can provide students, teachers, trainers and self-directed learners with access to online courses and educational materials, and connect them with colleagues and peers in order to share information and work together on projects.

- **Improved health care**: Broadband can help deliver better health care services to rural and remote areas by allowing medical professionals based in these areas to obtain diagnostic services and real-time assistance from colleagues in larger centres. It can also give residents of rural and remote areas improved access to information that may help prevent disease and promote healthy lifestyles.

- **New and improved business opportunities**: Broadband makes it possible to use innovative online marketing and e-commerce services to generate growth in tourism, recreation and other service industries, which are becoming important sources of employment in many rural and remote areas. Broadband access is also essential to

improving the productivity and competitiveness of resource-based, agricultural and manufacturing industries.

- **Stronger rural and remote communities**: Broadband can help empower residents of rural and remote areas by improving access to information about public policy issues affecting their communities, and facilitating engagement in governance activities at every level from local to national.

- **Enhanced cultural opportunities**: Broadband opens access to a wide range of entertainment products and services. It also provides opportunities to develop new forms of cultural expression and preserve traditional languages and cultures.

C. First Nations Definitions

For practical reasons, this report adopts the First Nations breakdown used by Aboriginal Affairs and Northern Development Canada (AANDC). This breakdown differs from that of the Assembly of First Nations (AFN) in two important ways. First, the AFN's breakdown currently recognizes 630 (and over) First Nations while the AANDC breakdown recognizes only 617. The difference between the two breakdowns is caused mainly by the fact that some of the First Nations included in AFN's definition are not considered bands under the Indian Act, and thus do not count towards AANDC's total. Another reason for this difference is that there are aboriginal communities which are not on reserves, like the Dene in the Northwest Territories, but that are still First Nations communities. In this sense, AFN provides a more up-to-date and inclusive list of First Nations than AANDC.

However, while the AFN's breakdown looks at each First Nation as a whole – that is, it focuses on the band level – the AANDC's breakdown has two levels of granularity: the first is the band level; the second is the reserve level. In AANDC's definition, a band area can (potentially) contain several reserves. As an example, AANDC lists 19 reserves under the Lac La Ronge First Nation (SK).[4] Although in general these reserves are fairly close to each other, this is not always the case. Thus, it is possible for broadband to be available for specific sub-areas (reserves) within a band area, but not for the band area as a whole. The greater granularity provided by reserve-level data makes it ideal for an analysis of the impacts of broadband on the economic development of First Nations in Canada.

The Aboriginal Community Population Profiles from the 2001 and 2006 Censuses provide both reserve-level and band-level data. A previous CSLS report (Tsiroulnitchenko and Hazell, 2011) matched the data from the Aboriginal Community Population Profiles to the

[4] A list of reserves for each of the 615 First Nations recognized by the AANDC can be found at: http://pse5-esd5.ainc-inac.gc.ca/fnp/Main/Search/SearchFN.aspx?lang=eng.

AANDC's list of bands and reserves. The resulting database was used in this report to construct a detailed list of 1,012 reserves in 615 bands for which at least basic demographic data were available (either from the Aboriginal Community Population Profiles or from AANDC). Note that this is not a comprehensive list of reserves – reserves for which no demographic data were available were not included. This was done to avoid including reserves which did not have a permanent population. In general, data were usually available for the largest reserves in each band, but not necessarily for smaller communities. As an example, the Flying Dust First Nation (SK) encompasses seven reserves, only two of which are included in our list, since no profile information was available for the other five.

D. Data Sources

This report has three main data sources:

- Broadband availability data were collected from Industry Canada's Broadband Canada Program. Broadband Canada has detailed maps of areas in Canada where broadband coverage is deficient. Along with those maps, there is a web tool called "Feedback from Canadians", which identifies broadband availability in a particular area as of July 2011. For Natuashish 2 (NFLD), for instance, the tool tells us that there is one existing broadband ISP (Bell Aliant Regional Communications) and specifies the provider type (DSL). The CSLS used this web tool to collect data for 1,012 First Nations reserves across Canada.

- Reserve-level data on population, labour market (including participation, employment, and unemployment rates), education, and average earnings were taken from the 2001 and 2006 Aboriginal Population Profiles, which were conducted as part of the censuses in those years. Out of the 312 reserves for which *all* of the above data were available in 2006, only 241 also had all the data in 2001. This group of 241 reserves constitutes our main sample and is used in all econometric exercises described in this report. A list of the 241 reserves can be found in the Appendix.[5]

- Lastly, the report also makes use of the remoteness data provided by Aboriginal Affairs and Northern Development Canada (AANDC). AANDC classifies all reserves into one of the four categories below:

    1. Zone 1 (Urban): Indicates a geographic zone where the First Nation is located within 50 km of the nearest service centre with year-round road access;

[5] The 241 reserves represent 228 First Nations. The following First Nations had more than one reserve present in the sample: Innu Takuaikan Uashat Mak Mani-Utenam (QC) (2 reserves), Lac La Ronge (SK) (5 reserves), Peter Ballantyne Cree Nation (SK) (3 reserves), Onion Lake (SK) (2 reserves), Montreal Lake (SK) (2 reserves), Dene Tha' (AB) (3 reserves), Frog Lake (AB) (2 reserves), and Bigstone Cree Nation (AB) (2 reserves).

2. Zone 2 (Rural): Indicates a geographic zone where the First Nation is located between 50 and 350 km from the nearest service centre with year-round road access;

3. Zone 3 (Remote): Indicates a geographic zone where the First Nation is located over 350 km from the nearest service centre with year-round road access;

4. Zone 4 (Special Access): Indicates a geographic zone where the First Nation has no year- round road access to a service centre and, as a result, experiences a higher cost of transportation (INAC, 2008).

III. An Overview of the State of Broadband Availability in First Nations in Canada

This section briefly describes the state of broadband availability in First Nations reserves in Canada reserves as of July 2011, according to the data collected by the CSLS on the Broadband Canada Program website. It should be noted, however, that we do not provide a comprehensive overview on the topic, which can be found in Fiser (2010) and Fiser *et al.* (2010).

The section is divided into three parts. In the first part, we describe broadband availability in 1,012 First Nations reserves across Canada, providing both national and provincial breakdowns of the data. We also describe the state of broadband availability specifically in the 241 reserves that are part of our main sample and in the remaining 771 reserves that are not. The second part looks at the relationship between broadband availability and remoteness in the 241 reserves in our main sample. Finally, we analyze the distribution of broadband ISPs by type (again, focusing only on our main sample).

A. Broadband Availability in First Nations Reserves

In 2011, broadband was available in 708 reserves out of the 1,012 First Nations reserves for which we had data (Table 1). Thus, at the national level, 70.0 per cent of First Nations reserves had access to the services of at least one broadband ISP. In contrast, Industry Canada estimated that 94 per cent of Canadian households had access to a minimum of 1.5 Mbps connectivity in 2009.

At the provincial/territorial level, broadband availability varied significantly. In general, broadband was available in almost all reserves in the Maritimes. Availability rates reached 100 per cent in Prince Edward Island (5 out of 5 reserves) and Nova Scotia (27 out of 27 reserves), and 81.8 per cent in New Brunswick (18 out of 22 reserves). The broadband availability rate in Newfoundland and Labrador was only 66.7 per cent (2 out of 3 reserves), but this number is not particularly meaningful given the small number of reserves. Central Canada provinces fared considerably worse, with availability rates of 63.3 per cent in Quebec (27 out of 42 reserves) and 60.4 per cent in Ontario (90 out of 149 reserves). Western Canada had a mixed performance, with a high availability rate in Saskatchewan, where broadband was available to 81.4 per cent of the reserves (105 out of 129), medium availability rates in Manitoba (63.0 per cent or 51 out of 81 reserves) and British Columbia (73.8 per cent of reserves or 315 out of 427), and low availability rates in Alberta (48.9 per cent or 44 out of 90 reserves). Regarding the Territories, broadband was available for a high proportion of reserves in the Yukon (83.3 per cent or 10 out of 12), but availability rates were much lower for reserves in the Northwest Territories (56.0 per cent or 14 out of 25 reserves).

Table 1: Broadband Availability in Reserves across Canada, 2011

A) All reserves

	Canada	Newfoundland and Labrador	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Yukon	Northwest Territories
	(number of reserves)												
Total	1012	3	5	27	22	42	149	81	129	90	427	12	25
Broadband	708	2	5	27	18	27	90	51	105	44	315	10	14
No Broadband	304	1	0	0	4	15	59	30	24	46	112	2	11
	(as a per cent of the total)												
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Broadband	70.0	66.7	100.0	100.0	81.8	64.3	60.4	63.0	81.4	48.9	73.8	83.3	56.0
No Broadband	30.0	33.3	0.0	0.0	18.2	35.7	39.6	37.0	18.6	51.1	26.2	16.7	44.0

B) Main sample (reserves for which both 2001 and 2006 Census Aboriginal Population Profiles data were available)

	Canada	Newfoundland and Labrador	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Yukon	Northwest Territories
	(number of reserves)												
Total	241	1	0	9	7	26	29	46	60	32	28	0	3
Broadband	174	1	0	9	7	16	17	29	50	19	24	0	2
No Broadband	67	0	0	0	0	10	12	17	10	13	4	0	1
	(as a per cent of the total)												
Total	100.0	100.0	..	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	..	100.0
Broadband	72.2	100.0	..	100.0	100.0	61.5	58.6	63.0	83.3	59.4	85.7	..	66.7
No Broadband	27.8	0.0	..	0.0	0.0	38.5	41.4	37.0	16.7	40.6	14.3	..	33.3

C) Only reserves NOT included in the main sample

	Canada	Newfoundland and Labrador	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Yukon	Northwest Territories
	(number of reserves)												
Total	771	2	5	18	15	16	120	35	69	58	399	12	22
Broadband	534	1	5	18	11	11	73	22	55	25	291	10	12
No Broadband	237	1	0	0	4	5	47	13	14	33	108	2	10
	(as a per cent of the total)												
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Broadband	69.3	50.0	100.0	100.0	73.3	68.8	60.8	62.9	79.7	43.1	72.9	83.3	54.5
No Broadband	30.7	50.0	0.0	0.0	26.7	31.3	39.2	37.1	20.3	56.9	27.1	16.7	45.5

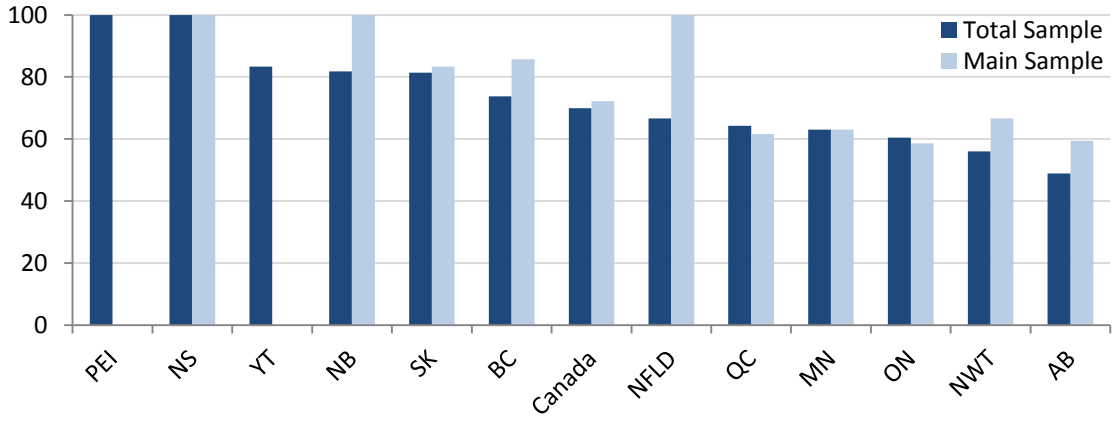
Source: Broadband availability data collected by the CSLS from the Broadband Canada Program website using the "Feedback from Canadians" web tool (http://www.ic.gc.ca/app/sitt/bbmap/hm.html?lng=eng).

Overall, the broadband availability patterns observed in our main sample of 241 reserves (for which both the 2001 and the 2006 Census Aboriginal Population Profiles had detailed economic data available) followed that of all reserves closely. A few differences, however, are worth noting (Chart 1):

- At the national level, the broadband availability rate was slightly higher in our main sample than for all reserves (72.2 per cent vs. 70.0 per cent);

- At the provincial/territorial level, meaningful divergences from the total sample happened in New Brunswick, where the broadband availability rate was 100.0 per cent in the main sample, but only 81.8 in the total sample; Alberta (59.4 per cent in the main sample vs. 48.9 per cent in the total sample); British Columbia (85.7 per cent vs. 73.8 per cent); and the Northwest Territories (66.7 per cent vs. 56.0 per cent). Thus, at least for some provinces/territories, our main sample significantly *overstates* broadband availability.

Chart 1: Broadband Availability Rates in First Nations Reserves, Canada and the Provinces, 2011



Source: CSLS calculations based on data from the Broadband Canada Program and INAC.

B. Broadband Availability and Remoteness

Focusing our attention only on our main sample from now on, we look at the relationship between broadband availability and remoteness. Table 2 shows that the majority of the 241 reserves in our main sample were situated in rural areas (121 reserves or 50.2 per cent of the total). Next came reserves in urban areas (69 reserves or 28.6 per cent of the total), followed by special access reserves (44 reserves or 18.3 per cent of the total), and reserves in remote areas (7 reserves or 2.9 per cent of the total).

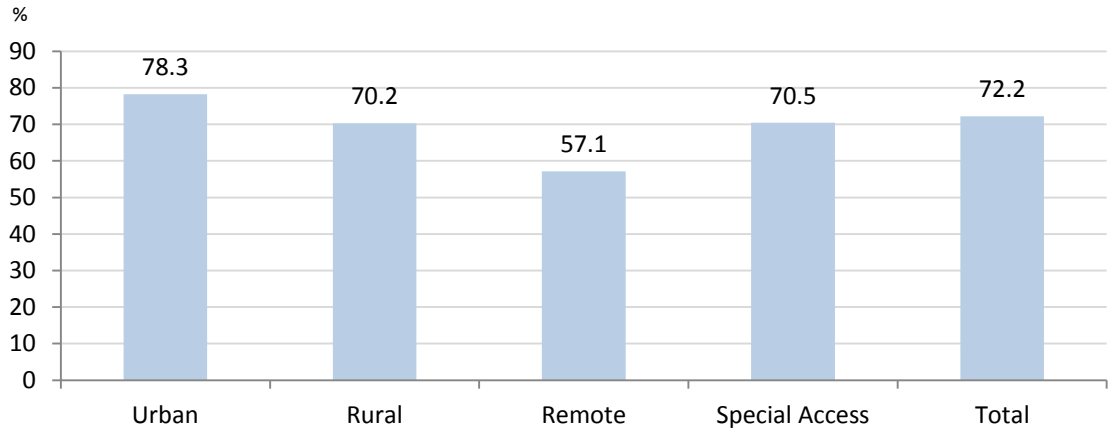
Table 2: Breakdown of Broadband Availability by Remoteness, 2011

		Broadband	No Broadband	Total
		(number of reserves)		
1	Urban	54	15	69
2	Rural	85	36	121
3	Remote	4	3	7
4	Special Access	31	13	44
	Total	174	67	241
		(per cent of total)		
1	Urban	31.0	22.4	28.6
2	Rural	48.9	53.7	50.2
3	Remote	2.3	4.5	2.9
4	Special Access	17.8	19.4	18.3
	Total	100.0	100.0	100.0

Source: 1) Broadband availability data collected by the CSLS from the Broadband Canada Program website using the "Feedback from Canadians" web tool (http://www.ic.gc.ca/app/sitt/bbmap/hm.html?lng=eng); 2) Remoteness data taken from INAC.

As expected, the likelihood of broadband availability varied according to the reserve's remoteness category (Chart 2). While 78.3 per cent of the reserves located in urban areas had access to broadband services, this number fell to 70.2 per cent in the case of reserves in rural areas, and 57.1 per cent in the case of reserves in remote areas.[6] Perhaps surprisingly, the share of special access reserves that had access to broadband services was similar to that of rural reserves (70.5 per cent).

Chart 2: Incidence of Broadband Availability by Remoteness, 2011



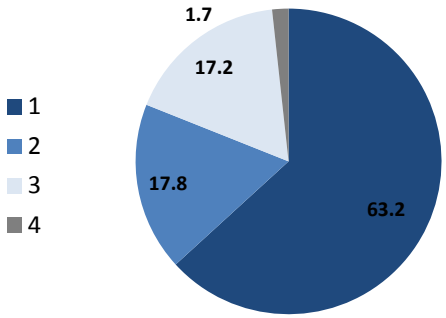
Note: Includes only the 241 reserves in our main sample (i.e. reserves for which both the 2001 and the 2006 Census Aboriginal Population Profiles had detailed economic data available).
Source: CSLS calculations based on data from the Broadband Canada Program and INAC.

[6] It should be taken into account, however, that the extremely low rate of broadband access in remote reserves might be in large part a product of the small sample of remote reserves (only seven out of 241).

C. Internet Service Providers (ISPs)

Table 1 showed that broadband was available in 174 reserves out of the 241 reserves that compose our main sample. The majority of the reserves where broadband was available (110 reserves or 63.2 per cent of 174 reserves) were offered broadband services by a single internet service provider (ISP) (Chart 3); 31 reserves (17.8 per cent) had two broadband ISPs, 30 reserves (17.0 per cent) had three, and only 3 reserves (1.7 per cent) had four. Thus, in reserves where broadband was available, competition was limited at best and inexistent at worst. This can be indicative, *ceteris paribus*, of relatively high prices for broadband services in those markets, which can pose a problem to increasing broadband penetration rates.

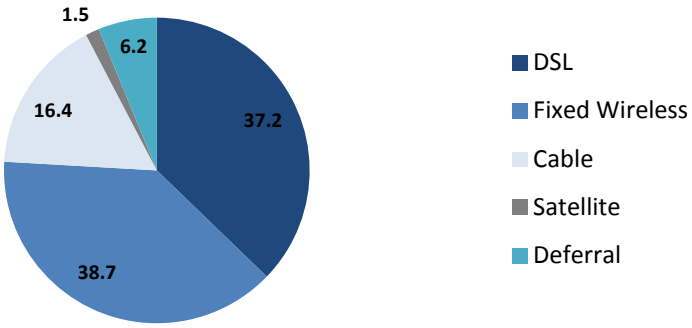
Chart 3: Per Cent of Reserves with One or More Broadband ISP, 2011



Note: Includes only the 241 reserves in our main sample (i.e. reserves for which both the 2001 and the 2006 Census Aboriginal Population Profiles had detailed economic data available).
Source: CSLS calculations based on data from the Broadband Canada Program.

Most of the broadband ISPs that offered their services to First Nations reserves were either fixed wireless (38.7 per cent) or DSL (37.2 per cent) ISPs (Chart 4). Cable ISPs represented 16.4 per cent of the total, while satellite ISPs accounted for only 1.5 per cent. 6.2 per cent of ISPs had a deferral account.

Chart 4: Per Cent of Broadband ISPs by Type, 2011



Note: Includes only the 241 reserves in our main sample (i.e. reserves for which both the 2001 and the 2006 Census Aboriginal Population Profiles had detailed economic data available).
Source: CSLS calculations based on data from the Broadband Canada Program.

IV. Measuring the Impact of Broadband on Economic Development: Literature Review

The mass availability of broadband Internet access is a recent phenomenon. As such, studies that seek to quantify the impact of broadband on economic development are still in their early days. In this section, we provide a detailed analysis of some of those studies. For each of the studies discussed here we highlight: a) how broadband was defined; b) the data used; c) the econometric techniques employed; and d) the main findings. Given that the objective of this report is to estimate the economic benefits of broadband use in First Nations reserves across Canada, particular attention is given to the potential impact of broadband in rural and remote communities.

It is important to note that the focus of this literature review is specifically on the effects of broadband on the economy. Although extensive literature exists on the economic impact of telecommunication infrastructure[7] and ICTs in general,[8] this literature is not discussed here. Furthermore, we do not discuss "forward-looking studies" of broadband, i.e. studies that project the economic impact of broadband in the near future, such as Crandall and Jackson (2001), Crandall, Jackson, and Singer (2003), Varian *et al.* (2002), and Katz and Suter (2009). While definitely important, these studies are forecasting exercises and do not estimate the *actual* contribution of broadband to the economy.

This section is divided into four parts. The first two parts focus on two different types of econometric studies: growth models and production function models. Growth models are used to estimate the impact of broadband (availability or penetration) on growth of a particular economic variable, such as employment or GDP. They are, in principle, "atheoretical" models, in the sense that economic theory plays no role in their basic structure. Production function models, on the other hand, do rely on economic theory, describing how inputs are combined to produce output. The third part highlights case studies on the economic impact of broadband, with special emphasis on the effect of broadband use on rural/remote communities. The fourth part provides a brief summary of the findings of the literature.

[7] See, for instance, Hardy (1980), Leff (1984), Cronin *et al.* (1991), Greenstein and Spiller (1995), Madden and Savage (1998, 2000), Röller and Waverman (2001), Sridhar and Sridhar (2004), Datta and Agarwal (2004), and Duggal *et al.* (2006).

[8] Some recent papers on the topic include Jorgenson *et al.* (2008), Basu and Fernald (2008), and Inklaar *et al.* (2008). Detailed literature reviews can be found in Sharpe (2006), Draca *et al.* (2006), and Cavosoglu *et al.* (2011).

A. Growth Model Studies

i. Lehr *et al.* (2005) and Gillett *et al.* (2006)

Broadband Definition	- Connections with speeds equal to or above 200 Kbps in at least one direction were considered to be broadband connections. - ZIP code-level: Broadband availability (ZIP codes with at least one broadband ISP). - State-level: Broadband penetration (number of lines per 100 persons).
Data	- 1998-2002 period. - U.S. ZIP code-level data (22,390 ZIP codes). - U.S. state-level data.
Dependent Variables	Employment growth (1998-2002), wage growth (1998-2002), growth in the number of business establishments (1998-2002), share of establishments in IT-intensive sectors (2002), share of establishments with fewer than 10 employees (2002), and median housing rent (2000).
Main Findings	- In all econometric exercises, broadband had a statistically significant, positive effect on employment growth. - In most econometric exercises, broadband was associated with higher levels of housing rent. - In the ZIP code regressions, broadband also showed statistically significant effects on industry composition variables. - The effect of broadband on wages was statistically insignificant in all econometric exercises.

Lehr, Osorio, Gillett, and Sirbu (2005) look at how broadband affected economic growth in the United States during the 1998-2002 period. They perform three types of econometric exercises:[9]

(i) Using state-level data, a variable denoting economic performance is regressed on *broadband use* and a number of controls;[10]

(ii) Using ZIP code-level data, a variable denoting economic performance is regressed on *broadband availability* in 1999 and a number of controls;

(iii) The third set of exercises involved a matching procedure. Communities with broadband (which could be seen as the "treatment group") were matched to communities with similar characteristics (e.g. similar population density) that did not have broadband (the "control group"). After the matching was completed, the average effect of broadband on the dependent variable of choice could be estimated.

[9] A detailed discussion of the more technical aspects of Lehr *et al.* (2005) can be found in Gillett *et al.* (2006).

[10] Controls include: 1) growth rate in the number of employees (1994-1998); 2) growth rate in the number of people (25+) with college degree or higher (1990-2000); 3) share of population (25+) with college degree or higher (2000); 4) growth rate in the number of establishments (1994-1998); 5) growth rate in median family income (1990-2000); 6) growth of the civilian employed labour force (1990-2000); 7) growth rate of the share of establishments in IT intensive sectors (1998-2000); 8) median housing rent (1990); 9) share of establishments with less than 10 employees (1998); share of establishments in IT-intensive sectors (1998); 10) share of urban housing units (2000); 11) share of urban population (2000).

Lehr *et al.* recognize that state-level data might be too aggregated to yield interesting results, especially taking into account that variations in broadband use are much higher within states than among states. However, the authors argue that state-level data are still important to analyze because they are the only available data on broadband use, as opposed to broadband availability.

The three types of econometric exercises are implemented using six different dependent variables: employment growth during the 1998-2002 period, wage growth during the same period, growth in the number of business establishments, share of establishments in IT-intensive sectors in 2002, share of establishments with fewer than 10 employees in 2002, and median housing rent in 2000. Table 3 summarizes the main results.

Table 3: Broadband Impact on Selected Economic Variables (Lehr *et al.*, 2005)

Variable	State	ZIP	Matched Panel
Employment Growth, 1998-2002	-/+*	+*	+*
Wage Growth, 1998-2002	-/+	-	-
Number of Establishments Growth, 1998-2002	-*/+	+*	+*
Share of IT-Intensive Establishments, 2002	-/+*	+*	-
Share of Establishments with fewer than 10 employees, 2002	-	-	-
Median Housing Rent, 2000	+*	+*	-

(+) Positive impact of broadband; (-) Negative impact of broadband; (-/+) Mixed results
*Statistically significant at 10% or less.
Source: Lehr *et al.* (2005:17).

In the state-level regressions, broadband use had a significant positive impact on employment growth and median housing rent. The ZIP-level regressions yielded more promising results, with broadband availability having a significant positive impact on employment growth, median housing rent, establishment growth, and growth in the share of firms in IT-intensive sectors. Table 4 shows the estimated impact of broadband availability in each of those variables. Finally, in the matched panel method, broadband availability had a significant (positive) impact only on employment growth.

Table 4: Broadband Impact on Selected Economic Variables – ZIP code regressions (Lehr *et al.*, 2005)

Variable	Measured Effect of Broadband Availability
Employment	Employment growth was 1.0 percentage point higher in ZIP codes where broadband was available.
Wages	No statistically significant impact of broadband availability.
Number of Business Establishments	The number of establishments grew 0.5 percentage points faster in ZIP codes where broadband was available
Share of IT-Intensive Establishments	The share of IT-intensive establishments was 0.5 percentage points higher in ZIP codes where broadband was available.
Share of Small Establishments	No statistically significant impact of broadband availability
Property Values	Housing rental rates were 6 per cent higher in ZIP codes where broadband was available.

Source: Lehr *et al.* (2005:17).

Lehr *et al* note that the above results should be interpreted with caution. As is the case with many economic variables, there is a problem here in pinpointing the direction of causality. In all likelihood, broadband infrastructure affects economic performance, but economic performance also gives rise to broadband infrastructure. After all, the "decision by providers to deploy broadband is related to economic characteristics of the community, such as income and population density" (Lehr *et al.*, 2005:21). To use a more technical term, broadband (availability and use) is *endogenous* to economic performance. Some econometric techniques, such as instrumental variables (IV), allow for the effect of economic performance on broadband to be disentangled from the effect of broadband on economic performance. Lehr *et al*, however, do not make use of such techniques.

Gillett, Lehr, Osorio, and Sirbu (2006) update the estimates on Lehr *et al.* (2005). Their findings are, in general, consistent with those in Lehr *et al.*, although their state-level regressions and their matched panel exercises yield better results (Table 5). It is not clear what is driving the differences in results, since both papers use the same dataset and appear to implement the same econometric exercises.

Table 5: Broadband Impact on Selected Economic Variables (Gillett *et al.*, 2006)

Variable	State	ZIP	Matched Panel
Employment Growth, 1998-2002	-/+	+*	+*
Wage Growth, 1998-2002	+	-/+	+
Number of Establishments Growth, 1998-2002	+	+*	+*
Share of IT-Intensive Establishments, 2002	-*/+	+*	+*
Share of Establishments with fewer than 10 employees, 2002	+	-*	-*
Median Housing Rent, 2000	+*	+*	-*

(+) Positive impact of broadband; (-) Negative impact of broadband; (-/+) Mixed results
*Statistically significant at 10% or less.
Source: Gillett *et al.* (2006:25-34).

ii. Crandall, Lehr, and Litan (2007)

Broadband Definition	- Connections with speeds equal to or above 200 Kbps in at least one direction were considered to be broadband connections. - Broadband penetration (number of lines per 100 persons).
Data	- 2003-2005 period. - U.S. state-level data.
Dependent Variables	Employment growth (2003/04-2005); GDP growth (2003/04-2005).
Main Findings	- Non-Farm Private Sector: Broadband penetration had a statistically significant, positive effect on employment growth, but not on GDP growth. - Two-Digit NAICS Sectors: The effect of broadband penetration on employment growth was statistically significant mainly in service industries, such as educational services, health care and social assistance, and finance and insurance. The effect of broadband on GDP growth was not particularly significant, except in the real estate, rental & leasing sector.

Crandall *et al.* (2007) use U.S. state-level broadband data from the Federal Communications Commission (FCC) to estimate the effect of broadband penetration on GDP and employment growth during the 2003-2005 period. The study adopts the FCC's definition of broadband, which considered all connections of 200Kbps or more as broadband, although Crandall *et al.* recognize that this definition was too "broad" at a time when speeds were routinely above 1Mbps. They argue, however, that FCC was the most detailed and reliable source of broadband penetration data.

Using ordinary least squares (OLS), the authors regress GDP growth (or employment growth) on broadband penetration (number of lines per 100 persons) and a number of control variables. The controls include: average mean temperature (a more favourable climate can attract workers to a particular state); a tax climate index (states with low business taxes should be able to attract more economic activity); union membership share of employment (low levels of unionization might induce more economic activity); share of population with post-secondary studies; and average hourly earnings in the non-farm private sector. Nine dummy variables for census regions are also included to capture other effects that may vary across regions.

Crandall *et al.* find a statistically significant, positive effect of broadband use on employment in the non-farm private sector. More specifically, they estimate that an increase of 1.0 percentage point in broadband penetration raised employment growth in one year by 0.2-0.3 percentage points. As the authors note: "For the entire U.S. private non-farm economy, this suggests an increase of about 300,000 jobs, assuming the economy is not already at 'full employment'" (Crandall *et al.*, 2007:2). Looking at a two year horizon, an increase of 1.0 percentage point in broadband penetration raised employment growth by 0.6 percentage points, between two to three times the one-year effect. The impact of broadband on output was not statistically significant (although the broadband coefficient had the expected positive sign). The authors argue that a possible reason for this result is the imprecise nature of GDP estimates at the state-level.

At the two-digit NAICS level, Crandall *et al.* find that broadband penetration had a positive and statistically significant effect on employment growth mainly in service sector industries. In particular, the broadband penetration coefficient was significant in the following industries: educational services; health care and social assistance; and finance and insurance (only in the 2003-2005 period). The broadband coefficient for the manufacturing sector was also statistically significant.

Table 6: Effect of Broadband Penetration on Employment and GDP (Crandall *et al.*, 2007)

A) Non-Farm Private Sector

Variable	Measured effect of Broadband Penetration
Employment	An increase of 1.0 percentage point in broadband penetration raises employment growth by 0.2-0.3 percentage points in one year and by 0.6 percentage points in two years.
GDP	The impact of broadband penetration was not statistically significant (although the broadband coefficient had the expected positive sign).

B) Two-Digit NAICS Level

	Employment 2005/2004	Employment 2005/2003	GDP 2005/2004	GDP 2005/2003
Construction	2.468	3.892	0.013	0.591
Manufacturing	0.371**	0.789**	0.567	0.577
Wholesale Trade	0.098	0.201	0.411	0.710
Information	0.169	0.443	0.372	0.315
Finance and Insurance	0.273	1.043***	0.493	1.900**
Real Estate and Rental & Leasing	0.125	0.483	0.481**	1.584***
Prof., Scientific, & Technical Services	0.066	0.380	0.194	0.339
Management of Companies and Enterprises	0.440	2.081	-0.196	2.209
Admin. & Support, Waste Management and Remedial Services	0.447	1.149	0.896**	1.163
Educational Services	2.741**	4.054***	0.299	1.071
Health Care and Social Assistance	0.369**	0.656**	0.121	0.334**
Arts, Entertainment & Recreation	-0.114	-0.031	-0.320	-0.032
Accommodation and Food Services	0.284**	0.361	0.317	0.501
Other Services	0.236	0.466	0.289	0.547**

*Statistically significant at 10% **Statistically significant at 5% ***Statistically significant at 1%

Note: The entries in Panel B should be interpreted as follows: "A 1.0 percentage point increase in broadband penetration increases employment growth in manufacturing by 0.371 percentage points in one year and by 0.789 percentage points in two years".

Source: Crandall *et al.* (2007:10-11, 13).

Much like the non-farm private sector regressions, the effects of broadband penetration on GDP at the two-digit NAICS level were not overwhelmingly significant. The only two-digit sector that had a statistically significant coefficient for broadband in both the 2004-2005 period and the 2003-2005 period was real estate and rental & leasing. Other sectors had a statistically significant effect of broadband on output, but only in one of the two periods (these sectors were: finance and insurance, educational services, and other services in the 2003-2005 period; admin. and support, waste management, and remedial services in the 2004-2005 period). Table 6 describes the main findings of Crandall *et al*.

iii. Shideler, Badasyan, and Taylor (2007)

Broadband Definition	- The paper does not explicitly define the broadband benchmark adopted. - Broadband availability (area for which broadband was available divided by total area).
Data	- 2003-2005 period. - County-level data for the state of Kentucky (120 counties).
Dependent Variables	Employment growth (2003-2005).
Main Findings	- Non-Farm Private Sector: Broadband saturation had a statistically significant, positive effect on employment growth. - Two-Digit NAICS Sectors: Broadband saturation had a statistically significant, positive effect on the following sectors: 1) mining; 2) construction; 3) information; 4) and administrative, support, waste management and remediation services. Broadband had a statistically significant, negative impact in one sector: accommodation and food services.

Using county-level data, Shideler *et al.* (2007) examined the impact of broadband use on economic activity in Kentucky during the 2003-2005 period. The focus on this particular state was due in large part to the quality of broadband data to which the authors had access. In 2004, the state of Kentucky launched the "Prescription for Innovation" project, with the objective of bringing full broadband deployment to the state by the end of 2007. This project was implemented by a public-private partnership called ConnectKentucky. In order to identify the underserved and unserved areas, ConnectKentucky had access to proprietary infrastructure data from broadband providers. Shideler *et al.*, in turn, had access to ConnectKentucky's Geographic Information System (GIS) database, and used this data to construct a measure of broadband availability:

> The GIS inventory provides a comprehensive view of broadband technologies, representing digital subscriber lines (DSL), cable modem service, and fixed wireless networks, measured at the point of service availability (i.e., at the location of infrastructure placement). Coverage areas were aggregated to the county level by Census block groups, and then the ratio of the coverage area to total area of the county was computed. This saturation rate was our measure of broadband infrastructure as of January 2004 (Shideler *et al.*, 2007:93).

The study considers this measure of broadband to be superior to the measures used in Lehr *et al.* (2005), Gillett *et al.* (2006), and Crandall *et al.* (2007). On one hand, Shideler *et al.* argue that ZIP code data from the FCC overestimate broadband availability because the entire ZIP code is considered to have broadband if at least one subscriber lives there. This is a particularly big problem in rural areas, where ZIP codes usually encompass a large area. On the other hand, they consider state-level broadband use data to be too "geographically aggregated to identify variances in broadband coverage" (Shideler *et al.*, 2007:89).

Shideler *et al.* use the same type of econometric model as Lehr *et al.* (2005). Since reliable estimates of output at the county-level are hard to construct, they focus on the impact of broadband on employment growth, both at the total economy level and at the two-digit NAICS level. They regress employment growth on broadband saturation, a squared-term for broadband (to control for diminishing returns of broadband infrastructure), and a number of control variables, including: educational attainment (share of the population 25 years and older with at least a college degree in 2000), number of limited-access highway miles (as a proxy of non-technological infrastructure), a dummy variable to control for differences between urban and rural areas, and the unemployment rate.

Table 7: Effect of Broadband Saturation on Employment Growth (Shideler *et al.*, 2007)

	Effect of Broadband Saturation on Employment Growth
Non-Farm Private Sector	0.173***
Forestry, Fishing, and Hunting	0.224
Mining	4.050**
Utilities	4.187***
Construction	0.797**
Manufacturing	-0.397
Wholesale Trade	-0.390
Retail Trade	0.055
Transportation Warehousing	0.675
Information	2.725***
Finance and Insurance	-0.109
Real Estate and Rental and Leasing	0.89
Regression Results for Professional, Scientific, and Technical Services	0.096
Management of Companies and Enterprises	-1.123
Administrative, Support, and Waste Management and Remediation Services	3.086***
Educational Services	3.403
Health Care and Social Assistance	0.099
Arts, Entertainment and Recreation	0.761
Accommodation and Food Services	-0.397*
Other Services	0.176

*Statistically significant at 10% **Statistically significant at 5% ***Statistically significant at 1%
Note: This table should be interpreted as follows: "A 1.0 percentage point increase in broadband saturation increases employment growth in the non-farm private sector by 0.173 percentage points".
Source: Shideler *et al.* (2007:95-115)

At the non-farm private sector level, the study finds that an increase of 1.0 percentage point in broadband saturation raised employment growth by approximately 0.17 percentage points. At the two-digit NAICS level, broadband increased employment growth in the following sectors: mining, construction, information, and administrative, support, waste management and remediation services. There was one sector where broadband had a significant negative impact on employment growth: the accommodation and food services sector. Shideler *et al.* raise two possible explanations for this negative impact of broadband: a) individuals could be relying more on the Internet for travel information, travel bookings, and hotel arrangements, which could reduce employment in the travel agency industry; and b) increased broadband availability might raise workers productivity, encouraging firms to substitute technology for labour. Table 7 summarizes the main findings of this study.

iv. Thompson and Garbacz (2008a, 2008b)

Broadband Definition	- Connections with speeds equal to or above 200 Kbps in at least one direction were considered to be broadband connections. - Broadband penetration (number of lines per 1,000 persons).
Data	- 2001-2006 period. - U.S. state-level data.
Dependent Variables	GDP per capita growth (2001-2006).
Main Findings	The direct effect of broadband penetration on GDP per capita was not statistically significant, but the indirect effect was. In other words, broadband helped increase the efficiency of production processes.

Thompson and Garbacz (2008a, 2008b) expand on the framework developed by Lehr *et al.* (2005), Gillett *et al.* (2006), and Crandall *et al.* (2007), investigating the effect of broadband penetration on U.S. GDP per capita growth during the 2001-2006 period. The authors distinguish between direct effects of broadband penetration and indirect effects. Direct effects include the economic gains (in the form of jobs and value added) of broadband infrastructure investment, as well as the gains derived from the services created by these investments. Indirect effects, on the other hand, include a number of different factors such as: increased ease of information access, reduction in transaction costs, improved supply coordination and management efficiency, cost-saving benefits of telecommuting, spillovers, etc. In general, indirect benefits reflect the potential of broadband use to increase the efficiency of production processes.

In their first study, Thompson and Garbacz (2008a) estimate the direct impact of broadband penetration on state-level GDP per capita growth. They regress GDP per capita growth on broadband penetration and a variety of controls, such as the proportion of the population with high-school education, proportion of population living in urban areas, state and local tax rates, etc. In line with previous studies, they find that broadband penetration did not yield a significant impact on GDP growth.

In their second study, however, Thomson and Garbacz (2008b) use a stochastic production function approach to assess the indirect impact of broadband on the economy. They estimate that, in fact, broadband played a significant role in increasing production efficiency, with a 10 per cent increase in broadband penetration accounting for a 3.6 per cent increase in efficiency.

B. Production Function Studies

i. Koutroumpis (2009)

Broadband Definition	- Connections with speeds equal to or above 1 Mbps in at least one direction were considered to be broadband connections. - Broadband penetration (number of lines per 100 persons).
Data	- 2002-2007 period. - 22 OECD countries.
Dependent Variables	Real GDP growth (2002-2007)
Main Findings	- Broadband penetration had a statistically significant, positive effect on GDP growth. - The effect of broadband penetration on GDP growth varied according to the level of broadband penetration. Countries with higher levels of broadband penetration experienced stronger effects than countries with lower levels of broadband penetration.

Koutroumpis (2009) investigates the effect of broadband penetration on the economic performance of 22 OECD countries during the 2002-2007 period. He recognizes the "two-way relationship between growth and broadband infrastructure" (Koutroumpis, 2009:474) and uses a simultaneous equations model to deal with this problem. Below, we describe the four equations in his model:

(i) The *aggregate production function* of the economy is modeled as a function of non-broadband capital stock, broadband capital stock, and human capital. Koutroumpis' main objective is to estimate the coefficient of broadband capital stock in this equation. This coefficient represents the elasticity of broadband capital with respect to real GDP. In other words, it tells us how much real GDP increases if broadband capital increases by one per cent.

(ii) *Demand for broadband infrastructure* is modeled as a function of GDP per capita, broadband prices, the per cent of GDP spent on education, the share of population that lives in urban areas, and the per cent of GDP spent on research and development.

(iii) *Supply for broadband infrastructure* is modeled as a function of broadband prices, the level of competition in the broadband market, and regulatory control (proxied by the "mandate of local loop unbundling on the incumbent's network") (Koutroumpis, 2009:474).

(iv) *Broadband infrastructure production* is modeled as a function of broadband investment during one year.

Koutroumpis estimates several alternative specifications of this system of equations using different econometric techniques. In some cases, he estimates the equations one by one; in other cases, he estimates them jointly. In all cases, he uses econometric techniques (such as the instrumental variable approach or three-stage least squares) that allow him to parse out the effect of broadband on output from the effect of output on broadband. According to his estimations, a 1.0 percentage point increase in broadband penetration increases GDP growth by approximately 0.02 percentage points.

Koutroumpis also finds that the effects of broadband on GDP growth vary according to the level of broadband penetration. Due to network externalities, regions with high broadband penetration see a greater impact of broadband on economic growth than regions with low broadband penetration (Table 8).

Table 8: Effect of Broadband Penetration Broken Down by Penetration Levels (Koutroumpis, 2009)

Broadband Penetration Level	Broadband Elasticity with Respect to GDP
Low (< 20%)	0.008-0.018
Medium (<30% and > 20%)	0.014-0.021
High (> 30%)	0.023-0.330

Source: Koutroumpis (2009:481).

Table 9: Impact of Broadband Infrastructure on Growth for Each Country (broken down by broadband penetration clusters)

	Average Real GDP Growth	Average % Impact of Broadband Infrastructure on GDP	Per Cent of Country's Growth Attributed to Broadband Infrastructure
		BB Penetration > 30%	
Denmark	2.11	0.38	18.15
Netherlands	2.03	0.39	19.03
Switzerland	2.06	0.39	18.95
Norway	2.79	0.41	14.59
Sweden	3.1	0.37	11.8
		BB Penetration <30% and >20%	
Germany	1.44	0.24	16.86
France	1.89	0.26	13.49
Japan	2.07	0.2	9.77
Belgium	2.19	0.21	9.55
United Kingdom	2.72	0.26	9.53
Australia	3.44	0.27	7.75
United States	2.95	0.2	6.92
Canada	2.71	0.19	6.87
Luxemburg	3.92	0.27	6.81
		BB Penetration < 20%	
Portugal	0.85	0.14	16.04
Italy	0.94	0.15	15.89
New Zealand	2.88	0.15	5.33
Austria	2.42	0.12	4.94
Hungary	3.65	0.15	4.09
Spain	3.49	0.14	3.91
Greece	4.33	0.16	3.68
Ireland	5.02	0.16	3.13
		EU Average	
22 country average	2.67	0.24	10.54

Source: Koutroumpis (2009:482).

Using these estimates, Koutroumpis estimates the contribution of broadband infrastructure to GDP growth during the 2002-2007 period for the 22 OECD countries in his sample (Table 9). He finds that broadband infrastructure accounted for 10.5 per cent of the average GDP growth of 2.67 per cent per year experienced by the 22 OECD countries in the period. The contribution of broadband to GDP growth ranged from 3.1 per cent of total growth (in Ireland) to 19.0 per cent (in the Netherlands).

ii. LECG (2009)

Broadband Definition	- Connections with speeds equal to or above 1 Mbps in at least one direction were considered to be broadband connections. - Broadband penetration (number of lines per 100 persons).
Data	- 1998-2007 period. - 15 OECD countries.
Dependent Variables	Labour productivity growth.
Main Findings	Effect of broadband penetration on real GDP contingent on overall ICT diffusion rates. Broadband had a statistically significant, positive impact on labour productivity growth in countries with medium/high levels of ICT diffusion, but little impact on countries with low ICT diffusion rates.

LECG (2009) analyzes the impact of broadband penetration on labour productivity growth of 15 OECD countries during the 1998-2007 period. The study uses a production function approach, with real GDP being modeled as a function of labour input, non-ICT capital

stock, and ICT capital. ICT capital, in turn, is a function not only of the overall level of ICT capital stock, but also of the broadband penetration rate. Furthermore, the model allows for a differentiated effect of broadband depending on whether ICT diffusion (proxied by PC penetration rates) in a country is classified as low (countries in the bottom 1/3 of the sample) or medium/high (countries in the top 2/3 of the sample) (Table 10). The main findings of the study are summarized below:

- The economic benefits of broadband depended on overall ICT diffusion. Countries that had low ICT diffusion rates did not see significant benefits in broadband adoption, while countries that had medium/high diffusion rates saw substantial economic gains. In countries with significant ICT diffusion, a 1.0 per cent increase in broadband penetration caused productivity growth to increase 0.1 per cent.

Table 10: Average PC Penetration by Country, 1998-2008 Average (LECG, 2009)

Rank by Average PC Penetration, 1998-2007	Country	Average PC Penetration	ICT Diffusion Level
1	USA	65.3	High
2	Sweden	63.4	High
3	Denmark	57.2	High
4	Netherlands	54.8	High
5	UK	47.8	High
6	Germany	44.6	Medium
7	Austria	44.1	Medium
8	Finland	42.7	Medium
9	Ireland	42.6	Medium
10	France	40.3	Medium
11	Belgium	29.2	Low
12	Italy	23.1	Low
13	Spain	21.5	Low
14	Portugal	12.5	Low
15	Greece	7.8	Low

Source: LECG (2009:28-29).

- In the case of the U.S. economy, broadband is estimated to have accounted for 12.0 per cent of the 2.1 per cent per year labour productivity growth observed during the 1999-2007 period. LECG also estimates that, "if the United States had about 5 more broadband lines for every 100 persons, U.S. GDP would be higher by over $50 billion" (LECG, 2009:20).

- The fact that the economic impact of broadband depends on the overall ICT diffusion rate suggests the existence of network externalities (benefits that are only accrued when a substantial number of people are using a particular technology). It also indicates that, for the full benefits of broadband to be tapped into, investment in complementary factors (such as re-skilling of the work force) has to be realized. As the study notes: "Our message here is that broadband is a good thing, potentially a very good thing, but it is not a 'magic bullet' solution for economic growth or productivity" (LECG, 2009:5).

- Consistent with the above message, the study argues that supply-side policies to improve broadband deployment and competition can lower broadband price and thus incent broadband adoption. However, these policies should be accompanied by demand-side policies, i.e. policies that target "the skills of consumers and the willingness of businesses to use technology in economically advantageous ways" (p. 8).

C. Case Studies

i. Currie (2003)

Broadband Definition	- The paper does not explicitly definite the broadband benchmark adopted. - Broadband use at the firm-level.
Data	- Survey conducted among businesses and organizations in the semi-rural Township of South Dundas (ON) in 2003. Surveys were sent to 124 out of 366 establishments, with a response rate of 75 per cent.
Dependent Variables	Revenues, GDP, employment.
Main Findings	- Broadband use directly created a substantial number of jobs and increased revenues. The effect is substantially greater when the indirect and induced effects of broadband are also taken into account. - Firms that use broadband experienced employment growth more often than firms that only used dial-up connections or did not use the Internet at all.

Currie (2003) studies the economic impact of a fibre optic network built on the small, semi-rural Township of South Dundas, located in Eastern Ontario, in mid-2001. In order to do so, he conducted a survey in mid-2003, asking businesses and organizations in the Township about any changes in employment, revenues, costs, as well as expansions of commercial/industrial facilities experienced by these establishments in the previous 12 months. Since business changes were not necessarily caused by broadband adoption, Currie also explicitly inquired about the potential relationship between these changes and the Internet (in general) and broadband (in particular). *Direct* economic effects were only attributed to broadband if the respondents argued that, without this technology, the change would not have been possible. Currie cites the example of a local trucking company, which serviced the delivery markets of Ottawa and Toronto:

> (…) with its dial-up connection to the Internet, it could not access dispatch sites quickly enough to obtain return loads. Consequently the many empty returns had a severe cost impact on operations. Within two months of installing a direct fibre connection, the owner announced in public that he had been able to book enough returns in that period to pay for his connection and service for the remainder of the year (p. 10)

Surveys were distributed to 124 out of the 366 businesses and organizations in South Dundas. There were 93 respondents (75 per cent response rate), which included all of the 24 subscribers of the fibre optic broadband network and the other 14 firms that already had access to broadband through other means. Currie finds the following direct economic effects of broadband to fibre network subscribers:

- 62.5 jobs created (the 0.5 stands for part-time workers), most of which were in manufacturing (73.6 per cent). This represents 8.7 per cent of the 717 jobs created in South Dundas during the 2001-2003 period;

- $2.8 million in the expansion of commercial/industrial facilities;

- $140,000 in increased revenues and decreased costs.

Using an input-output (I-O) model, Currie estimates the overall impact of broadband on the Township's economy. He differentiates between three types of effects:

- Direct Effects – Direct expenditures or sales associated with the fibre network;

- Indirect Effects – Purchases of goods and services using the Internet, but not directly attributable to the South Dundas fibre network;

- Induced Effects – Spending of wages and salaries received by workers because of increased economic activity in the community.

Table 11 summarizes the results from the I-O model. Taking into account all of the above effects, the fibre optic network is estimated to have increased sales and GDP in South Dundas by $25.2 million per year and $16.0 million per year (respectively), while creating 207 jobs/year.

Table 11: Results from the Input-Output Model (Currie, 2003)

Effect	Sales	GDP	Employment
	($ millions)		(persons)
Direct	16.4	11.7	79
Indirect	5.7		48.2
Induced	3.1	4.3	80
Total	**25.2**	**16.0**	**207.2**

Source: Currie (2003:27-29).

Additionally, the study finds evidence of a strong link between broadband use and employment growth: 50 per cent of the businesses that used broadband experienced employment growth in the 2002-2003 period, compared to 27.0 per cent of businesses which only had dial-up access and 5.6 per cent of the businesses that did not have Internet access.

ii. Zilber, Djwa, and Schneider (2005)

Broadband Definition	- The paper does not explicitly definite the broadband benchmark adopted. - Broadband use at the firm-level.
Data	- Survey data collected during the months of July and August in 2005. - Two rural/remote regions in British Columbia: the Peace River region and the South Similkameen region.
Dependent Variables	Business productivity; household income; household expenses.
Main Findings	- Broadband was found to significantly increase business productivity; - Broadband use was associated with higher household income and lower household expenses.

Zilber, Djwa, and Schneider (2005) analyze the economic impact of broadband use in two rural and remote areas in British Columbia: the Peace River region and the South Similkameen region. In 2005, they surveyed both residential broadband users and business broadband users in the two regions, asking details about how broadband affects their daily lives and business operations. Their main findings are highlighted below:

- 80 per cent of the business respondents indicated that the absence of broadband services would have a negative impact on their business; 18 per cent reported that they would not be able to run their business without broadband;

- 62 per cent of the business respondents stated that broadband caused a significant increase in their productivity. The majority of those businesses indicated that the broadband-driven productivity increase was greater than 10 per cent;

- 15 per cent of the residential respondents stated that their household income increased due to broadband use while 39 per cent said that household expenses declined due to broadband use;

- 75 per cent of the residential respondents indicated that broadband was essential at their place of work for at least one member of the household.

iii. LaRose, Strover, Gregg, and Straubhaar (2011)

Broadband Definition	- Connections with speeds equal to or above 768 Kbps in at least one direction were considered to be broadband connections. - Broadband penetration (number of lines per 100 persons).
Data	- 2005 and 2008. - 4 U.S. counties.
Dependent Variables	Economic development intentions.
Main Findings	- Both dial-up and broadband users had stronger intentions to improve their economic conditions than non-users. - However, there were no significant differences in personal economic development intentions between dial-up and broadband users.

LaRose *et al.* (2011) study the effect of broadband infrastructure in rural communities in the United States. The study looks at four counties that received Community Connect Grants from the U.S. Department of Agriculture in 2005. These grants are specifically targeted at rural communities in order to help them develop broadband infrastructure and community centres that offer public access to broadband. The four counties included in the study were: Pike (KY), Huron (MI), Zapata (TX), and Zavata (TX). At the time of the grant, the county of Pike also had an ongoing public campaign to educate its residents on the benefits of broadband use. Zavata county, on the other hand, had its grant suspended midway through the project, and thus can be seen as the "control group".

LaRose *et al.* conducted two surveys in the four counties, one in 2005 – when the grant was awarded – and the other in 2008 – after the grant funds had been invested –, and examined the data using multivariate statistical analysis. Their objective was to answer four main questions:

1. What impact do federally funded broadband networks and public education campaigns have on broadband adoption?

2. What impact do federally funded broadband networks and public education campaigns have on a) awareness and perceptions of broadband internet service and b) intentions to adopt it?

3. What impact do federally funded broadband networks and community education campaigns have on personal economic development intentions (such as developing a home business and telecommuting or using the internet for education and training)?

4. What impact do government funded broadband networks and public information campaigns have on the community satisfaction level of rural residents?

Regarding question (1), LaRose *et al.* report mixed results. All counties experienced an increase in broadband adoption between 2005 and 2008 (Table 12). The greatest increase in broadband adoption happened in Pike county (which had both a grant and a public campaign). Zavata county (the "control group" which had the grant suspended), however, saw an increase in broadband adoption more significant than that of one of the other counties which had the grant, probably due to above average levels of *private* broadband investment. The study notes that the public campaign in Pike county boosted broadband adoption well above the effect of the federal grant. In the words of LaRose *et al.*:

> (…) the combination of federal grant and community education had an incremental effect on adoption over and above that found in the best case where a federal grant had been implemented and also in comparison to the control condition" (LaRose *et al.*, 2009: 96).

Table 12: Broadband Adoption in 4 U.S. Counties, 2005 and 2008 (LaRose *et al.*, 2011)

County	Treatment Condition	Broadband Adoption (per cent)		
		2005	2008	Change
Pike (KY)	Grant + Campaign	12.0	45.0	33.0
Huron (MI)	Grant only	15.0	40.0	25.0
Zapata (TX)	Grant only	18.0	23.0	5.0
Zavala (TX)	Control	10.0	22.0	12.0

Source: LaRose *et al.* (2011:96).

With respect to question (2), the study finds that, compared to the control community: a) neither the grants nor the public campaign were effective in raising broadband awareness; b) the grants did not have a significant impact in increasing the positive perception of broadband services, but the public campaign did; and c) intentions to adopt broadband increased significantly in the presence of a public campaign. The authors conclude that: "(…) community education outreach may be essential to make rural residents aware of the benefits of broadband and to prompt them to adopt the technology" (p. 97).

In the case of question (3), La Rose *et al.* report that broadband adoption had no significant impact on personal economic development intentions. More precisely, both dial-up and broadband users had "stronger intentions to improve their economic conditions than non-users" (p. 97), but there were no significant differences between dial-up users and broadband users. Finally, regarding question (4), the study finds no significant impact of broadband adoption on community satisfaction.

D. The Evidence so Far

The literature discussed in this section points to a significant impact of broadband use on economic development. It is important to acknowledge, however, that there are significant disagreements as to the magnitude of this impact and as to which economic variables are affected. Below, we summarize the main findings of the literature so far:

- In general, growth model studies have found a statistically significant, positive impact of broadband availability and penetration on employment growth, but not on GDP growth. This is a somewhat puzzling result, since one would expect employment growth to be accompanied by GDP growth. A possible reason for this result is data quality.

- Another possible reason refers to the fact that most (if not all) of the growth models seen in this section do not address endogeneity of broadband, i.e. broadband use can cause economic development, but economic development also induces broadband use. The failure to take this problem into account might have an impact on the overall quality of the estimated impact of broadband on economic development. Econometric techniques

such as instrumental variables (IV) can be used to address this issue, producing more reliable estimates.

- Production function models have found a statistically significant, positive effect of broadband penetration on GDP growth and GDP per capita growth. The results of both Koutroumpis (2009) and LECG (2009) suggest that the economic benefits of broadband are a function of broadband penetration. Thus, the impact of broadband on economic growth is greatest once a certain "critical mass" has been reached. Conversely, if broadband penetration is low, the benefits of broadband might be modest at best.

- The case studies discussed show that broadband had a positive effect on the economic development of rural communities. Businesses that used broadband saw a significant increase in sales, GDP, employment, and the efficiency of their production processes. Households also reported benefitting from broadband use, in particular through reduced household expenses, although the mechanisms by which broadband might reduce expenses are not particularly clear.

V. An Empirical Assessment of the Economic Impacts of Broadband on First Nations in Canada

This section represents a first attempt at estimating the economic impact of broadband on First Nations reserves across Canada using econometric tools. The section is divided into four subsections. The first subsection describes the model and explains our motivation for choosing this particular model over other possibilities. The second subsection provides summary statistics of all the variables included in the model. Next, we present and interpret the estimation results. Finally, data limitations are discussed. The accuracy of the estimation results is crucially dependent on the quality of the underlying data. In this subsection, we explain how our dataset deviates from an "ideal" dataset and the possible impact that this might have on our estimates.

A. The model

This report adopts a growth model similar to the ones used by Lehr *et al.* (2005), Gillett *et al.* (2006), Crandall *et al.* (2007), and Shideler *et al.* (2007). This type of model can be seen as an "atheoretical" model, in the sense that economic theory plays no role in its basic structure. As Shideler *et al.* (2007) note, a growth model simply "(…) predicts the economic growth of a region during one period based upon the level of economic activity of some previous period plus any compounded growth that would be expected to occur between the two periods" (p. 90). Mathematically, this can be understood as:

$$Y_t = AY_{t-i}^{\alpha} e^{ri} \qquad (1)$$

where Y_t is the level of the economic variable at time t, A is a constant, α is a scaling parameter, and e^{ri} represents the (continuous) compounding term with interest rate r for i periods. Taking the natural logarithms of both sides of equation (1) and assuming that A and α are equal to 1 (a standard assumption), we have that:

$$\ln\left(\frac{Y_t}{Y_{t-i}}\right) = g_{t,t-i} \qquad (2)$$

where $g_{t,t-I} = ri$, i.e. the total growth of variable Y between periods t-1 and period t. For the purpose of multivariate regression analysis, equation (2) can be expanded to incorporate other elements:

$$\ln\left(\frac{Y_t}{Y_{t-i}}\right) = g_{t,t-i} + X\beta + \varepsilon \qquad (3)$$

where X is a matrix of explanatory variables, β is a vector of parameters, and ε is an error term. In equation (3), $g_{t,t-i}$ can be seen as "trend growth", i.e. the growth between periods t and t-i that is not accounted for by the variables in X. The estimated parameters in β represent the (marginal) effect of different explanatory variables to the overall growth in the period.

Table 13 describes the variables in our main specification of equation (3). Our two dependent variables are employment rate growth during the 2001-2006 period ($gr\_emp_{01\text{-}06}$) and average earnings growth during the 2000-2005 period ($gr\_avE_{00\text{-}05}$). The one-year difference in periods reflects the fact that earnings data from the censuses refer to the previous calendar year, while employment data refer to the week prior to census day. These five-year growth rates are ideal to understand how broadband can impact economic development because its impact may occur with substantial lags (in which case the reliance on one-year growth rates would understate the economic benefits of broadband).[11]

These two dependent variables are regressed on broadband availability and a number of control variables. Broadband availability (BB) is a dummy variable equal to 1 if the reserve had access to broadband and equal to 0 if it did not. The controls included are: growth rate in the number of people with post-secondary education in the 2001-2006 period ($gr\_PS_{01\text{-}06}$), share of the population with post-secondary education in 2001 (sh_PS_{01}), and a dummy variable representing the remoteness of the reserves in the sample (1=urban; 2=rural; 3=remote; 4=special access).

Table 13: Variables Used in the Multivariate Regression Analysis

Category	Variable	Description	Source
Dependent Variables	$gr\_emp_{01\text{-}06}$	Employment rate growth between 2001 and 2006 (in log terms).	2001 and 2006 Censuses
	$gr\_avE_{00\text{-}05}$	Average earnings growth between 2000 and 2005 (in log terms).	2001 and 2006 Censuses
Broadband	BB	Broadband availability in 2011.	Industry Canada
Independent Variables	$gr\_PS_{01\text{-}06}$	Growth rate in the number of people with post-secondary education between 2001 and 2006 (in log terms).	2001 and 2006 Censuses
	sh_PS_{01}	Share of population with post-secondary education in 2001.	2001 and 2006 Censuses
	Remote	Remoteness.	Indian and Northern Affairs Canada

Source: CSLS.

In line with most of the studies discussed, equation (3) is estimated using ordinary least squares (OLS), the staple technique in regression analysis. More sophisticated studies, such as Koutroumpis (2009) and LECG (2009) have used other estimation techniques, such as instrumental variables (IV), which have the advantage of correcting the possible endogeneity bias in estimations. Estimating equation (3) using IVs would undoubtedly be an advantage to this

[11] This point is widely discussed in the general ICT literature. See, for instance, Brynjolfsson and Hitt (2003) and Basu and Fernald (2008).

study, if only to check the robustness of our results.[12] We could not, however, find a good enough instrument for broadband availability at the reserve level.

One last point that should be addressed has to do with the choice of model. Why use a growth model approach similar to that of Crandall *et al.* (2007) and Shideler *et al.* (2007) instead of a production function approach, such as the one adopted by Koutroumpis (2009) and LECG (2009)? The answer, once more, is determined by data availability at the reserve level. A production function describes how inputs are combined in order to generate output. Inputs would include, at the very least, human capital, non-broadband capital, and broadband capital. While we do have data on human capital at the reserve level, data on non-broadband capital and broadband capital are not available. In the end, the growth model in equation (3) has considerably less data requirements than a basic production function model.

B. Summary Statistics

Table 14 provides summary statistics for the variables included in our model, as well as for other relevant variables. Broadband was available for 174 out of the 241 reserves (72.2 per cent) for which both 2001 and 2006 census data were available. Overall, the summary statistics of reserves where broadband was available and reserves without broadband access were very similar. There are small differences that are worth highlighting. Compared to reserves where broadband was not available, reserves that had broadband also had:

- Smaller populations (797 persons vs. 883 persons);
- Slightly lower average earnings in 2000 ($15,601 vs. $15,909), but slightly higher average earnings in 2005 ($18,315 vs. 18,058), which implies faster average earnings growth during the 2000-2005 period (16.5 per cent vs. 12.5 per cent).
- Higher employment rates in both 2001 and 2006 (as well as faster employment rate growth);
- A higher share of the 25+ population with post-secondary education in 2001;
- Slower growth in the number of people (25+) with post-secondary education during the 2001-2006 period.

Most of these differences, however, were not statistically significant.

[12] Interestingly enough, LECG (2009) find that, in their model, the estimated effect of broadband on economic growth changed very little whether OLS or IV was used.

Table 14: Summary Statistics

		All Reserves	Broadband	No Broadband
Number of Reserves		241	174	67
Aboriginal Population, 2006	(number of persons)	821 (654)	797 (613)	883 (752)
Average Earnings, 2000	(dollars per person employed)	15,694 (3,527)	15,611 (3,758)	15,909 (2,853)
Average Earnings, 2005	(dollars per person employed)	18,244 (3,957)	18,315 (4,150)	18,058 (3,427)
Average Earnings Growth, 2000-2005	(per cent)	15.4 (20.6)	16.5 (21.8)	12.5 (17.2)
Employment Rate, 2001	(per cent)	35.9 (10.2)	36.0 (10.3)	35.5 (9.8)
Employment Rate, 2006	(per cent)	37.3 (10.8)	37.6 (10.9)	36.5 (10.5)
Employment Rate Growth, 2001-2006	(per cent)	3.5 (23.2)	4.0 (24.2)	2.4 (20.5)
Share of Aboriginal Population 25+ with Post-Secondary Education, 2001	(per cent)	28.9 (12.7)	30.8 (12.2)	24.0 (12.8)
Growth in the Number of Persons 25+ with Post-Secondary Education	(per cent)	18.3 (42.6)	17.2 (41.2)	21.1 (46.4)
Remoteness		2.11 (1.02)	2.07 (1.02)	2.21 (1.01)

Note: For each variable, the first number is the average and the second one (in parentheses) is the standard deviation.
Source: CSLS.

C. Estimation Results

Table 15 summarizes the estimation results. Specifications (1) and (2) use reserve-level employment growth in the 2001-2006 period as the dependent variable, while in specifications (3) and (4) the dependent variable is reserve-level average earnings growth in the 2000-2005 period. Specifications (1) and (3) regress the dependent variable on broadband availability (BB) only, and specifications (2) and (4) regress the dependent variable on broadband availability and the controls described in Table 13. As mentioned previously, all models were estimated using OLS.

Table 15: Estimation Results

	(1) gr_emp_{01-06}	(2) gr_emp_{01-06}	(3) gr_avE_{00-05}	(4) gr_avE_{00-05}
Intercept	0.02393	-0.05517	0.12506***	0.13000***
	(0.02843)	(0.05223)	(0.02517)	0.04998
BB	0.01598	0.02058	0.04001	0.04360
	(0.03346)	(0.03189)	(0.02962)	(0.03052)
gr_PS_{01-06}		0.2195***		0.05247
		(0.03366)		(0.03221)
sh_PS_{01}		0.00074		-0.00030
		(0.00116)		(0.00111)
Remote		0.00665		-0.00395
		(0.01373)		(0.01314)
Observations	241	241	241	241
Degrees of Freedom	239	236	239	236
R-Squared	0.00	0.16	0.01	0.02

*significant at 10% ** significant at 5% *** significant at 1%

Source: CSLS.

Although the broadband dummy had the correct sign in all specifications, it was not statistically different from zero in any of them. Overall, the inclusion of controls in specifications (2) and (4) had little impact on the estimated broadband coefficients. We experimented with several other, alternative specifications, none of which yielded significant results for the broadband coefficient.[13] As the next section makes it clear, however, the above results should be interpreted with caution.

With the exception of gr_PS_{01-06} (the growth rate in the number of people with post-secondary education between 2001 and 2006), none of the control variables were statistically significant. The coefficient of gr_PS_{01-06} in specification (2) implies that an increase of one per cent in the growth rate of the number of people with post-secondary education is associated with a 0.22 percentage point increase in employment rate growth over a five-year period.

D. Data Limitations and Discussion

The estimates described in the previous subsection were calculated using the best reserve-level data available. In this case, however, the "best data available" are very different from the "ideal" data. Below, we discuss four data-related issues that may have had a negative impact in the accuracy of our estimates:

[13] Additional specifications, for which we do not report results, include: i) variations of specifications (2) and (4) with provincial/territorial dummies to control for region-specific effects; ii) variations of specifications (1) and (2) using different dependent variables (such as employment growth, unemployment growth, unemployment rate growth, employment rate in 2006, average earnings in 2006).

- The main data problem is the period mismatch between our dependent variables, which refer either to the 2000-2005 period or to the 2001-2006 period, and the broadband availability dummy, which refers to 2011. Ideally, the broadband availability data would refer to 2000 (or perhaps 2001). If this were the case, not only would the link between economic growth and broadband be made much clearer, but endogeneity bias would also be less of a problem. The reason is that broadband availability in 2000 might induce economic growth in the 2000/01-2005/06 period, but economic growth in that period cannot induce broadband availability in 2000 (since it already happened). Using broadband data from 2011, we are implicitly assuming that reserve-level broadband availability remained constant during the 2000-2011 period, which is obviously not true.

- Another factor that can affect the overall economic impact of broadband is the number of years in which broadband had been available in a particular reserve. As mentioned earlier, the literature indicates that the economic benefits of ICTs can take time to fully materialize. This can have at least two important consequences. First, reserves where broadband has just been made available will probably benefit from it only years ahead; second, in reserves where broadband has been available for a while now, it is possible that most of the economic benefits have already been accrued. If data were available, our econometric model would definitely benefit from incorporating the broadband availability period for each reserve.

- Broadband data refer to broadband availability instead of broadband penetration. Broadband penetration, measured as the number of broadband lines per 100 persons, is a better measure than broadband availability because it takes into consideration how many people are actually *using* broadband. Broadband availability, on the other hand, only tells us that at least one Internet Service Provider offers broadband services in the reserve area. High prices can severely limit broadband use, even if the service is available. In this sense, a statistically insignificant effect of broadband availability on employment or average earnings growth might just indicate a very low penetration rate.

- If data were available, additional controls could have been included. In particular, variables that reflect the overall business environment at the reserve level would have been important. Such variables include: number of business establishments, average size of business establishments, share of business establishments that use ICT more intensively, capital stock, infrastructure, etc. Lehr *et al.* (2005) and Gillett *et al.* (2006) include several such variables in their regressions. Shideler *et al.* (2007), in the absence of non-technological infrastructure data, uses number of limited-access highway miles as a proxy.

VI. Policy Background and Recommendations

This section provides an overview of broadband policies in Canada and makes some general recommendations. It is divided into three parts. The first one looks at general broadband policies in Canada. The second one focuses on broadband policies which focus on First Nations. Finally, policy recommendations are made.

A. Broadband Policy Overview

As noted in the 2006 final report of the Telecommunications Policy Review Panel (TPRP) (2006:8-3), Canada was among the first countries to recognize the potential for information and communications technologies to transform and enrich economic and social life. Since 1993, it has been government policy to increase the level of electronic connectedness of consumers and businesses to each other and to the world. Examples of programs established to attain this objective include the federal government's SchoolNet program, making Canada the first country in the world to connect all schools and libraries to the Internet, and Industry Canada's Community Access Program (CAP), which provided Internet access in a public setting to hundreds of thousands of Canadians.

In 2000, the federal government set a policy goal to ensure that broadband networks and services would be available in every Canadian community. A National Broadband Task Force was created to recommend how this goal could be met. In response to the Task Force, Industry Canada launched the Broadband for Rural and Northern Development (BRAND) pilot program in 2002 and the National Satellite Initiative in 2003.

In additional to public investments, the private sector has played a crucial role in making Canada a global leader in broadband deployment. In the 1990s, cable and telephone companies began offering high-speed access over upgraded facilities in urban centres. As noted by the Telecommunications Policy Review Panel (TPRP, 2006:8:3), by 2003 the subsequent large-scale deployment of broadband over DSL (digital subscriber line) technology propelled Canada to the second-highest level of broadband service penetration in the world.

The CRTC reported that in 2005 broadband access was available to 89 per cent of all Canadian households, broken down into 98 per cent of urban households and 69 per cent of rural households. About one half (48 per cent) of households with access to broadband subscribe to the service (TPRP, 2006:8-4). By 2009, Broadband Canada estimated that 94 per cent of Canadian households had access to a minimum of 1.5 Mbps connectivity. The remaining 6 per cent were considered unserved (no access to the Internet or dial-up service only) or underserved (broadband speeds of less than 1.5 Mbps) and lived in remote and rural regions of Canada.

The Telecommunications Policy Review Panel (TPRP, 2006:8-7) put forward three principles to guide Canada's telecommunications policy in meeting the challenge of ubiquitous broadband access:

- to rely primarily on market forces to achieve telecommunications policy objectives;
- to use well-targeted government measures in cases where the market has failed or is likely to fail; and
- to ensure that government measures are efficient and proportionate to their objectives to do so.

The key question is whether market forces alone can be relied upon to meet the objective. Opinions differ markedly on this point. The Telecommunications Policy Review Panel undertook a detailed study on this issue (TPRP, 2006:8-8). It identified areas where a viable business case might exist if least-cost technologies were used to extend broadband networks to these areas and to provide access within them. It also identified areas where some form of subsidy likely would be required to make broadband available on a basis that would be sustainable, scalable and upgradable as markets grow and technology evolves. The Panel consequently concluded that "market forces alone will not provide Canada with ubiquitous, affordable broadband access by 2010, particularly in rural and remote areas". It is likely that this conclusion from 2006 is still valid in 2012.

The federal government has indicated its commitment to closing the broadband gap in rural and remote Canada. It believes that it is a sound economic investment to provide rural households, businesses and community institutions with Internet service levels comparable to those enjoyed by many urban counterparts. Investments in broadband infrastructure not only enhance communities' competitiveness but also create higher value-added jobs and make new business models possible.

This recognition by the government of the TPRP view that market forces alone will not ensure broadband access for all Canadian households has resulted in the development of government programs to encourage the private development of rural broadband infrastructure.

In 2009, Canada's Economic Action Plan announced that $225 million would be provided for the development and implementation of a strategy to extend broadband coverage. By far the biggest component of this strategy was Broadband Canada: Connecting Rural Canadians, an initiative that targets Canadians living in unserved and underserved areas. The federal government provides up to 50 per cent of eligible project costs for Internet Service Providers that have been selected to deploy broadband infrastructure and services to unserved/underserved

areas. The other 50 percent of costs, or more, is borne by the applicants. First Nations projects are eligible for up to 100 per cent federal funding.

As of April 20, 2011, there were 86 projects, serving approximately 210,000 households, receiving funding under the Broadband Canada: Connecting Rural Canadians program, representing a federal investment of approximately $112 million.

As the previous section makes clear, the fact that this report did not find a significant impact of broadband on the economic development of First Nations reserves should not be interpreted as broadband being irrelevant to the economic development of these communities; rather, it should be seen as a first attempt at the task, limited by poor data availability. In this sense, policy recommendations should be made taking into account the entire body of evidence presented by the literature so far, which points to a significant impact of broadband on economic development.

B. First Nations Broadband Policy Overview

The Assembly of First Nations (AFN) has long recognized the importance of connectivity in general, and broadband access in particular, for the economic development and well-being of First Nations. Whiteduck (2009) provides a history of the building of the First Nations e-community. In 2006, the AFN established a series of national think tanks to continue round table discussions on connectivity issues by national Aboriginal organizations. These think tanks led First Nation service providers to support the development of a First Nations e-Community framework, a process that continues today. An AFN ICT Working Group has been established to assist in the development of this e-Community framework.

The document "Overcoming the Digital Divide: An Historical Overview of First Nations Connectivity" (AFN, 2010), produced by the AFN Chiefs Committee on Economic Development in 2010, provides an overview of the main initiatives and policies developed to bring internet connectivity to First Nations and lays out the connectivity issues facing First Nations to overcome the digital divide. In particular, it identified a number of conditions for successful ICT broadband connectivity (AFN, 2010:24), namely 1) fully engaged community members; 2) local ownership and control of the distribution system; 3) cohesive planning and consistent understanding; and 4) access to multiple sources of revenue and sustainable funding.

In 2011, the AFN released three policy papers on specific connectivity issues related to First Nations. One paper was on certain socio-economic indicators which assess the First Nations labour force and human capacity (AFN, 2011a); the second on operations, maintenance and sustainability of First Nations broadband (AFN, 2011b); and the third on the geographical and organizational challenges in meeting First Nations ICT infrastructure needs (AFN, 2011c).

The two federal government programs developed in the 1990s to foster connectivity mentioned above have been important for First Nations, the Community Access Program and the SchoolNet Program. In 1998, 107 of the 1,500 communities funded by the Community Access Program (CAP) were considered First Nations, Inuit, and Métis sites, although the importance of this program has since diminished. Under Industry Canada's SchoolNet program, between 1995 and 1998 nearly 80 per cent of First Nations were connected to the internet. In 2002, the responsibility for overseeing program delivery was assigned to Regional Management Organizations (RMOs), most of which included Tribal Councils and First Nations agencies and organizations.

C. Policy Recommendations

With 30 per cent of First Nations still without broadband access, much remains to be done to improve the situation. This section puts forward some preliminary recommendations. Given a careful review of the evidence, this report echoes the warning made by LECG (2009):

> Merely adding broadband lines in rural communities and other under-served areas may provide little economic return, or only provide economic returns with a significant lag, until and unless there is adequate attention paid to skills and also to the propensity of business, government and individuals to change their ways of working to take advantage of technology. More traditional communities may be resistant to the kind of disruptive change that broadband and ICT can create. The benefits from adopting a coordinated approach to broadband and ICT would logically seem larger than the benefits from a policy that relies upon the premise 'if you build it, they will come' (LECG, 2009:9).

For broadband to be an effective tool in promoting economic development, a mix of supply-side and demand-side policies has to be implemented jointly. Supply-side policies can improve broadband deployment and competition, thus lowering broadband price and increasing broadband adoption. However, these policies should be accompanied by demand-side policies, i.e. policies that target "the skills of consumers and the willingness of businesses to use technology in economically advantageous ways" (p. 8). This point is reinforced by LaRose *et al.* (2011), who find that broadband adoption rates increased significantly in the presence of a public campaign to educate people on the use of broadband. For the full benefits of broadband to be realized, investment in complementary factors – such as education, re-skilling of the work force, etc – is of the utmost importance. This is particularly relevant for First Nations communities, given the significant human resources challenges they face. It is recommended that the skill gaps in First Nations that impede access to broadband be identified and that policies and programs be developed and implemented to address these barriers.

It is unfortunate that First Nations organizations were not invited to provide inputs for selection criteria and procedures for the allocation of funds for the Connecting Rural Canadians program run by Broadband Canada (AFN, 2010:16). Given that members of First Nations represent a disproportionate share of Canadians who do not have broadband access, it is recommended that Broadband Canada make First Nations broadband access a priority.

There is a link between the level of funding of schools on First Nations, widely recognized an inadequate, and the availability and use of broadband. Without adequate resources First Nations schools cannot purchase the appropriate computer equipment and hire high-quality teachers to teach students the skills needed to make effective use of modern communications tools such as broadband. Given this funding gap, it is recommended that the federal government ensure the funding for First Nations schools is equivalent to their provincial counterparts.

The 2009 evaluation of the First Nations SchoolNet program stated that "funding levels to First Nations have not allowed the program to keep abreast of technological advances nor to attain its original objectives" (AFN, 2010:22). Given this funding shortfall, it is recommended that funding be returned to levels that allow the program to keep abreast of technological advances.

In contrast to the traditional "last mile" approach to connectivity where First Nations are serviced by external providers, the "first mile" approach sees First Nations communities shaping and using broadband systems to meet their unique, local requirements. While this approach should not be accepted uncritically as a policy for broadband development policy (McMahon et al., 2011:9), it has much merit. It is recommended that First Nations continue to fully engage local community members in broadband development.

The Alternative Federal Budget (AFB), released by the Canadian Centre for Policy Alternatives (CCPA, 2012) on March 15, 2012, contained a chapter on communications. The implementation of a number of the recommendations in this chapter would contribute to greater First Nations broadband access. AFB recommendations that may merit support from First Nations include:

- A ramping up to $1 billion annually over 10 years to modernize Canada's digital communications infrastructure;

- The reinvestment of the proceeds from the upcoming spectrum auction to finance the modernization of Canada's digital infrastructure;

- The immediate extension and expansion of Industry Canada's Connecting Rural Canadians program;

- The allocation of $40 million to support new and existing national public access sites in the 2012-13 budget year;

- The continuation of HRSDC support for digital literacy through its CAP-YI youth initiatives program;

- The allocation of $250,000 to fund a broad national consultation of modern communications policy in Canada.

VII. Future Research

The issues discussed in the previous section remind us why our estimation results are by no means definitive. This report represents a first attempt at econometrically estimating the contribution of broadband to economic development in First Nations reserves. As such, its estimates should be understood as initial, "rough" estimates. A pre-requisite for improved estimates is more and better data. In particular, we suggest that further econometric studies would greatly benefit from the following:

- *A dataset on how broadband availability at the reserve-level has evolved over time.* Although broadband availability is not the preferred broadband measure, it can still be informative. Reserves that have had access to broadband for longer periods of time are more likely to have a higher rate of broadband adoption and are therefore more likely to experience greater benefits from broadband than reserves where broadband access is very recent.

- *Data on broadband penetration at the reserve-level*. This data can be either a) collected through household surveys; or b) requested from Internet Service Providers who offer broadband services. Each option has its own advantages and disadvantages.

    a) Household surveys allow for more detailed data on broadband use to be collected. In particular, household surveys can ask respondents not only if they have a broadband connection, but also *how* they use this broadband connection – is it used mainly for work? Job-searches? Leisure activities? Education or health purposes? The downside is that household surveys can be expensive both to design and to conduct. There is already progress on this front. The First Nations Information Governance Centre (FNIGC), along with AANDC, will be conducting a survey on education and employment in over 200 First Nations communities. This survey will most likely include questions on broadband use.

    b) Internet Service Providers (ISPs) have detailed information on their client-base. They could potentially provide numbers on how many people have broadband connections in First Nations communities, and whether these connections are in households, businesses, or community centres. While not as costly as household surveys, access to such information will only be granted if internet service providers agree to share it, which might involve a time-consuming negotiation process and is by no means guaranteed to yield results.

- *Detailed and timely data on socio-economic variables for First Nations reserves*. In order to measure the economic impact of broadband on First Nations in Canada, we need not only broadband data, but also data on socio-economic variables. The Census' Aboriginal Communities Population Profiles is probably the most comprehensive source of data on First Nations communities. Unfortunately, it is updated only every five years. Currently, the data only goes up to 2006 (2011 data will probably be available by 2013). Alternatively, more frequently updated data sources on employment, unemployment, size of the labour force, income, and other variables must be developed so that the evolution of First Nations communities in Canada can be tracked more efficiently.

- *Data on the overall business environment in First Nations communities.* As mentioned previously, econometric studies on the effect of broadband on First nations communities would benefit immensely from data on the number of business establishments, average size of business establishments, share of business establishments that use ICT more intensively, capital stock, infrastructure, etc.

VIII. Conclusion

This report looked at the link between broadband and economic development in First Nations reserves in Canada. Although a growing literature points to an important role of broadband in promoting economic growth, our econometric analysis did not find a statistically significant impact of broadband availability on employment growth and average earnings growth in our sample of 241 First Nations reserves.

These results, however, should be interpreted with caution. Even though this report used the best data available, several data-related problems might have had a negative impact on the accuracy of our estimates. In particular: 1) there was a period mismatch between our dependent variables (from the 2001 and 2006 Censuses) and the broadband availability data (from 2011); 2) there were no reserve-level data on the year broadband became available for each reserve; and 3) reserve-level broadband data referred to availability instead of penetration, which is a better measure because it takes into account actual broadband use.

In light of these facts, we recommend that priority be given to collecting detailed reserve-level broadband data (for example, data on broadband penetration and on the year broadband became available). The accuracy of future econometric studies can only be as good as the underlying estimates allow.

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Appendix: List of Reserves – Main Sample

Obs	Province	Band	Reserve	On-Reserve Population (2006)	Aboriginal Identity Population (2006)	Broadband (2011)
1	NL	Miawpukek	Samiajij Miawpukek	867	775	Yes
2	NS	Chapel Island First Nation	Chapel Island 5	444	430	Yes
3	NS	Eskasoni	Eskasoni 3	2,952	2,930	Yes
4	NS	Membertou	Membertou 28B	726	685	Yes
5	NS	Millbrook	Millbrook 27	703	640	Yes
6	NS	Paq'tnkek First Nation	Pomquet And Afton 23	361	340	Yes
7	NS	Pictou Landing	Fisher's Grant 24	429	400	Yes
8	NS	Shubenacadie	Indian Brook 14	1,014	975	Yes
9	NS	Wagmatcook	Wagmatcook 1	408	400	Yes
10	NS	Waycobah First Nation (Whycocomagh)	Whycocomagh 2	623	615	Yes
11	NB	Burnt Church	Burnt Church 14	1,120	1,065	Yes
12	NB	Eel Ground	Eel Ground 2	503	450	Yes
13	NB	Eel River Bar First Nation	Eel River 3	312	285	Yes
14	NB	Elsipogtog First Nation (Big Cove)	Richibucto 15	1,897	1,860	Yes
15	NB	Metepenagiag Mi'kmaq Nation	Red Bank 4	383	360	Yes
16	NB	Saint Mary's	Devon 30	767	670	Yes
17	NB	Tobique	Tobique 20	878	825	Yes
18	QC	Atikamekw d'Opitciwan	Obedjiwan	1,782	1,770	No
19	QC	Bande des Innus de Pessamit	Betsiamites	2,357	2,335	Yes
20	QC	Conseil de la Première Nation Abitibiwinni	Pikogan	487	475	Yes
21	QC	Conseil des Atikamekw de Wemotaci	Wemotaci	1,073	1,030	No
22	QC	Cree Nation of Chisasibi	Chisasibi	3,972	3,780	No
23	QC	Cree Nation of Mistissini	Mistissini	2,897	2,810	Yes
24	QC	Cree Nation of Nemaska	Nemiscau	642	615	Yes
25	QC	Cree Nation of Wemindji	Wemindji	1,215	1,185	Yes
26	QC	Eastmain	Eastmain	650	635	No
27	QC	Innu Takuaikan Uashat Mak Mani-Utenam	Maliotenam	1,123	1,095	Yes
28	QC	Innu Takuaikan Uashat Mak Mani-Utenam	Uashat	1,190	1,155	Yes
29	QC	Kitigan Zibi Anishinabeg	Kitigan Zibi	1,165	1,115	No
30	QC	La Nation Innu Matimekush-Lac John	Matimekosh	528	495	No
31	QC	Les Atikamekw de Manawan	Manawan	1,843	1,825	No
32	QC	Les Innus de Ekuanitshit	Mingan	407	405	Yes
33	QC	Listuguj Mi'gmaq Government	Listuguj	1,475	1,405	Yes
34	QC	Montagnais de Natashquan	Natashquan	810	800	Yes
35	QC	Montagnais de Unamen Shipu	La Romaine	926	915	Yes
36	QC	Montagnais du Lac St.-Jean	Mashteuiatsh	1,749	1,550	Yes
37	QC	Naskapi Nation of Kawawachikamach	Kawawachikamach	569	565	No
38	QC	Nation Anishnabe du Lac Simon	Lac-Simon	1,165	1,165	Yes
39	QC	Odanak	Odanak	469	285	Yes
40	QC	Première nation de Whapmagoostui	Whapmagoostui	812	775	No
41	QC	The Crees of the Waskaganish First Nation	Waskaganish	1,864	1,810	Yes
42	QC	Timiskaming First Nation	Timiskaming	505	455	No
43	QC	Waswanipi	Waswanipi	1,473	1,445	Yes
44	ON	Alderville First Nation	Alderville First Nation	506	370	Yes
45	ON	Algonquins of Pikwakanagan	Pikwakanagan (Golden Lake 39)	406	365	Yes
46	ON	Aroland	Aroland 83	325	325	Yes
47	ON	Aundeck-Omni-Kaning	Sucker Creek 23	346	325	No

Obs	Province	Band	Reserve	On-Reserve Population (2006)	Aboriginal Identity Population (2006)	Broadband (2011)
48	ON	Beausoleil	Christian Island 30	584	570	No
49	ON	Chippewas of Mnjikaning First Nation	Mnjikaning First Nation 32 (Rama First Nation 32)	846	750	Yes
50	ON	Curve Lake	Curve Lake First Nation 35	1,060	775	Yes
51	ON	Deer Lake	Deer Lake	681	680	Yes
52	ON	Eabametoong First Nation	Fort Hope 64	1,144	1,145	No
53	ON	Garden River First Nation	Garden River 14	985	930	Yes
54	ON	Grassy Narrows First Nation	English River 21	633	625	No
55	ON	Iskatewizaagegan #39 Independent First Nation	Shoal Lake (Part) 39A	346	345	Yes
56	ON	Kee-Way-Win	Kee-Way-Win	318	315	No
57	ON	Lac Seul	Lac Seul 28	821	820	No
58	ON	M'Chigeeng First Nation	M'Chigeeng 22 (West Bay 22)	766	725	Yes
59	ON	Mishkeegogamang	Osnaburgh 63B	347	345	No
60	ON	Mississauga	Mississagi River 8	414	380	Yes
61	ON	Moravian of the Thames	Moravian 47	412	395	Yes
62	ON	Nipissing First Nation	Nipissing 10	1,413	905	Yes
63	ON	Poplar Hill	Poplar Hill	457	445	Yes
64	ON	Sagamok Anishnawbek	Sagamok	884	875	No
65	ON	Sandy Lake	Sandy Lake 88	1,843	1,830	No
66	ON	Saugeen	Saugeen 29	758	715	Yes
67	ON	Serpent River	Serpent River 7	340	320	Yes
68	ON	Wapekeka	Wapekeka 2	350	345	No
69	ON	Wasauksing First Nation	Parry Island First Nation	350	325	Yes
70	ON	Webequie	Webequie	614	615	No
71	ON	Whitefish Lake	Whitefish Lake 6	349	330	Yes
72	ON	Whitefish River	Whitefish River (Part) 4	379	350	No
73	MN	Barren Lands	Brochet 197	306	305	Yes
74	MN	Berens River	Berens River 13	739	775	Yes
75	MN	Birdtail Sioux	Birdtail Creek 57	345	340	Yes
76	MN	Bloodvein	Bloodvein 12	576	550	No
77	MN	Brokenhead Ojibway Nation	Brokenhead 4	467	450	Yes
78	MN	Bunibonibee Cree Nation	Oxford House 24	1,947	1,925	Yes
79	MN	Canupawakpa Dakota First Nation	Canupawakpa Dakota First Nation (Oak Lake 59)	295	290	Yes
80	MN	Chemawawin Cree Nation	Chemawawin 2	983	970	Yes
81	MN	Ebb and Flow	Ebb and Flow 52	1,189	1,185	Yes
82	MN	Fisher River	Fisher River 44	1,129	1,120	No
83	MN	Fort Alexander	Fort Alexander 3	2,121	2,110	Yes
84	MN	Garden Hill First Nations	Garden Hill First Nation	1,898	1,895	No
85	MN	God's Lake First Nation	God's Lake 23	1,105	1,095	No
86	MN	Grand Rapids First Nation	Grand Rapids 33	651	650	Yes
87	MN	Hollow Water	Hole or Hollow Water 10	619	610	Yes
88	MN	Lake Manitoba	Dog Creek 46	617	610	No
89	MN	Lake St. Martin	The Narrows 49	505	505	No
90	MN	Little Black River	Black River 9	460	460	No
91	MN	Little Grand Rapids	Little Grand Rapids 14	796	760	Yes
92	MN	Long Plain	Long Plain (Part) 6	752	745	Yes
93	MN	Manto Sipi Cree Nation	God's River 86A	556	545	No
94	MN	Mathias Colomb	Pukatawagan 198	1,478	1,440	No
95	MN	Mosakahiken Cree Nation	Moose Lake 31A	698	695	Yes
96	MN	Nisichawayasihk Cree Nation	Nelson House 170	2,096	2,055	Yes
97	MN	Northlands	Lac Brochet 197A	604	590	No
98	MN	Norway House Cree Nation	Norway House 17	4,071	4,015	No
99	MN	O-Chi-Chak-Ko-Sipi First Nation	Crane River 51	432	415	Yes

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100	MN	Opaskwayak Cree Nation	Opaskwayak Cree Nation 21E	2,187	2,135	Yes
101	MN	O-Pipon-Na-Piwin Cree Nation	South Indian Lake	857	845	Yes
102	MN	Pauingassi First Nation	Pauingassi First Nation	352	340	No
103	MN	Peguis	Peguis 1B	2,513	2,485	Yes
104	MN	Pine Creek	Pine Creek 66A	614	610	Yes
105	MN	Poplar River First Nation	Poplar River 16	643	630	No
106	MN	Rolling River	Rolling River 67	336	335	Yes
107	MN	Roseau River Anishinabe First Nation Government	Roseau River 2	568	565	Yes
108	MN	Sandy Bay	Sandy Bay 5	2,518	2,510	Yes
109	MN	Sapotaweyak Cree Nation	Shoal River Indian Reserve 65A	603	595	No
110	MN	Sayisi Dene First Nation	Churchill 1	330	325	No
111	MN	Shamattawa First Nation	Shamattawa 1	920	915	Yes
112	MN	Sioux Valley Dakota Nation	Sioux Valley Dakota Nation (Sioux Valley 58)	1,079	1,070	Yes
113	MN	Skownan First Nation	Waterhen 45	389	390	Yes
114	MN	St. Theresa Point	St. Theresa Point	2,632	2,630	No
115	MN	Tootinaowaziibeeng Treaty Reserve	Valley River 63A	427	420	Yes
116	MN	Wasagamack First Nation	Wasagamack	1,160	1,150	No
117	MN	Waywayseecappo First Nation Treaty Four - 1874	Waywayseecappo First Nation	1,127	1,115	Yes
118	MN	York Factory First Nation	York Landing	416	415	Yes
119	SK	Ahtahkakoop	Ahtahkakoop 104	1,101	1,095	Yes
120	SK	Beardy's and Okemasis	Beardy's 97 and Okemasis 96	1,161	1,160	Yes
121	SK	Big River	Big River 118	1,437	1,430	Yes
122	SK	Birch Narrows First Nation	Turnor Lake 193B	413	395	Yes
123	SK	Black Lake	Chicken 224	1,109	1,090	Yes
124	SK	Buffalo River Dene Nation	Buffalo River Dene Nation 193 (Peter Pond Lake 193)	741	735	No
125	SK	Canoe Lake Cree First	Canoe Lake 165	822	810	Yes
126	SK	Carry The Kettle	Assiniboine 76	671	665	Yes
127	SK	Cote First Nation 366	Cote 64	607	605	Yes
128	SK	English River First Nation	Wapachewunak 192D	526	520	Yes
129	SK	Fishing Lake First Nation	Fishing Lake 89	381	375	Yes
130	SK	Flying Dust First Nation	Flying Dust First Nation 105 (Meadow Lake 105)	619	610	Yes
131	SK	Fond du Lac	Fond du Lac 227	801	775	Yes
132	SK	Gordon	Gordon 86	866	860	Yes
133	SK	Hatchet Lake	Lac La Hache 220	953	935	No
134	SK	Island Lake First Nation	Ministikwan 161	533	530	Yes
135	SK	James Smith	James Smith 100	708	710	Yes
136	SK	Kahkewistahaw	Kahkewistahaw 72	506	500	Yes
137	SK	Kawacatoose	Poorman 88	688	685	Yes
138	SK	Keeseekoose	Keeseekoose 66	500	495	No
139	SK	Kinistin Saulteaux Nation	Kinistin 91	271	270	Yes
140	SK	Lac La Ronge	Grandmother's Bay 219	320	320	Yes
141	SK	Lac La Ronge	Kitsakie 156B	671	665	Yes
142	SK	Lac La Ronge	Morin Lake 217	406	405	No
143	SK	Lac La Ronge	Stanley 157	1,467	1,455	Yes
144	SK	Lac La Ronge	Sucker River 156C (Nemebien River 156C)	290	285	Yes
145	SK	Little Pine	Little Pine 116	577	570	Yes
146	SK	Makwa Sahgaiehcan First Nation	Makwa Lake 129B	800	795	No
147	SK	Mistawasis	Mistawasis 103	968	965	Yes
148	SK	Montreal Lake	Montreal Lake 106	880	875	No
149	SK	Montreal Lake	Montreal Lake 106B	345	345	No

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150	SK	Moosomin	Moosomin 112B	465	460	Yes
151	SK	Mosquito, Grizzly Bear's Head, Lean Man Fst.Natns.	Mosquito 109	393	390	Yes
152	SK	Muskeg Lake	Muskeg Lake Cree Nation 102	293	290	Yes
153	SK	Muskoday First Nation	Muskoday First Nation	553	540	Yes
154	SK	Muskowekwan	Muskowekwan 85	488	485	Yes
155	SK	Ochapowace	Ochapowace 71	448	440	Yes
156	SK	One Arrow	One Arrow 95	365	365	Yes
157	SK	Onion Lake	Makaoo (Part) 120	390	390	Yes
158	SK	Onion Lake	Seekaskootch 119	1,752	1,735	Yes
159	SK	Pasqua First Nation #79	Pasqua 79	472	460	Yes
160	SK	Pelican Lake	Chitek Lake 191	818	805	Yes
161	SK	Peter Ballantyne Cree Nation	Kimosom Pwatinahk 203	821	805	Yes
162	SK	Peter Ballantyne Cree Nation	Pelican Narrows 184B	1,342	1,335	No
163	SK	Peter Ballantyne Cree Nation	Southend 200	910	890	Yes
164	SK	Piapot	Piapot 75	448	445	Yes
165	SK	Poundmaker	Poundmaker 114	489	490	Yes
166	SK	Red Earth	Carrot River 29A	590	590	Yes
167	SK	Red Pheasant	Red Pheasant 108	656	645	No
168	SK	Saulteaux	Saulteaux 159	432	430	Yes
169	SK	Shoal Lake of the Cree Nation	Shoal Lake 28A	545	540	Yes
170	SK	Standing Buffalo	Standing Buffalo 78	446	445	Yes
171	SK	Sturgeon Lake First Nation	Sturgeon Lake 101	1,116	1,110	No
172	SK	Sweetgrass	Sweet Grass 113	483	485	Yes
173	SK	Thunderchild First Nation	Thunderchild First Nation 115B	819	810	Yes
174	SK	Wahpeton Dakota Nation	Wahpaton 94A	281	280	Yes
175	SK	Waterhen Lake	Waterhen 130	727	715	Yes
176	SK	White Bear	White Bear 70	796	720	Yes
177	SK	Witchekan Lake	Witchekan Lake 117	338	335	Yes
178	SK	Yellow Quill	Yellowquill 90	420	415	Yes
179	AB	Alexander	Alexander 134	962	925	Yes
180	AB	Alexis Nakota Sioux Nation	Alexis 133	734	725	Yes
181	AB	Bearspaw, Chiniki, Stoney, Wesley	Eden Valley 216	370	370	Yes
182	AB	Beaver Lake Cree Nation	Beaver Lake 131	379	375	Yes
183	AB	Bigstone Cree Nation	Wabasca 166A	648	625	No
184	AB	Bigstone Cree Nation	Wabasca 166D	863	860	No
185	AB	Blood	Blood 148	4,177	4,175	Yes
186	AB	Cold Lake First Nations	Cold Lake 149	438	435	Yes
187	AB	Dene Tha'	Bushe River 207	400	390	No
188	AB	Dene Tha'	Hay Lake 209	951	925	No
189	AB	Dene Tha'	Upper Hay River 212	289	285	No
190	AB	Driftpile First Nation	Drift Pile River 150	720	700	Yes
191	AB	Ermineskin Tribe, Louis Bull, Montana	Pigeon Lake 138A	353	355	Yes
192	AB	Fort McKay First Nation	Fort Mackay	521	500	Yes
193	AB	Frog Lake	Puskiakiwenin 122	411	410	Yes
194	AB	Frog Lake	Unipouheos 121	749	740	Yes
195	AB	Horse Lake First Nation	Horse Lakes 152B	335	335	Yes
196	AB	Little Red River Cree Nation	Fox Lake 162	1,753	1,715	No
197	AB	Louis Bull	Louis Bull 138B	1,180	1,175	Yes
198	AB	Montana	Montana 139	635	635	Yes
199	AB	O'Chiese	O'Chiese 203	450	440	No
200	AB	Paul	Wabamun 133A	1,088	1,080	Yes
201	AB	Saddle Lake	White fish Lake 128	1,237	1,220	Yes

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202	AB	Samson	Samson 137	3,295	3,265	Yes
203	AB	Siksika Nation	Siksika 146	2,767	2,730	No
204	AB	Stoney	Stoney 142, 143, 144	2,529	2,520	Yes
205	AB	Sturgeon Lake Cree Nation	Sturgeon Lake 154	1,051	1,045	Yes
206	AB	Sucker Creek	Sucker Creek 150A	594	575	No
207	AB	Sunchild First Nation	Sunchild 202	482	475	No
208	AB	Swan River First Nation	Swan River 150E	305	290	No
209	AB	Whitefish Lake	Utikoomak Lake 155	786	760	No
210	AB	Woodland Cree First Nation	Woodland Cree 226	439	420	No
211	BC	Chehalis	Chehalis 5	560	545	Yes
212	BC	Chemainus First Nation	Chemainus 13	684	660	Yes
213	BC	Coldwater	Coldwater 1	254	250	No
214	BC	Cowichan	Cowichan 1	1,768	1,750	Yes
215	BC	Esketemc	Alkali Lake 1	363	365	No
216	BC	Gitanmaax	Gitanmaax 1	723	710	Yes
217	BC	Gitanyow	Gitanyow 1	387	380	Yes
218	BC	Gitsegukla	Gitsegukla 1	721	585	Yes
219	BC	Gitwangak	Gitwangak 1	465	455	Yes
220	BC	Gitxaala Nation	Dolphin Island 1	417	410	No
221	BC	Gwa'Sala-Nakwaxda'xw	Tsulquate 4	432	425	Yes
222	BC	Heiltsuk	Bella Bella 1	1,066	1,015	Yes
223	BC	Iskut	Iskut 6	335	325	Yes
224	BC	Kamloops	Kamloops 1	1,786	795	Yes
225	BC	Kispiox	Kispiox 1	617	600	Yes
226	BC	Kitasoo	Kitasoo 1	282	275	Yes
227	BC	Kwakiutl	Kippase 2	271	250	Yes
228	BC	Lake Babine Nation	Woyenne 27	614	605	Yes
229	BC	Lower Nicola	Nicola Mameet 1	483	430	Yes
230	BC	Musqueam	Musqueam 2	1,371	605	Yes
231	BC	Nak'azdli	Nak'azdli (Necoslie 1)	495	495	Yes
232	BC	Osoyoos	Osoyoos 1	599	345	No
233	BC	Saik'uz First Nation	Stony Creek 1	384	375	Yes
234	BC	Seabird Island	Seabird Island	548	510	Yes
235	BC	Skidegate	Skidegate 1	781	710	Yes
236	BC	Squamish	Capilano 5	2,492	850	Yes
237	BC	Tl'etinqox-t'in Government Office	Anahim's Flat 1	526	520	Yes
238	BC	Tsawout First Nation	East Saanich 2	1,637	585	Yes
239	NWT	Deninu K'ue First Nation	Fort Resolution	525	495	No
240	NWT	Fort Good Hope	Fort Good Hope	484	450	Yes
241	NWT	K'atlodeeche First Nation	Hay River Dene 1	309	300	Yes