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THE ECONOMICS OF TELECOMMUNICATIONS IN CANADA: A BACKGROUNDER

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SUMMARY

The telecom sector in Canada attracts no small amount of attention from policy-makers, most of it focusing on the prices and services paid by households and revolving around the question of whether telecom firms are taking advantage of consumers.

Overlooked amid these policy debates is how vital the telecom sector has become in the digital era to the health of all Canadian businesses. For example, it typically is among the top three or four sectors in terms of annual capital investment. Further, it annually generates over \$50 billion in gross revenue, with a bit over half coming from sales to household consumers and just under half contributed by sales to the business sector. Telecom, like electricity, has become a crucial pipeline that powers virtually every business in the country, with all critical sectors either buying significant telecom services or benefiting from them indirectly. This is a reality that policy-makers may not yet have grasped. Given telecom's importance, that could have troubling knock-on effects across the economy.

When it comes to the very things that policy-makers do seem more likely to show interest in, namely the prices, service and value that telecom companies provide to Canadian households, there in fact seems far less cause for concern. Consumers continue to find significant value in the internet and mobile services they are buying and are increasingly choosing higher quality services that involve higher costs and prices.

While the Big Three telecom firms are regularly scrutinized by regulators for evidence of exercise of market power, data suggest that the three firms' abilities to earn profits over the last decade has not, in fact, changed markedly, despite the explosion in internet, satellite and mobile-data users.

All of this is occurring as the sector in Canada faces significant regulatory challenges along with those associated with serving large geographic areas with relatively low population densities. Other challenges include increasing costs (for example, salaries in the telecom sector have been growing at rates above the national average), along with the large capital requirements associated with high replacement rates that accompany a rapid rate of innovation necessary to remain competitive. It is interesting that the telecom sector is responsible for over five per cent of all industry capital expenditures in Canada. In summary, the services that the telecom sector provides are not only important for Canadian households, but are also critical for every other Canadian industry. One often overlooked fact is that virtually every other Canadian sector employs a significant value of telecom products as an input, thus making telecom a critical keystone of the Canadian economy.

1 INTRODUCTION

Since 2007 the telecommunications sector (telecom) in Canada has seen a dramatic shift towards the increased use of data-enabled mobile devices and a continuing rollout of fixed broadband services. Expenditure on telecom services in Canada exceeds \$50 billion annually and the underlying value to consumers is significantly higher than that.¹ The sector directly contributes more than \$30 billion to GDP annually and is responsible for a significant portion of all capital expenditures in Canada. Out of the more than 200 separate sectors identified in the available data, the total value of private investment in the telecom sector ranks behind only oil and gas extraction, electrical power generation, transmission and distribution, and mining and quarrying.²

This is consistent with the common recognition of telecommunications as a general purpose technology, defined as any technology that is: i) pervasive, with a demonstrated ability for its use to spread to most sectors; ii) continually improving and hence contributing to lower overall costs to its users; and iii) innovation spawning (Bresnahan and Trajtenberg, 1995; Jovanovic and Rousseau, 2005).

This paper examines the role of the telecommunications sector in Canada's economy with respect to capital expenditure, the provision of intermediate inputs to other sectors, and the provision of final consumer goods and linkages to other sectors. For this purpose we present an overview of the direct economic impact within a national economic accounting perspective associated with activity of the Canadian telecom sector. We use an income and expenditure analysis of the telecommunications sector to examine its direct economic impact and its position within the Canadian economic value chain (section 2). We also examine trends in investment and service provision (section 3).

Our focus here is on the directly measurable economic linkages between telecom and other sectors and consumers. We do not assess the overall economy-wide total factor productivity implications of investment in telecom. While these are likely very significant given its aforementioned role as a general purpose technology, such an investigation would require the use of empirical modelling (either econometric analysis or a calibrated general equilibrium approach) beyond the scope of this study.

In general the value created by telecom services includes both a systems component and a network component. The systems component arises because the telecom sector provides services that are only of value within a larger system, which includes content and the hardware and software embodied in the devices used to access telecom services. Telecom networks, including fixed and mobile telecom, create value only "when they are used in conjunction with broad and capable devices to deliver useful applications and content" (FCC, 2010).

The network component arises because telecom networks (either wired or wireless) connect two or more distinct types of customers (firms or households as end-service users, application developers, handset manufacturers, network operators, advertisers, etc.) giving rise to the creation of network effects. Network effects are indirect benefits that accrue to existing network participants from the addition of new network participants. Generally, the more participants using any specific online platform (social media, app-store developers/customers, telephony) the higher the value to any single participant (Garcia-Swartz and Garcia-Vicente, 2015).

Adding to the complexity of the telecom sector is the recent rapid development of mobile telecom

¹ Value in excess of expenditure recognizes the presence of consumer surplus for household consumers. This is discussed in more detail in section 2.1.

² Based on three-digit NAICS code sector definitions See: CANSIM Table 029-0046 "Capital and Repair Expenditures, Non-Residential Tangible Assets, by North American Industry Classification System (NAICS)." Also see Figure 9.

services outside of traditional telephony. Over the last decade the ownership and use of data-enabled mobile devices (smartphones and tablets) connected to mobile telecom (i.e., cellphone data) networks have grown rapidly. This growth has, by extension, been accompanied by the emergence of new software app development (Bresnahan et al., 2014a) and a convergence across different technologies to network connectivity based on the uniform internet protocol and associated internet connectivity.

This is a market that could not exist without the expansion of telecom service provision.³ While the increased use of smart wireless devices is a particularly visible manifestation of this trend, fixed telecom services (i.e., broadband) have also witnessed significant growth. Cloud storage and the perceived shift from traditional media consumption (broadcast and cable TV services) to online content (streaming services such as Netflix and CraveTV) are indicative of the same trend.

This does create a challenge in defining the scope of this analysis since, as indicated, telecom forms one component of a larger economic system (with associated network effects). To ensure appropriate scoping we base our examination on survey data and have adopted the North American Industry Classification System (NAICS) and the North American Product Classification System (NAPCS) definitions of the telecom sector and its associated products. NAICS and NAPCS assign specific codes to industries and products (respectively) in order to organize and aggregate economic and financial data for specific industries and products.

The telecom sector is defined by the NAICS under Code 517 “Telecommunications”. From the formal definition: “This subsector comprises establishments primarily engaged in providing telecommunications and/or video entertainment services over their own networks, or over networks operated by others ...” (Statistics Canada, 2012a). Our focus on this sector definition is not trivial, since it clearly distinguishes telecom from related but distinct industries such as digital content creation and retail (i.e., the production and retail of digital entertainment media such as streaming services like Netflix and Hulu).

This distinction is further enforced by the NAPCS definition of the products produced by the telecom sector. Under the NAPCS, telecom is deemed to produce products in four separate reporting categories. These are defined by Statistics Canada (2012b) as:

- Code 72311 – Fixed telecommunications services (except internet access).
- Code 72312 – Fixed internet access services
- Code 72321 – Mobile telecommunications services (including mobile internet/data services)
- Code 731 – Cable, satellite and other program distribution services

Notice that the product code descriptions all reference network-based information exchange services. Even under the final entry (Cable, satellite and other program distribution services) it is indicated that the product definition includes only the distribution services, and not the production of content itself.⁴

³ Expansion of the app market has also occurred “because platform providers Apple and Google have lowered the costs of development and distribution of mobile applications” (Bresnahan et al., 2014b). However, the provision of network access was a necessary condition for the development of the app market, while the reduction in development costs facilitated by Apple and Google was not.

⁴ As a concrete example, in producing a program like *Game of Thrones*, the production company (HBO) is a content creator (which would be classified under NAPCS code 72121 – Movie, television program and video production, post-production and editing services) and not a telecommunications service provider. Similarly, companies providing smartphone apps and web content like Uber, Facebook or Twitter are not included in the measures of telecommunications activity.

2 AN ECONOMIC MAPPING OF THE TELECOM SECTOR IN CANADA

From an economic perspective, the position of the telecom industry in the Canadian economy can be described in terms of its position in the value chain. Downstream linkages effectively represent revenues generated by the sector while upstream linkages represent expenditures (including payments to capital and labour) of the sector. The key economic linkages in any economic value chain on the downstream are the industry's final outputs (the value of products to end consumers' households) and intermediate outputs (purchased by other businesses). Upstream linkages are grouped as intermediate inputs (inputs purchased by the sector representing upstream production that is motivated by production in telecom) and value added (income generated from the use of primary factors of production: labour, capital and resources).⁵

As with other sectors in the economy, the downstream linkages or outputs of the telecom sector support both final use (by households) and facilitating production and promoting efficiencies in other industries. This latter role is accomplished through the provision of intermediate use inputs; that is, services produced by the telecom sector and purchased by firms in other sectors. This distinction between intermediate and final usage is important in understanding the industry's role and we discuss the valuations of these contributions in more detail in section 2.1 below.

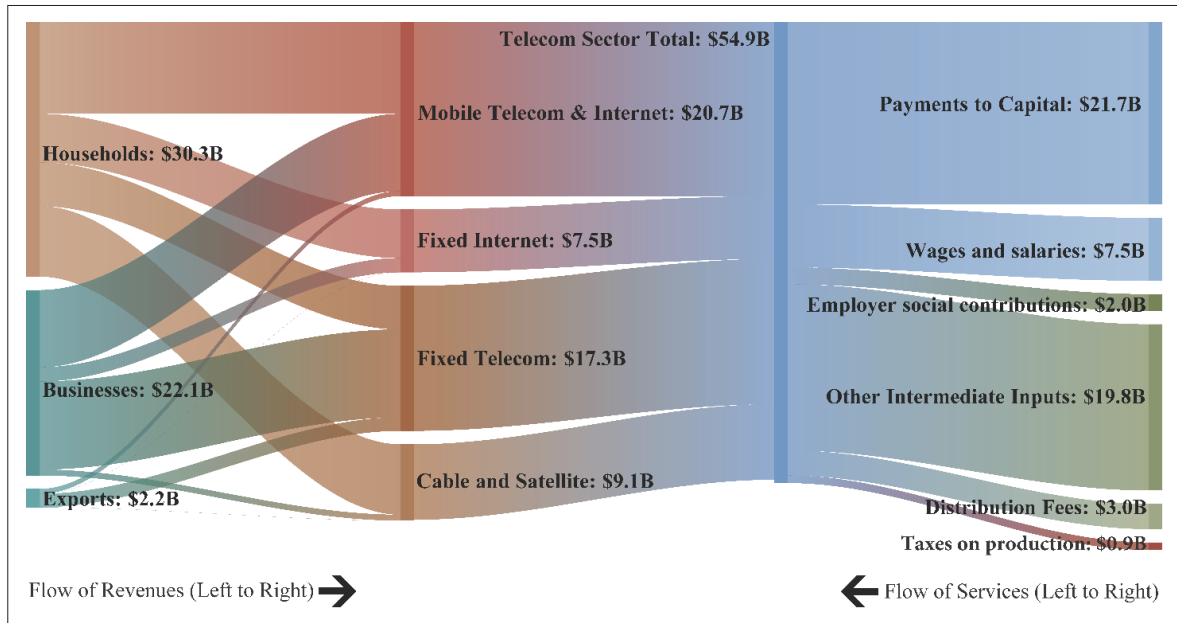
Similarly, the upstream linkages or inputs use labour and capital, which together form the value-added inputs along with other intermediate inputs. As with the downstream linkages we will also discuss the magnitude and composition of these upstream linkages below (in section 2.2).

Figure 1 is a Sankey diagram of the financial flows through the telecom sector in Canada in 2013.⁶ The figure should be interpreted as a flow of revenue (left to right) and a corresponding flow of services (right to left) under the fundamental relationship that consumers (on the left) are exchanging money for goods and services which are provided by suppliers (on the right). In this representation the telecom sector acts as both a consumer (of upstream and value-added inputs) and as a supplier of the four indicated products (which match the NAPCS product codes outlined in the introduction) that are sold to households and to businesses in other industries.

⁵ The term "value added" is often applied inappropriately in economic policy debates. In the present context, we employ a technical definition of value added as: The total income accruing to the direct use of capital and labour as employed by the industry and the associated tax revenue. For a more comprehensive discussion of the term "value added", see Tombe (2015).

⁶ More recent data are not yet available in a useful form. Aside from persistent trends observed in pre-2013 data (and discussed in more detail in sections 2.1 and 2.2) the data used to construct Figure 1 are generally representative of the relative magnitudes of indicated value chain flows.

FIGURE 1 THE CANADIAN TELECOM SECTOR VALUE CHAIN (2013)



Data Source: Statistics Canada 2013 “Supply and Use Tables, 2013.”

* Within column totals may not sum to the same aggregate value (54.9) due to rounding of figures in less aggregated depictions.

Figure 1 illustrates that in 2013 the telecom industry produced \$54.9 billion in gross output. On the inputs side, intermediate inputs accounted for \$22.8 billion of the gross value of telecom output (this is the aggregation of distribution fees and other intermediate inputs sourced from more than 200 other Canadian industries). The industry faced approximately \$0.9 billion in direct taxes on production.⁷

At \$31.2 billion, the value-added inputs (payments to capital, wages and salaries and employer social contributions) constituted the bulk (56.8 per cent) of gross value produced by the telecom industry. At a fundamental level, the value-added measure represents the direct contribution made by the telecom sector to overall Canadian GDP.⁸

2.1 Value Chain Outputs

From Figure 1, household expenditure on telecom products was \$30.3 billion in 2013. This can be broken down as \$5.2 billion on “Fixed Telecommunications Services”, \$5.8 billion on “Fixed Internet Access”, \$10.9 billion on “Mobile Telecom and Internet” and \$8.4 billion on “Cable and Satellite”.

Industrial expenditure (purchases of telecom sector outputs by firms in other sectors) was \$22.1 billion in 2013. This expenditure can be broken down as \$10.5 billion on “Fixed Telecommunications Services”, \$1.7 billion on “Fixed Internet Access”, \$9.2 billion on “Mobile Telecom and Internet” and \$0.7 billion on “Cable and Satellite”. The telecom industry also sold \$2.2 billion worth of products to consumers outside of Canada.

⁷ It should be noted that this number does not include the consumption taxes paid by consumers of telecom industry products since these taxes do not flow through the telecommunications sector, and are instead paid directly by consumers (on the left side of the figure) to the federal and provincial governments (where appropriate).

⁸ This valuation is based on an income approach to calculating GDP. While it is less conventional to break down GDP contributions under an expenditure approach, a rough measure here would be the aggregation of household consumption (\$30.3 billion) and exports (\$2.2 billion) of telecommunications services, a total direct contribution of \$32.5 billion.

It is worth noting that businesses represent a much higher proportion of total expenditure on fixed telecom services than households, while households represent a much higher proportion of expenditure on fixed internet services. Households also represent all but a very small proportion of expenditure on cable and satellite.⁹

FIGURE 2 HOUSEHOLD CONSUMPTION EXPENDITURE ON TELECOM SERVICES (NOMINAL DOLLARS)



Data Source: Statistics Canada 2013 "Supply and Use Tables, 2013."

Figure 2 presents the trends in nominal household expenditure on the four telecom product categories (as well as the associated tax revenue, accruing directly to federal and provincial governments) from 2010 to 2013.¹⁰ Aside from fixed telecom services, household expenditures on telecom products have persistently increased for all years indicated. Not surprisingly, growth in expenditure on mobile telecom services has shown the largest increase (both in levels and proportionally) while fixed internet access is the second fastest growing category of household telecom product expenditure. Taken together this may suggest that, while consumers are substituting from fixed telecom to mobile telecom the same is not true for internet services. In particular, it appears that expenditure on fixed internet access is stable and growing despite the rise of mobile internet.

⁹ The bulk of business expenditure on Cable and Satellite is attributed to "Food services and drinking places" at 18 per cent (\$119 million/\$660 million), "Lessors of real estate" (acting as purchasing agents for these services on behalf of tenants) at seven per cent (\$48 million/\$660 million) and "Traveller accommodation" at seven per cent (\$47 million/\$660 million). The remaining 68 per cent of this expenditure is split over 215 other industries with expenditures from most of these less than \$1 million in 2013.

¹⁰ This level of detailed data is currently only available for 2010 to 2013.

Somewhat surprisingly, given the attention paid to the “cutting the cord” rhetoric surrounding Canadian cable TV services from the media and from retailers,¹¹ household expenditure on cable and satellite services persistently increased between 2010 and 2013. While detailed expenditure data (as used in Figure 1 and Figure 2) are not yet available post-2013, other sources estimate that there has been a persistent trend in annual reductions in subscriptions from 2012 to 2017.¹² Despite this, from a value-creation perspective, it is important to distinguish expenditure from subscription numbers, and the indicated trend, pre-2013, is towards growing expenditure on cable and satellite services. This could either indicate a change in expenditure trend post-2013 (which is not yet observable due to the lag in expenditure data) or that the composition of remaining subscriptions has shifted to higher value and higher priced subscription packages. It is evident that this deserves more attention once data become available to support future research.

Figure 3 presents the trends in nominal business expenditure on the four telecom product categories from 2010 to 2013.¹³ Business expenditure exhibits some of the same characteristics as household expenditure for these four telecom categories; however, businesses’ total expenditure on each of the four telecom products categories has remained far more stable compared to households.

As in the household case, Figure 3 indicates persistent increases in business expenditure on cable and satellite as well as fixed internet.¹⁴ Business expenditure on fixed telecom increased from 2010 to 2011, before falling from 2011 to 2012 (yet remaining above its 2010 level) and falling again from 2012 to 2013 (eventually to a level below that in 2010).

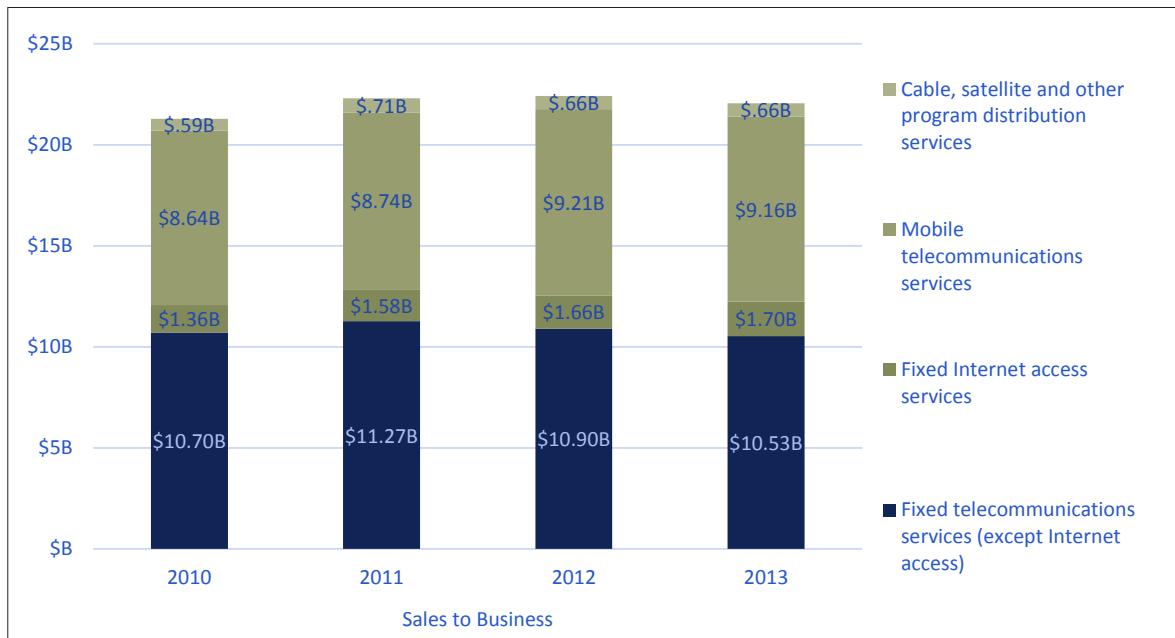
¹¹ See for example:
CBC News, “Cable TV Cord-Cutting in Canada Expected to Accelerate,” April 2017. <http://www.cbc.ca/news/business/cord-cutting-convergence-group-1.4075486>
Financial Post, “Cord Cutting Escalates for Canada TV Subscribers in First Three Quarters of 2016,” December 2016. <http://business.financialpost.com/technology/cord-cutting-escalates-for-canada-tv-subscribers-in-first-three-quarters-of-2016/>
Toronto Sun, “Cutting the Cord,” April 2017. <http://www.torontosun.com/2017/04/28/cutting-the-cord-five-things-to-consider-before-ditching-traditional-tv>
Best Buy Canada, “Tips for Cutting the Cord and Getting Great TV in 2017.” <http://blog.bestbuy.ca/tv-audio/tips-cutting-cord-getting-great-tv> Accessed July 2017.

¹² Convergence Research Group Ltd. (2017).

¹³ This level of detailed data is currently only available for 2010 to 2013.

¹⁴ While not clearly indicated in Figure 3, there is nevertheless a small increase in business expenditure on cable and satellite between 2012 and 2013.

FIGURE 3 BUSINESS EXPENDITURE ON TELECOM SERVICES (NOMINAL DOLLARS)



Data Source: Statistics Canada 2013 "Supply and Use Tables, 2013."

Mobile telecom (a product category which shows extensive growth in household expenditure) shrinks in terms of business expenditure between 2012 and 2013. While the reduction is small it is nevertheless significant. Considered within the context of rapid and widespread digital and mobile telecom adoption (discussed in the introduction) we would expect expenditure on mobile telecom to be persistently increasing at a fairly extensive rate. This reduction in expenditure, and the relatively persistent expenditure on mobile telecom for the years from 2010 to 2012, may indicate either a rationalization on the part of those businesses purchasing mobile telecom services (making better use of the telecom services provided) or an overall increase in the value of the product being provided with no requisite increase in telecom service providers' prices.

In extending this discussion, it is important to draw attention to the fact that the values quoted above represent expenditure on telecom services but may not represent the actual value of those services. Expenditure is a measure of the total compensation provided to producers by consumers (essentially the price paid for a good multiplied by its quantity). However, it is generally accepted that the actual underlying value of any good or service exchanged in the economy may be different from its price. This wedge between the consumer value of a good or service and the price actually paid for a good or service is referred to as the "consumer surplus".

2.1.1 Consumer Surplus

In drawing the distinction between value and expenditure in telecom-related products, Syverson (2017) observes that "Many of the fastest-diffusing technologies since 2004 – like smartphones, online social networks, and downloadable media – involve consumption of products that are time-intensive but do not impose a large direct monetary cost on consumers." Applying a revealed preference argument based on time allocation from Becker (1965), Syverson further concludes that "the fact that these new products are not particularly expensive (at least relative to consumers' supposed interest in them) could result in a relatively modest portion of their delivered consumption benefit to be reflected in GDP."

Therefore, from a household expenditure perspective, given the increasing time allocated to products and services accessed via telecom networks (and in particular mobile telecom) it is likely that the actual value of telecom services to Canadian consumers exceeds the value chain expenditure on these services.

Taken together we can conclude that the value of telecom products exceeds the total expenditure on these services (\$54.9 billion in 2013). The extent of the wedge between expenditure and consumer value (the “consumer surplus” wedge) is not directly identifiable using available statistics. Given this, we do not provide a direct measure of this wedge, but instead describe it in qualitative terms.

A recent paper by Hausman and Ros (2013) presents a measure of consumer surplus in Mexico, relative to other jurisdictions with similar levels of GDP per capita. Mexico, like Canada, has a relatively concentrated telecom industry. However, Hausman and Ros (2013) found that, contrary to expectation, Mexican consumers pay mobile telecom prices that are 30 to 60 per cent lower than what would be expected based on a statistical analysis of comparable countries. For fixed-line services the Mexican price was 15 per cent lower. Hausman and Ros conclude that these lower prices effectively increased consumer surplus by \$4 billion to \$5 billion for mobile telecom consumers (in 2010) and \$1 billion for fixed-line telecom consumers (in 2011).

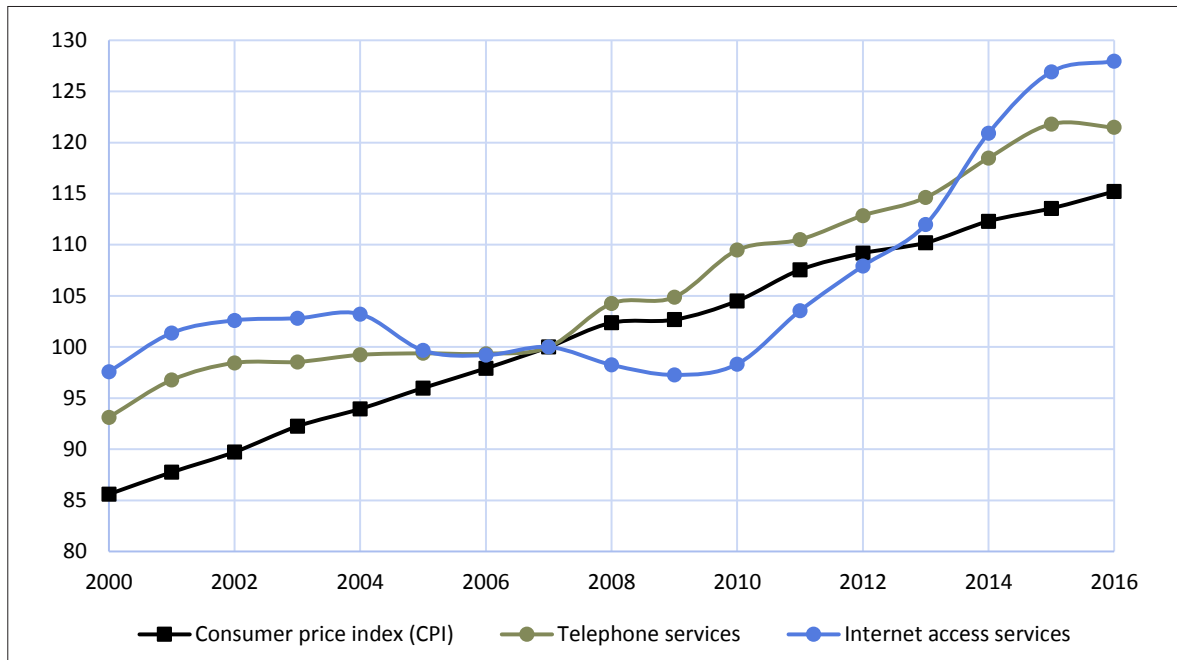
While a full analytical estimate and description of consumer surplus in the telecom industry is beyond the scope of this study, we do examine pricing trends to draw some general conclusions about the direction of changes in Canadian consumer surplus in this market.^{15,16}

Figure 4 illustrates the trend in prices for telephone and internet access services relative to overall inflation as measured by the consumer price index (base year 2007). The price indices in this figure illustrate a weighted average of the price movements for a basket of goods. The CPI is an overall price index based on a weighted average of the prices for a representative bundle of goods and services embodied in household consumption. For telephone service (itself a component of the CPI) the index shown is based on landline and mobile wireless services (including a representative mix of various options, features, long-distance services, installation and repair services). For internet services (again, a component of overall CPI) the index is based on a mix of differing quantity and quality internet services (a representative mix of various subscriptions through a wired line to household residences).

¹⁵ A review of the extant literature indicates no existing credible estimates of consumer surplus for the Canadian telecom industry. An explicit estimate of overall consumer surplus requires a complex technical analysis of consumer spending on telecom services and potentially on other consumption items.

¹⁶ Gupta (2013) does present estimates of the effect of price changes as observed in OECD data on consumer surplus across several countries, including Canada. However, the OECD data Gupta employs are questionable and subject to significant critique as Hausman and Ros (2012) explain. In particular, the OECD price basket was changed twice from 2000-2009 which, by the OECD’s own admission, had significant but unaddressed impacts on the bundle price levels that were collected and recorded.

FIGURE 4 CONSUMER PRICE INDEX AND PRICE INDICES FOR TELEPHONE SERVICES AND INTERNET ACCESS SERVICES (2007=100)



*Data Source: CANSIM Table 326-0020 “Consumer Price Index (CPI)” and authors’ calculations.

Despite significant reductions in the price of the internet services basket in 2004 and then from 2007 to 2009, over the post-2010 period the internet price index shows increases outpacing overall inflation as measured by the CPI.

The higher rate of increase in the combined internet and telephone services over more recent periods might suggest a reduction in the consumer surplus associated with purchases of these two classes of goods. However, such a conclusion would ignore the possibility that new services and potential quality improvements in existing services (as included in the basket of goods) may have changed the value proposition for consumers.

Statistics Canada’s current practice in calculating CPI and its contributing indices is “to measure the household expenditure weights comprehensively for a 12-month period, and to refresh these estimates every two years.”¹⁷ Because of this, the price indices as represented in Figure 4 reflect both price changes for individual goods within the representative basket for each element and changes in the relative household expenditures on those goods. As such, the indices data may not necessarily reflect an increase in prices for specific internet and telephone services, but instead a pattern of substitution of consumers to higher price (and higher value) telephone services.¹⁸

While this is speculation, it is supported somewhat by list-price data collected and reported by Nordicity (2016). The figures in Table 1 provide a less aggregated view of some of the services that would likely be represented (in aggregate) in the Statistics Canada price indices shown in Figure 4. It is interesting to note that at all service levels except the basic level 1 (150 minutes) prices have declined over the period 2008 to 2016. It is also interesting to note that Nordicity chose to start collecting data on higher service levels (4, 5 and 6) in the later time periods due to a belief that

¹⁷ Statistics Canada (2015), “The Canadian Consumer Price Index Reference Paper,” Catalog no. 62-553-X. <http://www.statcan.gc.ca/pub/62-553-x/62-553-x2015001-eng.pdf>

¹⁸ We can speculate that, all else being equal, any substitution by consumers to a higher priced good directly implies that good has a higher value as well. This is known as the revealed preference approach. For a rational consumer, if good A is chosen over (or substituted for) good B, we can conclude that good A represents a better value proposition than good B.

the demand and usage for these service levels “has increased significantly, particularly in case of wireless services”.¹⁹

It seems likely therefore that the price growth indicated by the Statistics Canada price indices reflects a move to greater value (and higher priced services) rather than an increase in the prices of existing telecom services. By extension, this implies that the consumer surplus, while we have no reasonable estimate of its overall size, has likely been growing over the same time period as consumers freely chose to switch to higher priced and presumably higher valued services.

TABLE 1 CANADIAN AVERAGE WIRELESS SERVICE BUNDLE PRICES

Service Level	2008	2009	2010	2011	2012	2013	2014	2015	2016
1: 150 Minutes	\$32.73	\$33.03	\$34.03	\$33.73	\$34.32	\$30.71	\$35.70	\$37.29	\$41.08
2: 450 Minutes, 300 Texts	\$60.81	\$57.78	\$53.49	\$50.51	\$51.31	\$44.86	\$45.26	\$48.68	\$48.77
3: 1,200 Minutes, 300 Texts, 1 GB Data	\$112.34	\$103.24	\$109.59	\$99.69	\$98.37	\$93.59	\$79.69	\$85.22	\$74.67
4: Unlimited Minutes & Texts, 2 GB Data							\$92.99	\$83.08	\$81.05
5: Unlimited Minutes & Texts, 5 GB Data								\$107.50	\$96.55
6: Unlimited Minutes & Texts, 10 GB Data, 3 Lines									\$231.99

*Data Source: Nordicity (2016), “2016 Price Comparison Study of Telecommunications Services in Canada and Select Foreign Jurisdictions.” Prepared for: *The Canadian Radio-Television and Telecommunications Commission (CRTC)*.

For wired internet services the same pattern emerges, but it is not as well defined. As Figure 4 indicates, the weighted average price index for internet services dips well below overall CPI growth from 2008 to 2010, before rising significantly from 2010 to 2016. The overall effect is that for the entire 2008 to 2016 period the internet service price index well exceeds the rate of inflation. The list prices for lower quality services show similar price growth.

Table 2 shows that the prices of level 1 (3 to 9 Mbps) and 2 (10 to 15 Mbps) baskets increase by 28 per cent and 26 per cent (respectively) from 2008 to 2016. This is closely in line with the overall increase described by the weighted internet services price index displayed in Figure 4. Specifically, this price index increases from a value of 98 in 2008 to a value of 128 in 2016 (overall increase of approximately 30 per cent).

TABLE 2 CANADIAN AVERAGE WIRED INTERNET SERVICE PRICES

Level	2008	2009	2010	2011	2012	2013	2014	2015	2016
1: 3 to 9 Mbps	\$32.88	\$30.98	\$31.44	\$34.85	\$39.37	\$38.91	\$50.00	\$47.51	\$41.94
2: 10 to 15 Mbps	\$46.58	\$47.26	\$47.60	\$49.79	\$54.31	\$51.20	\$55.10	\$56.66	\$58.88
3: 16 to 40 Mbps	\$68.74	\$60.08	\$61.88	\$63.44	\$67.94	\$65.18	\$68.60	\$67.81	\$63.48
4: 41 to 100 Mbps				\$77.71	\$94.39	\$82.88	\$86.46	\$80.63	\$78.77
5: Over 100 Mbps									\$114.65

*Data Source: Nordicity (2016), “2016 Price Comparison Study of Telecommunications Services in Canada and Select Foreign Jurisdictions.” Prepared for: *The Canadian Radio-Television and Telecommunications Commission (CRTC)*.

Given that the Statistics Canada Index price for wired internet services grows at a rate exceeding even the fastest growing list price as indicated in Table 2, substitution of consumers to higher quality and higher priced services almost certainly accounts for a portion of the increase in the

¹⁹ Nordicity (2016).

overall internet service price index. It is also worth highlighting here that the prices for higher level services (3 and 4) are stable or falling over the recorded period.

While it is difficult to draw definitive conclusions from this discussion, it does seem evident that price growth in telephone and internet services is not altogether out of line with overall inflation in Canada. Nevertheless, price changes in some markets over certain periods may require policy attention. For example, such would be the case if price increases in the 3 to 15 Mbps market segment were used as a strategic tool by internet suppliers to induce substitution towards higher quality (and higher priced) internet services.²⁰

2.1.2 Downstream Linkages

To continue the discussion of value chain outputs we now move to intermediate goods production. Figure 5 presents the top 60 industries consuming telecom services (as measured by total expenditure on the four identified telecom product categories).²¹ Of particular interest here are the dominance of service industries and the relative absence of manufacturing and resource industries. Of the 60 industries listed, only five have a primary focus that is not service oriented.²² Given the Canadian economic transition towards service-oriented sectors, this is perhaps not surprising, but it is nonetheless noteworthy as we consider the future of the telecom sector within the context of its downstream linkages.

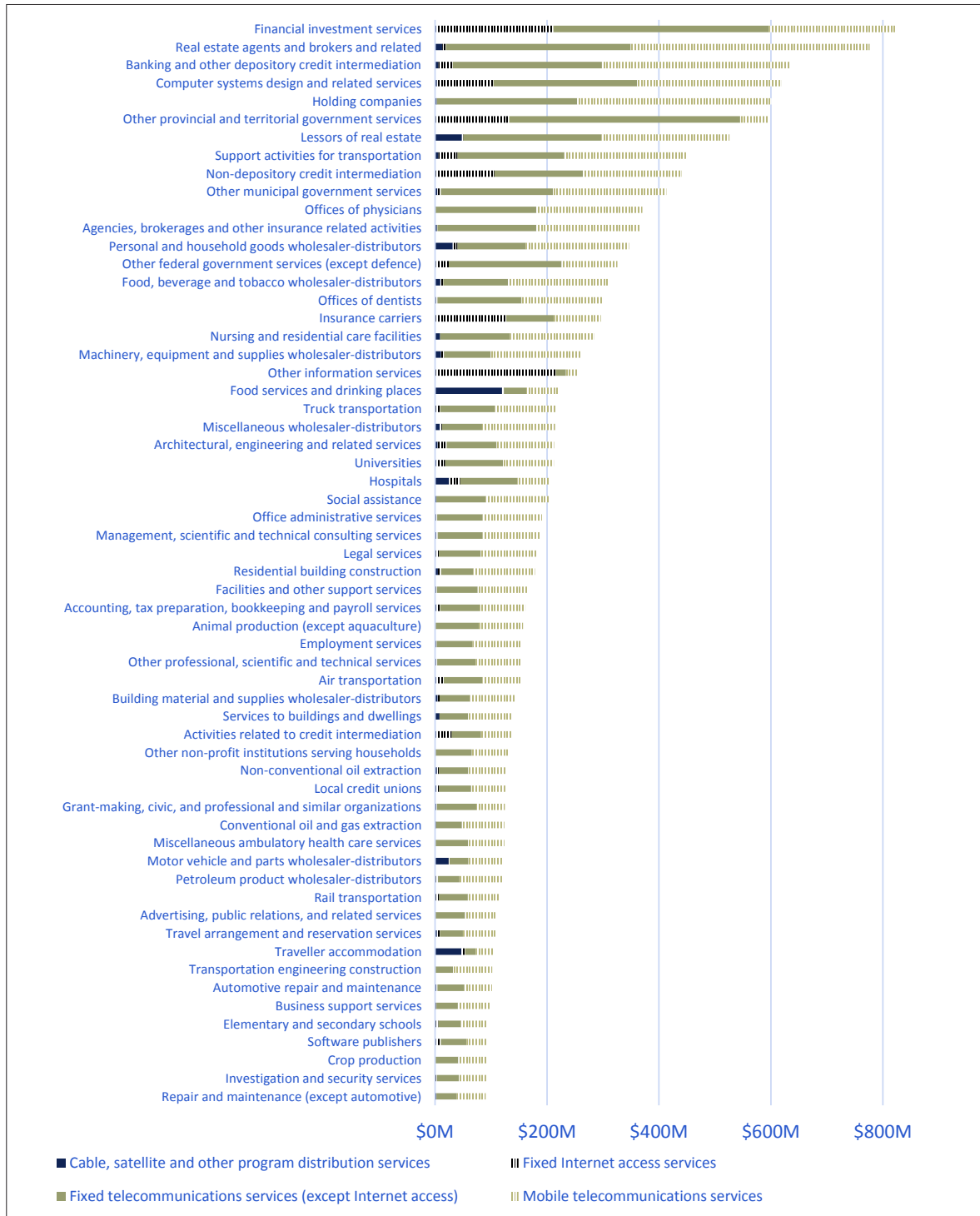
This point notwithstanding, even sectors which do not directly purchase significant quantities of telecom sector output are still highly integrated with the telecom sector through indirect channels. Specifically, sectors that are not directly reliant on inputs from the telecom sector are still reliant on inputs from other sectors which are themselves directly reliant on inputs from the telecom sector.

²⁰ If this is the case, then the revealed preference argument used above (see footnote 18) no longer holds.

²¹ The top 25 per cent of sectors (the top 60 out of 240 sectors) account for 67 per cent of total industrial expenditure on telecom products.

²² These five industries are: crop production, transportation engineering construction, conventional oil and gas extraction, nonconventional oil and gas extraction and residential building construction.

FIGURE 5 TOP 60 INDUSTRIAL CONSUMERS OF TELECOM SERVICES, BY GROSS VALUE PER SECTOR (2013)



Data Source: Statistics Canada 2013 "Supply and Use Tables, 2013."

2.2 Value Chain Inputs

This section identifies the value and type of intermediate inputs (that is, inputs other than capital and labour, the direct factors of production) the telecom sector uses. The language on intermediate inputs is directly carried over from the value-chain outputs discussion (section 2.1) with an important distinction; in the outputs discussion the intermediate inputs being discussed are those

produced by the telecom sector and supplied to downstream industries whereas in the inputs discussion the intermediate inputs being discussed are produced by other industries and supplied to the telecom sector.

As indicated above, total intermediate input expenditure by the telecom sector amounted to \$22.8 billion in 2013. Figure 1 itemizes “Distribution Fees” (\$3.0 billion) separately from “Other Intermediate Inputs” (\$19.8 billion) given the relative size and importance of distribution fees as an intermediate input to the telecom sector. Other products accounting for large telecom input expenditures include manufacturing inputs in the form of “Other Communications Equipment” (\$2.4 billion) and “Telephone Apparatus” (\$1.3 billion). Beyond these large expenditures the telecom sector tends to make relatively smaller intermediate input expenditures which are widely spread across all other product categories.²³

Given that primary factors of production (labour and capital) represent 68 per cent of upstream expenditures by the telecom sector versus just 32 per cent of expenditures on intermediate inputs, the remainder of this section focuses on the trends in labour and capital investment decisions made by the telecom sector. To reiterate from Figure 1, the largest elements of input expenditure are “Payments to Capital” and “Wages and Salaries.”

We turn first to a discussion of telecom labour inputs before moving on to a discussion of capital stock and investment in the telecom sector (in section 2.2.2).

2.2.1 Employment

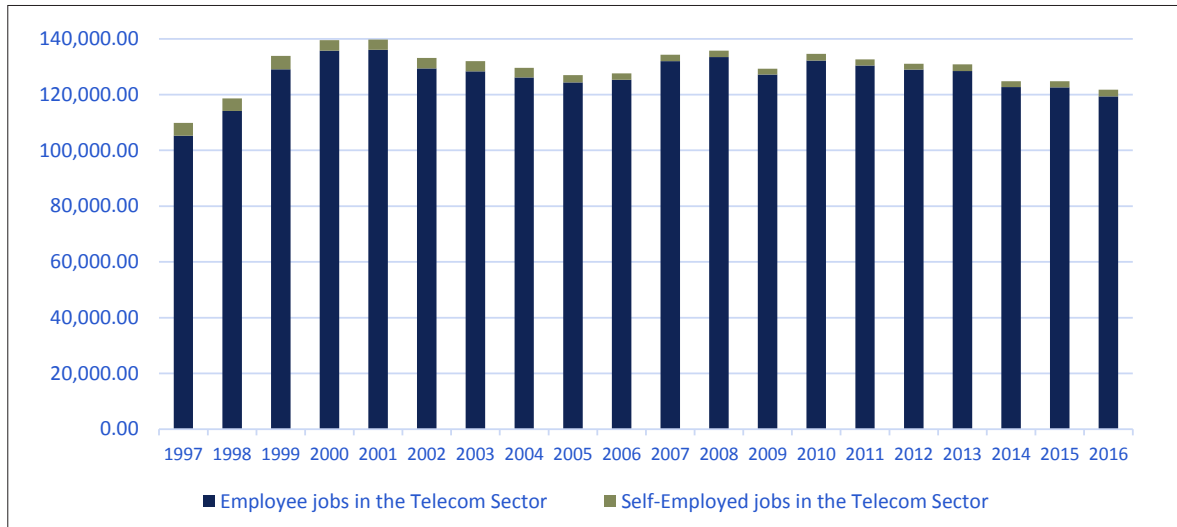
Figure 6 illustrates the total jobs directly attributed to the Canadian telecom sector from 1997 to 2016. It is evident that, except for some high growth at the end of the 1990s, there has been relative stability, perhaps with a slight downward trend, in telecom employment over the last 16 years. This trend is present both in the “employee” and in the “self-employed” jobs categories (the latter of which is likely made up of independent contractors or subcontractors engaged in work for larger telecom firms). The absence of expansion in telecom employment combined with overall employment growth in the economy has meant a decline in the relative importance of the former, at least if one looks at just the direct employment that the telecom sector generates.

Another way to view this is to compare growth rates. Figure 7 plots annual job growth rates (per cent growth in jobs year over year) for the telecom sector, along with the job growth rate for all sectors of the economy. While the Canadian economy maintained overall positive growth in jobs for every year between 1998 and 2016 (except 2009 in the wake of the 2008 global recession), the telecom sector experienced significant negative job growth in nine of the last 19 years and negligible (near zero) growth in three of the last 19 years. It is clear that the post-1999 trend is toward fewer telecom jobs notwithstanding spikes in job growth in 2007 (just prior to the 2008 global recession) and 2010 (during the recovery).²⁴

²³ The median intermediate input product category expenditure by the telecom industry is \$7.8 million and the telecommunications industry purchases inputs from all recorded NAPCS categories except “Steam and heated or cooled air or water”.

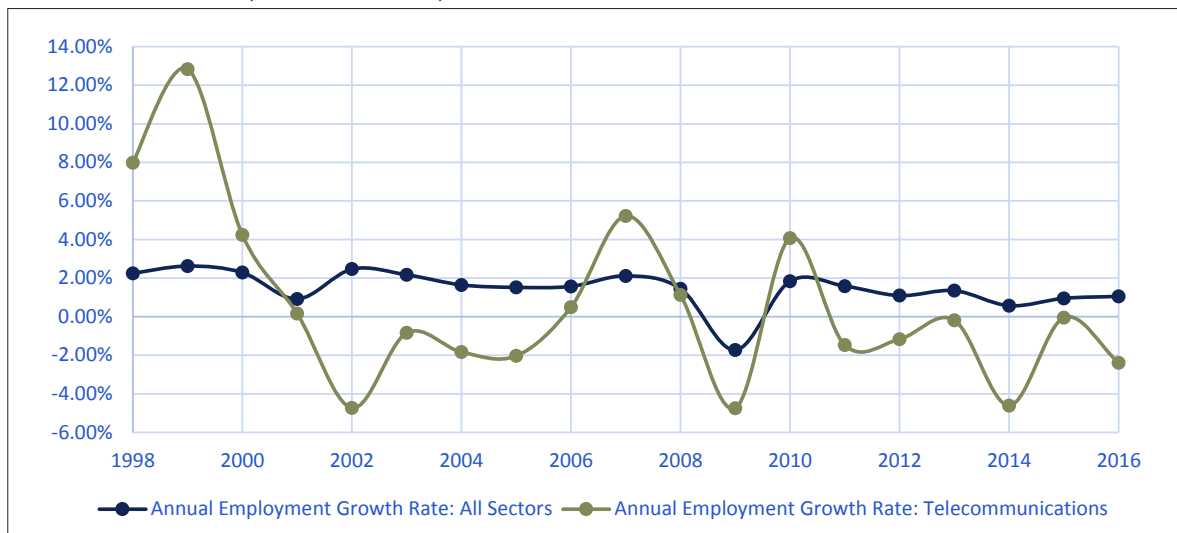
²⁴ Inspection of Figure 7 indicates that the variance of the telecommunications job growth rate is higher than that of the total national job growth rate. This is expected and should not be interpreted as telecom having less predictable job growth than other sectors. Because the national job growth rate is an aggregate of several industries, each with its own growth rate and associated variance, it is expected that it would have a lower overall variance through time.

FIGURE 6 TOTAL JOBS (EMPLOYEE AND SELF-EMPLOYED) IN THE CANADIAN TELECOM INDUSTRY



*Data Source: CANSIM Table 383-0031 "Labour Statistics Consistent with the System of National Accounts (SNA)."

FIGURE 7 ANNUAL (YEAR OVER YEAR) JOB GROWTH RATES: TELECOM AND TOTAL NATIONAL JOBS



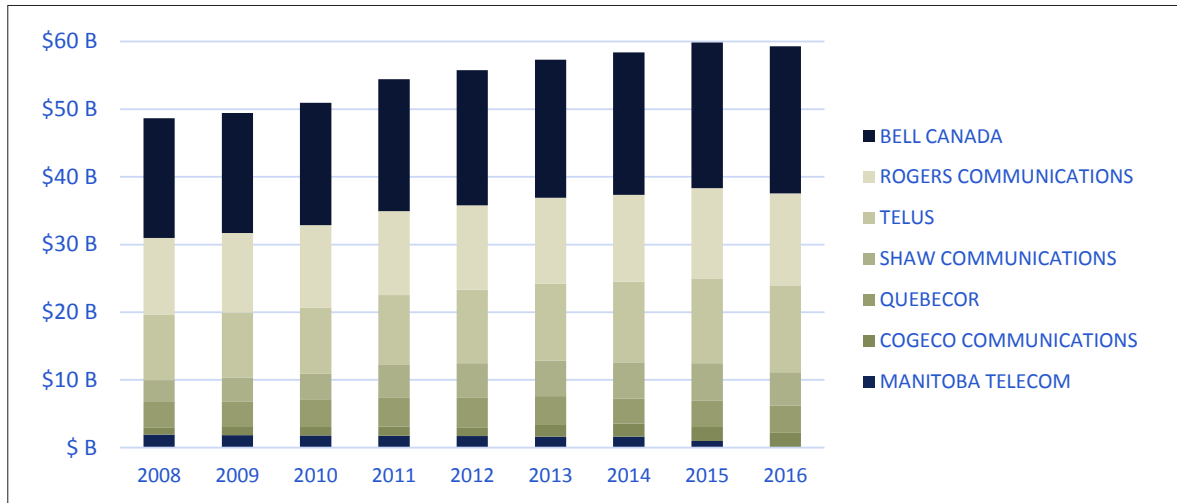
*Data Source: CANSIM Table 383-0031 "Labour Statistics Consistent with the System of National Accounts (SNA)."

However, job growth is only one of two margins determining the telecom sector’s expenditure on labour inputs. The other margin is the compensation (wages and benefits) per job. Between 1997 and 2016, compensation in the telecom sector has consistently exceeded the Canadian national average. Additionally, over the period 1997 to 2016, compensation per telecom sector job has grown almost four per cent faster than the national average compensation per job.²⁵

From 1997 to 2016 the telecom labour compensation rate (compensation per job) has increased faster than any reductions in telecom employment (number of jobs). It follows that, while the telecom sector is generating more overall labour income, this income is being distributed across a smaller number of jobs.

²⁵ Data source: CANSIM Table 383-0031, "Labour Statistics Consistent with the System of National Accounts (SNA)." Annual compensation includes wages and salaries as well as employer social contributions.

FIGURE 8 TELECOM SECTOR REVENUES (NOMINAL DOLLARS)



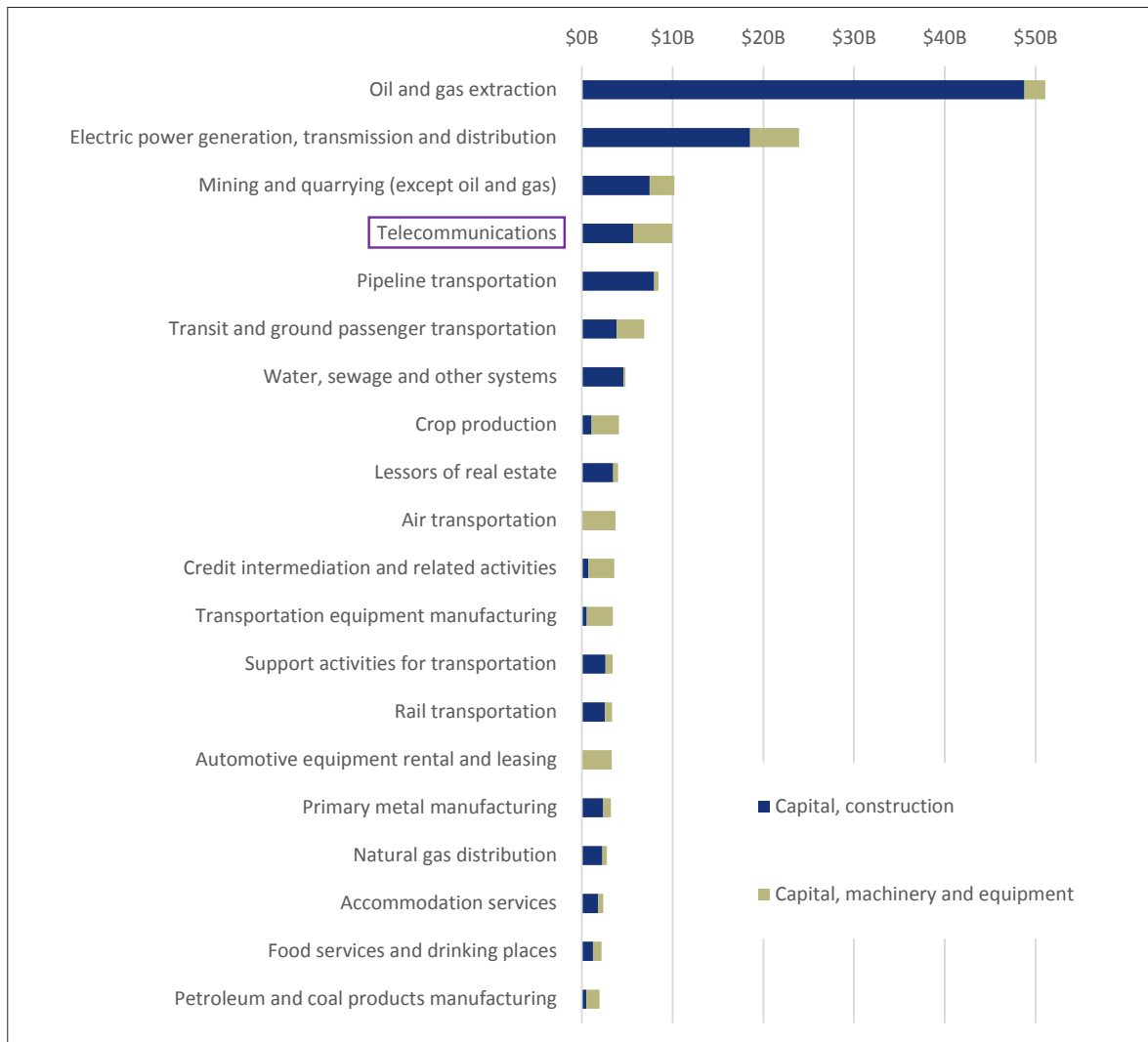
*Data Source: Compustat Database - Retrieved May 2017; Publicly traded firms only, excludes small firms.

Figure 8 shows that, overall, the telecom sector’s revenues have risen over the past decade. When combined with the previous observation of higher overall labour income but somewhat declining job creation, a conventional efficiency wage argument (Yellen, 1984) suggests that the overall increase in compensation per job could be the result of increased labour productivity. As the telecom workforce becomes more efficient, fewer workers are needed to supply the market. Yet firms in the market increase job compensation in order to continue attracting and retaining those more efficient workers.

2.2.2 Capital Stock and Investment

Total annual capital expenditures in the telecom sector relative to the other top 20 non-publicly funded sectors in Canada are shown in Figure 9. While the oil and gas and electricity utilities sectors have significantly higher capital expenditures, telecom comes a close fourth behind mining and quarrying and just ahead of pipeline transportation (itself closely related to oil and gas extraction). Placing these numbers into the wider context, telecom is responsible for just over five per cent of all capital expenditures in Canada (including all industries, not just the top 20 indicated in Figure 9). This expenditure is fairly evenly split between Construction Investment (\$5.6 billion in 2015) and Machinery and Equipment Investment (\$4.3 billion in 2015).

FIGURE 9 CAPITAL EXPENDITURE (TOP 20 NON-PUBLICLY FUNDED INDUSTRIES, 2015)



*Data Source: CANSIM Table 029-0046 “Capital and Repair Expenditures, Non-Residential Tangible Assets, by North American Industry Classification System (NAICS).”

Publicly funded industries (public administration, education and health care) are excluded

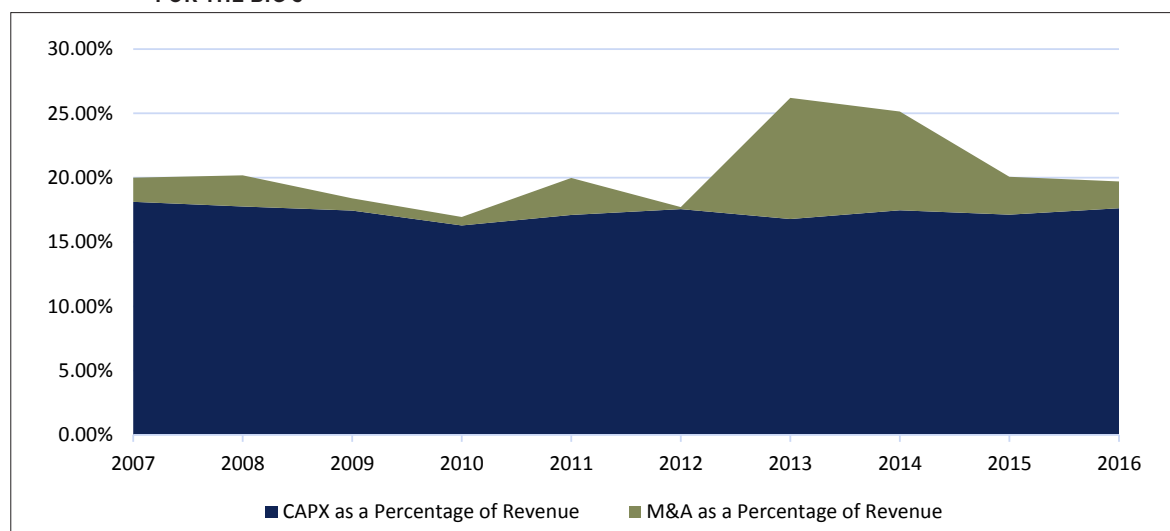
From the breakdown in Figure 1 it is evident that payments to capital play a significant role in the telecom value chain. Figure 9 adds an additional dimension to this, indicating the importance of continued capital expenditure in the sector. That is, it is not just payments to capital that are high in the sector, it is also capital expenditure in the form of creation of new capital. This underscores both the importance of capital expenditure in the evolving telecom sector, as well as the importance of telecom as a channel for generating capital expenditure and investment within the Canadian economy.

It is also useful to examine capital expenditure behaviour at the firm level (rather than solely at the industry level). From Figure 8 it is clearly evident that the majority of revenue generated in the Canadian telecom sector can be attributed to three firms: Bell Canada, Rogers Communications and Telus. Given this observation, in the remainder of this section we focus on assessing summary statistics for the Big 3 telecom firms: Bell Canada, Rogers Communications and Telus.

Recall from Figure 1 that the telecom sector’s Payments to Capital amounted to \$21.7 billion in 2013. This is roughly 39.5 per cent of the total value of inputs (including both factor inputs and intermediate inputs) into the telecom sector value chain.

Figure 10 shows capital expenditure (CAPX) and mergers and acquisition (M&A) expenditure as a proportion of revenue for the Big 3. While these expenditures may not necessarily be financed through retained earnings it follows that these firms are making significant contributions to asset growth relative to their revenues. Setting aside for the moment the M&A expenditure hump in 2013 and 2014, annual CAPX and M&A expenditure by the Big 3 can be characterized at a fairly steady level of approximately 20 per cent of their incoming revenue.

FIGURE 10 CAPITAL AND MERGERS AND ACQUISITION EXPENDITURE AS A PROPORTION OF REVENUE FOR THE BIG 3



*Data Source: Compustat Database - Retrieved May 2017.

Outside of the relatively persistent 20 per cent CAPX- and M&A-to-revenue ratio, Figure 10 shows a two-year hump rising above 25 per cent in 2013 and 2014. This hump is the combined result of expenditures associated with Industry Canada’s auctioning of a section of wireless spectrum and large M&A activity by the Big 3.

The Canadian Radio-Television and Telecommunications Commission (CRTC) has indicated that CAPX and M&A expenditure increased in 2014 as a result of the 700MHz spectrum auction that year (CRTC, 2016). In addition to this, the Big 3 made other acquisitions in 2013 and 2014 which contributed to the CAPX and M&A bump. Altogether, the majority of this increase can be explained as a combination of Bell Canada’s purchase of Astral Media in 2013 (Bell Canada, 2013) and Rogers Communications’ expenditure of \$3.3 billion during the 2014 spectrum auction (Rogers Communications, 2014).²⁶

M&A activity notwithstanding, a large proportion of the capital investment expenditure (CAPX and M&A) is devoted to replacing depreciated assets rather than growing the total stock of capital assets of the Big 3. Table 3 indicates a breakdown of the property, plant and equipment growth for each Big 3 firm.

These firms experience average effective depreciation rates of 16.64 per cent (Bell), 20.45 per cent (Rogers) and 21.75 per cent (Telus). Related to this, the effective investment rates for these firms are

²⁶ Bell Canada also incurred a \$566 million expenditure on spectrum; however, Bell also had a \$766 million disposition of other assets, meaning the effect of the spectrum auction expenditure is not apparent in either the bottom line balance sheet or the aggregate Compustat data presented in Figure 10 and Table 3. Similarly, Telus incurred a \$1.1 billion expenditure during the 2014 spectrum auction (Telus, 2014). However, this is also absent from the aggregate Compustat data, potentially either due to deferred payments (Telus appears to be paying for spectrum over a multi-year period) or some other financial/accounting arrangement.

very similar to their depreciation rates: 16.52 per cent (Bell), 22.83 per cent (Rogers) and 23.07 per cent (Telus). This suggests that a bulk of capital investment is devoted to asset replacement rather than growth in the nominal value of the firms' capital stocks.

TABLE 3 PROPERTY PLANT AND EQUIPMENT GROWTH RATE DECOMPOSITION FOR THE BIG 3

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Bell Canada (Compound Annual Growth Rate: 2.06%)										
Effective Depreciation Rate	17.20%	16.84%	17.34%	16.71%	17.36%	16.93%	16.29%	16.19%	15.81%	15.70%
Effective Investment Rate	16.94%	15.40%	14.68%	15.02%	17.33%	17.57%	17.22%	17.43%	16.76%	16.88%
Per Cent Growth from M&A	0.88%	0.29%	1.74%	0.31%	3.62%	0.06%	13.74%	0.08%	1.44%	4.12%
Net Annual Growth Rate	0.62%	-1.16%	-0.92%	-1.38%	3.59%	0.70%	14.66%	1.33%	2.39%	5.30%
Rogers Communications (Compound Annual Growth Rate: 4.41%)										
Effective Depreciation Rate	21.75%	21.98%	21.03%	19.39%	19.69%	19.66%	19.02%	20.12%	20.71%	21.17%
Effective Investment Rate	24.64%	25.59%	22.63%	21.65%	23.34%	22.37%	21.84%	22.21%	22.19%	21.88%
Per Cent Growth from M&A	7.37%	2.42%	0.13%	2.37%	5.84%	0.00%	10.53%	32.44%	9.79%	0.00%
Net Annual Growth Rate	10.26%	6.03%	1.73%	4.63%	9.48%	2.70%	13.36%	34.52%	11.28%	0.71%
Telus (Compound Annual Growth Rate: 4.28%)										
Effective Depreciation Rate	22.50%	23.41%	22.28%	22.47%	22.54%	22.90%	21.49%	20.19%	19.64%	19.68%
Effective Investment Rate	24.67%	25.41%	27.21%	22.29%	23.19%	23.88%	19.52%	21.02%	21.01%	22.53%
Per Cent Growth from M&A	0.00%	9.51%	0.34%	0.00%	0.00%	0.65%	3.10%	0.54%	0.10%	0.86%
Net Annual Growth Rate	2.16%	11.51%	5.27%	-0.18%	0.65%	1.63%	1.13%	1.37%	1.48%	3.72%

*Data Source: Compustat Database – Retrieved May 2017 and authors' calculations.

"Effective Depreciation Rate" is defined as depreciation and amortization over net property plant and equipment.

"Effective Investment Rate" is defined as capital expenditures over net property plant and equipment.

"Per Cent Growth from Mergers and Acquisitions" is defined as acquisitions over net property plant and equipment.

"Net Annual Growth Rate" is the cumulative sum of the above defined rates and should be interpreted as the annual growth rate in net property plant and equipment.

This is perhaps not surprising given the rapid rate of technological change in the telecom sector. Computer equipment and similar asset classes are recognized to depreciate and amortize faster than other asset classes as new innovations render older technologies redundant, obsolete or substandard.

Bell's average effective investment rate is slightly lower than its average effective depreciation rate between 2007 and 2016 (16.52 per cent vs. 16.64 per cent). This means that Bell is not quite replacing the value of depreciated assets through new investment on an annual basis. Bell's modest capital stock growth is therefore entirely the result of M&A activity. By comparison, both Telus and Rogers exhibit average investment rates in excess of depreciation, meaning that the growth of those two firms' capital stocks are the result of combined CAPX (in excess of depreciation) and M&A expenditures.²⁷

When considered alongside the labour assessment made in Section 2.2.1 above, it is evident that modest growth in capital stock and the overall reduction in industry jobs imply that the sector's

²⁷ It is worth noting that, even though Telus exhibits limited M&A activity in Table 3, the timing of this activity increases its weight in the compound annual growth rate. Telus' purchase of Emergis Inc. (an e-business company dealing with interactions between companies and associated electronic commerce) in 2009 means that subsequent growth rates are measured on a higher base (since all rates in Table 3 are relative to net property, plant and equipment). As such, the effect of this M&A expenditure would weight higher in the 2007-2016 compound annual growth rate calculations when compared to later M&A expenditures. For details on Telus' acquisition of Emergis Inc. see: http://about.telus.com/community/english/investor_relations/shareholder_%26_bondholder_services/shareholder_services/mergers_and_acquisitions

capital labour ratio has been growing. This is also consistent with the efficiency wage argument presented above as a possible explanation for the increased job compensation rate in the presence of falling industry job numbers.

The fact that the growth in physical capital for the Big 3 is the joint result of CAPX in excess of depreciation (for the two smaller firms) and M&A expense (for all three firms) indicates that rationalization in the market (that is, the purchase of smaller firms by larger firms) is playing a role in overall sector growth. This fits in with analysis by Church and Wilkins (2013a) who argue that the mobile telecom sector in particular, due to the high fixed costs involved, has “a natural upper limit on the number of wireless carriers”. It might therefore be expected that smaller firms would be purchased by larger firms as they mature, allowing these larger firms (in particular the Big 3 along with Shaw Communications) to take advantage of economies of scale post-acquisition to enhance labour and capital efficiencies. The end result would be an increase in the overall value provided to end consumers (both the expenditure and the consumer surplus wedge associated with the end consumption and downstream linkages as discussed in section 2.1) relative to the sector’s input costs.

The fact that reinvestment (through CAPX and M&A) as a proportion of overall revenue has held reasonably constant over the last decade (as Figure 10 illustrates), when combined with modest growth of the Big 3 firms’ capital stock, suggests that the firms’ ability to earn profits from the market has not changed markedly in the last decade.²⁸ Were the opposite true, we might expect to see revenues growing at a faster rate than reinvestment rather than the constant ratio between the two that we currently observe.

In the context of investments it is important to note that Canada has heavy regulatory restrictions on foreign direct investment (FDI) in its telecom sector. This is illustrated in Figure 11 which shows the level of restrictiveness in Canada’s fixed telecom and mobile telecom sectors relative to that in the United States and, on average, in the OECD countries. Given this, it is not surprising that of the FDI in Canada, very little has gone to the telecom sector. For example, while Canada has received significant flows of Chinese FDI,²⁹ most of this has gone to the oil and gas, and metals and mining sectors³⁰ with very little going to the telecom sector.³¹

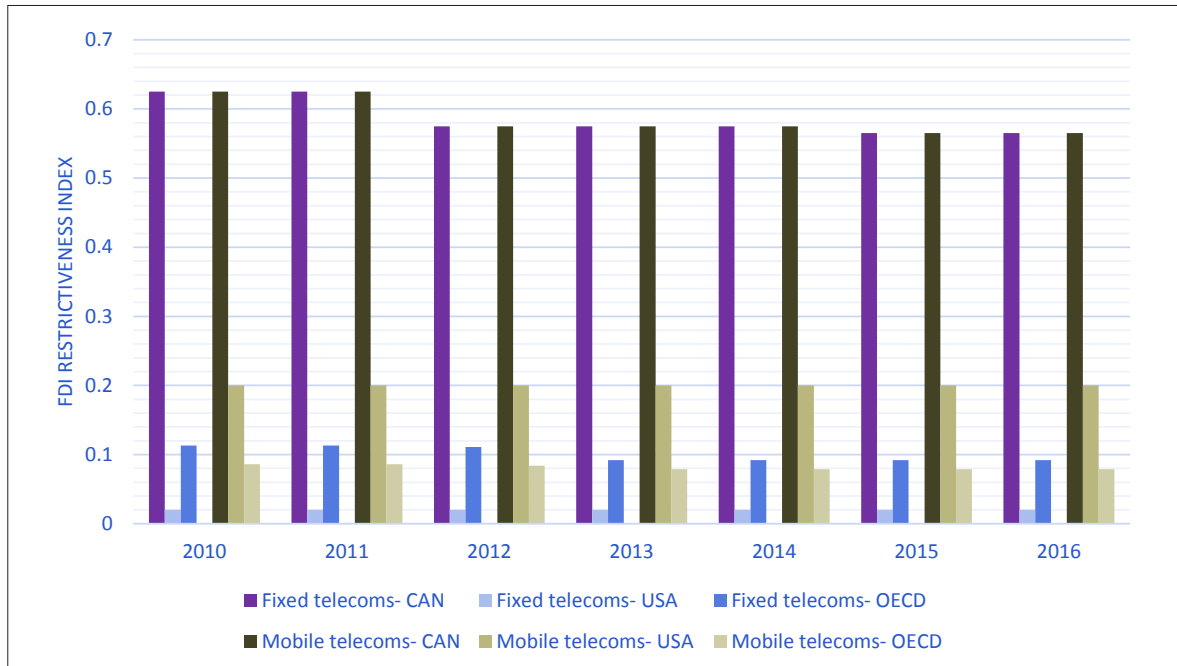
²⁸ Church and Wilkins (2013b, 2014) make similar points.

²⁹ Approximately \$47 billion between 2003 and 2013 (Anderson and Sutherland, 2015)

³⁰ See section 2.2.2.

³¹ Less than 0.6 per cent of all Chinese FDI between 2003 and 2013 accrued to the telecommunications sector.

FIGURE 11 FDI REGULATORY RESTRICTIVENESS INDEX, 2010-2016 (0 = OPEN, 1 = CLOSED)



Source: OECD, 2016.

The elevated FDI restrictiveness for Canadian telecom follows from the *Telecommunications Act*, which imposes ownership requirements for telecom carriers in Canada. Before 2012, the *Telecommunications Act* prohibited the ownership of Canadian telecom carriers by non-Canadians. These restrictions were relaxed in 2012, when the federal government lifted foreign ownership restrictions on carriers holding less than a 10 per cent share of the Canadian telecom market. However, despite the partial relaxation of foreign investment restrictions, no well-established foreign player has yet to enter the Canadian telecom market.

Through the analysis of data in this section, some general themes emerge, illustrating the importance of the telecom sector as a component of the economic value chain in Canada. On the downstream side, telecom supports both consumer welfare (through sales to households) and additional industrial production (through sales to businesses) with mobile telecom services becoming an increasingly important part of this contribution. On the upstream side, the telecom sector's activities motivated over \$23 billion in upstream production by industries supplying inputs to telecom and over \$31 billion in overall value added. While total labour employment in the sector has been relatively stable over most of the last decade, it continues to compensate employees at a rate well above the national average such that overall labour income generated by telecom is actually increasing. The sector also displays very high capital intensity, trailing only resource extraction (mining and oil and gas) and electricity utilities sectors in terms of industry-wide capital expenditure.

3 CONCLUDING REMARKS

In 2013 the telecom sector contributed products and services worth well over \$30.3 billion to Canadian households³² and products and services worth well over \$22.1 billion to other Canadian industries.³³ Of the \$54.9 billion gross value measurement, well over half (\$31.2 billion) represents value added to the Canadian economy through the use of capital and labour as factors of production, while the remainder (\$23.7 billion) represents additional upstream activity motivated by the telecom sector's activities.

As the use of IP-based networking applications and broadband penetration in Canada increases, telecom more and more is beginning to look like a traditional utility (like electricity) with significant and widespread downstream linkages, rather than a typical goods or services sector.

The services provided by the telecom sector are not only important for Canadian households, but are also critical for every other Canadian industry. Figure 5 and the underlying data from Statistics Canada (2013) show that every single Canadian sector employs some value of telecom products as an input, making telecom a critical keystone of the Canadian economy.

³² Total valuation of telecom goods and services to households is the \$30.3 billion expenditure indicated in Figure 1 and the additional consumer excess consumer surplus representing the difference between inframarginal consumers' valuations and the equilibrium prices for telecom goods and services determined at the margin.

³³ Total valuation of telecom goods and services to other industries is the \$22.1 billion expenditure indicated in Figure 1 and the additional consumer excess consumer surplus representing the difference between inframarginal consumers' valuations and the equilibrium prices for telecom goods and services determined at the margin.

4. WORKS CITED

- Anderson, J., and D. Sutherland. 2015. "Developed Economy Investment Promotion Agencies and Emerging Market Foreign Direct Investment: The Case of Chinese FDI in Canada," *Journal of World Business*, 50 (4) 815-825.
- Becker, G.S. 1965. "A Theory of the Allocation of Time," *The Economic Journal*, 493-517.
- Bobonis, G.J., and H.J. Shatz. 2007. "Agglomeration, Adjustment, and State Policies in the Location of Foreign Direct Investment in the United States," *The Review of Economics and Statistics*, 89(1), 30-43.
- Bresnahan, T.F., and M. Trajtenberg. 1995. "General Purpose Technologies 'Engines of Growth'?" *Journal of Econometrics*, 65(1), 83-108.
- Bresnahan, T.F., J.P. Davis, and P.L. Yin. 2014. "Economic Value Creation in Mobile Applications," in *The Changing Frontier: Rethinking Science and Innovation Policy*, 233-286. University of Chicago Press.
- Church, J., and A. Wilkins. 2013. "Wireless Competition in Canada: An Assessment," *The School of Public Policy Research Papers* (6)27.
- Church, J., and A. Wilkins. 2014. "Wireless Competition in Canada: Damn the Torpedoes! The Triumph of Politics over Economics," *The School of Public Policy Research Papers* (7)20.
- Convergence Research Group Ltd. 2017. *The Battle for the Canadian Couch Potato: Online & Traditional TV and Movie Distribution*.
- CRTC. 2016. Communications Monitoring Report 2016.
- FCC. 2010. "FED. COMMC'NS COMM'N, CONNECTING AMERICA: THE NATIONAL BROADBAND PLAN XI, XIV."
- Garcia-Swartz, D.D., and F. Garcia-Vicente. 2015. "Network Effects on the iPhone Platform: An Empirical Examination," *Telecommunications Policy*, 39(10), 877-895.
- Gupta, A. 2013. "Estimating Direct Gains in Consumer Welfare in Telecommunications Sector," *Journal of Consumer Policy*, 36(2), 119-138.
- Hausman, J. A., and A.J. Ros. 2012. "Correcting the OECD's Erroneous Assessment of Telecommunications Competition in Mexico," *CPI Antitrust Chronicle*.
- Hausman, J. A., and A.J. Ros. 2013. "An Econometric Assessment of Telecommunications Prices and Consumer Surplus in Mexico Using Panel Data," *Journal of Regulatory Economics*, 43:3, 284-304.
- Isfeld, Gordon. 2015. "CRTC Says Big Telecom Companies Must Open Fibre Networks to Smaller Providers," Canadian Press. June 22. Available at <http://business.financialpost.com/technology/crtc-says-big-telecom-companies-must-open-fibre-networks-to-smaller-providers/>.
- Jovanovic, B., and P.L. Rousseau. 2005. "General Purpose Technologies," in *Handbook of Economic Growth*, vol. 1, 1181-1224. Elsevier.
- Khanal, Mukesh. 2017. "Canada-Bound Greenfield Investments, 2003-2014." *The School of Public Policy Briefing Paper* (unpublished).
- Mintz, Jack, and Andrey Tarasov. 2007. "Canada is Missing out on Global Capital Market Integration," *C.D. Howe Institute e-brief* 48 (August). Available at https://www.cdhowe.org/sites/default/files/attachments/research_papers/mixed//ebrief_48.pdf.

- OECD. 2015. *Digital Economy Outlook 2015*.
- OECD. 2016. "New Forms of Work in the Digital Economy," *OECD Digital Economy Papers* 260. May. 7
- Rogers Communications. 2014. Annual Report. Available at <http://netstorage-ion.rogers.com/downloads/IR/pdf/annual-reports/Rogers-2014-Annual-Report.pdf>.
- Statistics Canada. 2012. "North American Industry Classification System (NAICS) Canada 2012." Available at <http://www.statcan.gc.ca/eng/subjects/standard/naics/2012/index>.
- Statistics Canada. 2013. "Supply and Use Tables, 2013."
- Statistics Canada. 2015. "The Canadian Consumer Price Index Reference Paper," Catalogue no. 62-553-X. Available at <http://www.statcan.gc.ca/pub/62-553-x/62-553-x2015001-eng.pdf>.
- Syverson, C. 2016. "Challenges to Mismeasurement Explanations for the US Productivity Slowdown," (No. w21974). National Bureau of Economic Research.
- Tombe, T. 2015. "Better Off Dead: 'Value Added' in Economic Policy Debates," *The School of Public Policy Research Papers* 8(9).
- Wang, M., and M.C.S. Wong. 2009. "What Drives Economic Growth? The Case of Cross-Border M&A and Greenfield FDI Activities," *KYKLOS* 62(2).
- Yellen, J.L. 1984. "Efficiency Wage Models of Unemployment," *The American Economic Review*, 74(2), 200-205.

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<https://www.policyschool.ca/wp-content/uploads/2018/10/Homelessness-Kneebone.pdf>
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<https://www.policyschool.ca/wp-content/uploads/2018/10/Social-Policy-Trends-Canada-Rents-October-2018.pdf>
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ASSESSING POLICY SUPPORT FOR EMISSIONS-INTENSIVE AND TRADE-EXPOSED INDUSTRIES

<https://www.policyschool.ca/wp-content/uploads/2018/10/Assessing-EITE-Policy-Winter-Dobson.pdf>
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TAX POLICY TRENDS: CANADIAN POLICY MAKERS CONSIDER RESPONSE TO U.S. TAX OVERHAUL

<https://www.policyschool.ca/wp-content/uploads/2018/10/Tax-Trends-US-Tax-Overhaul-Mintz-Bazel-Final.pdf>
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FISCAL POLICY TRENDS: ALBERTA'S GOVERNMENT SPENDING: HOW BIG A PROBLEM?

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<https://www.policyschool.ca/wp-content/uploads/2018/10/Progressive-Trade-Agenda-Stephens-final.pdf>
Hugh Stephens | October 2018

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SOCIAL POLICY TRENDS: HEALTH VERSUS SOCIAL SPENDING BY CANADIAN PROVINCIAL GOVERNMENTS

<https://www.policyschool.ca/wp-content/uploads/2018/09/Social-Policy-Trends-Health-vs-Social-Spending-September-2018.pdf>
Margarita Wilkins and Ronald Kneebone | September 2018

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<https://www.policyschool.ca/wp-content/uploads/2018/09/Fiscal-Constitution-Morton-final.pdf>
F.L. (Ted) Morton | September 2018