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The importance of a healthy telecommunications industry to Canada's high tech success

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Executive Summary

The importance of a healthy telecommunications industry to Canada's high-tech success serves as a follow-up to the study titled *Understanding affordability of consumer mobile wireless services in Canada* and aims to identify the cost drivers ('factors of production') for telecom companies in Canada. It does so in the context of a healthy industry, where companies can maintain investment levels required to deploy the up-to-date telecom network that underpins the digital economy. Key insights and conclusions from the study include:

- Canadian telecommunications providers (telcos)[1] spend approximately 5.3 percentage points more on capital expenditures (CapEx) as a percentage of revenue than comparison countries, due to higher factors of production largely driven by geography, scale, and spectrum costs
- The higher factors of production for Canadian telcos require higher EBITDA levels than comparison countries to maintain investment levels while keeping healthy free cash flows[2]
- Canadian telecom free cash flow yields, a measure of financial solvency (health), are 26% below the S&P 500 median, suggesting that Canadian telcos are not producing abnormal earnings
- An unhealthy Canadian telecom industry, where telcos lack adequate free cash flows to invest in 5G networks, would be unable to invest in 5G at the same pace as major trading partners[3]
- 5G infrastructure is expected to cost up to 70%[4] more than 4G, with the benefits mostly realized by the broader economy by enabling Industry 4.0
- US, China, South Korea, and other countries have invested in 5G, enabling them to move ahead in Industry 4.0 and potentially create significant advantages for their economies
- For Canada to maintain economic competitiveness against major trading partners, all stakeholders in the 5G ecosystem will need to cooperate

5G network infrastructure will be the backbone of Industry 4.0 as 5G will deliver a step change in connectivity through faster speeds, ultra-reliable communications, and the ability to connect one million devices per square kilometer. This will allow end-to-end digitization of physical assets and integration into a digital ecosystem marked by hyper-intelligent, autonomous devices.

The benefits of Industry 4.0 will likely be realized by the first-movers, making the timely deployment of 5G relative to major trading partners critical. However, timely deployment will come at a significant additional cost to telecom network operators. A recent report by CWTA and Accenture estimated $26 billion will need to be invested between 2020 and 2026 for 5G roll-out in Canada.

That kind of an investment will require a healthy telecommunications industry, with the cash flows that enable investment, and the regulatory conditions that incentivize investment. For participating telcos, it means having the financial strength (revenues, free cash flows) and network readiness (quality of existing infrastructure) to make future investments. For the overarching economy and regulatory environment, it means (i) having competition that spurs and supports innovation, (ii) transparent, predictable, and fair regulation for investment planning, and (iii) strong economic growth to support future cash flows.

Canadian telcos have historically played their part in ensuring a healthy industry by investing 40% more on CapEx as a percentage of revenue versus comparison countries. To maintain competitiveness, these players must continue to do so due to unique, unfavorable factors of production local to Canada (versus comparison country average), notably:

- 2X higher CapEx per wireless subscriber, due to higher population dispersion;
- 3X higher spectrum costs; and
- 80% smaller scale, resulting in lower purchasing power.

Canadian telcos need to maintain higher EBITDA margins in order to fund these higher capital investments. EBITDA margins alone are therefore not an adequate measure of the operational health of a capital intensive industry such as telecommunications. This report focuses on free cash flows as a metric of operational health, and finds that free cash flows for Canadian telcos are on par with comparison countries. This implies that after paying all operational and capital expenditures, telcos in Canada are left with the same amount of cash as peers.

To maintain this investment level in CapEx and spectrum, Canadian telcos will need to operate in an industry that supports healthy free cash flows through appropriate levels of competition and government intervention. If not, network investment in Canada is likely to suffer.

1. This report uses the term "telcos" to represent all telecommunications service providers, including those that are primarily Cable Companies, as long as telecommunications services is a major part of their business.
2. This report uses Levered Free Cash Flows, as represented by S&P Capital IQ throughout this document. It does not segment free cash flows further, or recalculate them to account for any reporting differences.
3. According to Cisco, 5G is the fifth generation of cellular technology. It is designed to increase speed, reduce latency, and improve flexibility of wireless services.
4. Source: GSMA's 5G-era Mobile Network Cost Evolution.

Broadly, PwC's research found three different models across geographies to fund network infrastructure investment:

1. The telcos invest through retail prices. The US is an example of this model, supporting facilities-based competition across both wireless and wireline with no direct government intervention in network deployment, leading the global roll-out of 4G, and heading towards 5G leadership (facilities-based competition model).
2. The government invests through taxpayer dollars, with direct government participation in designing, building, and operating communications networks, serving as a monopoly wholesale provider to service-based private players. Australia's lagging NBN is an example of this model (structural separation model).
3. Telcos charge mandated low prices through network sharing. Investment lags and the consumer and economy operate on a below par telecommunications networks. Introduction of service-based competition in Europe limited the incentives and ability of telcos to invest in 3G and 4G network technology, contributing to Europe lagging behind the US and Japan, despite leading in 2G (service-based competition model).

Based on this comparison, combined with the relatively higher factors of production in Canada and the potentially high cost of 5G deployment, facilities-based competition is most likely to incentivize and facilitate efficient network investment in Canada. As seen in the US, facilities-based competition supports a healthy telecommunications industry with strong and stable free cash flows determined by market forces.

However, all players in the 5G ecosystem - the regulator, Canadian telcos, and other beneficiary industries - will need to collaborate to keep pace with global trading partners in 5G deployment and Industry 4.0. Failure to keep pace could have a significant impact on Canada's high tech success – eventually affecting employment and GDP.

1. A healthy telecom industry

1.1 Definition of a healthy industry

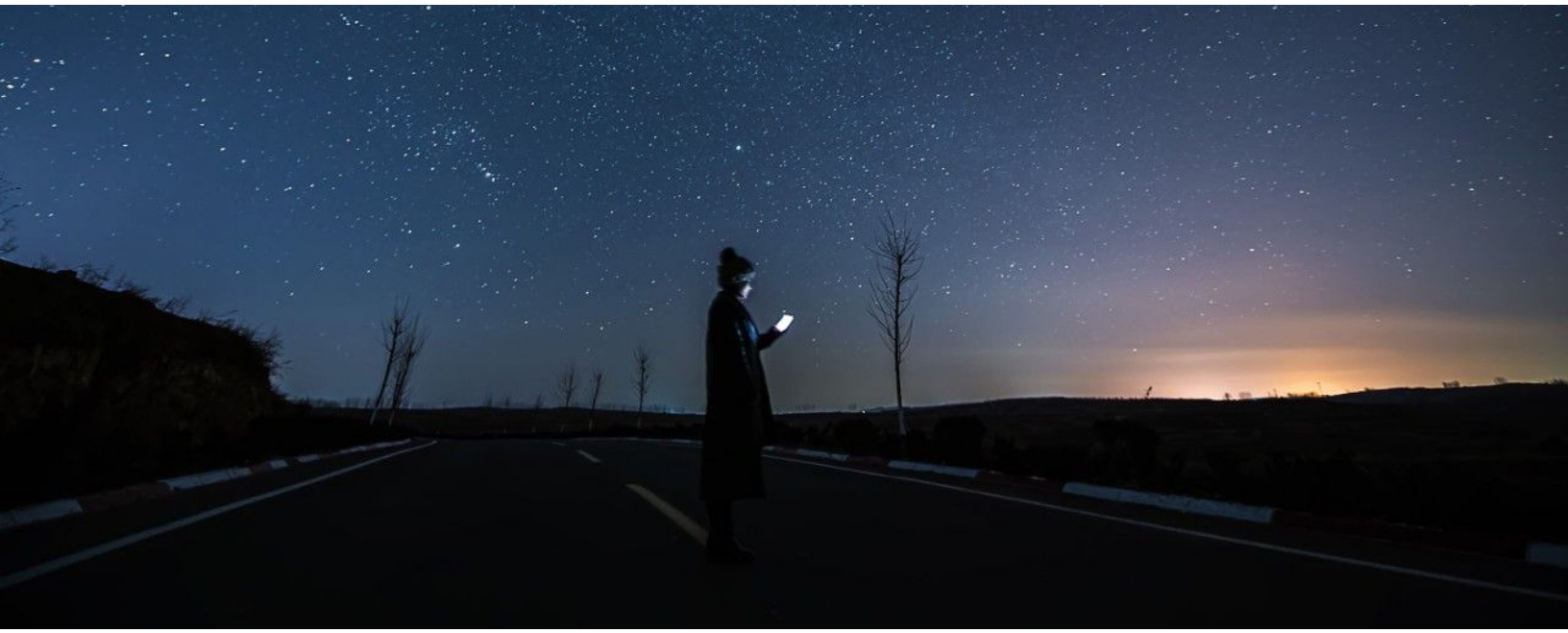
An industry can be understood as a combination of the participating firms, and the surrounding regulatory and market infrastructure. While the firms act as investment-makers and profit-keepers, the overarching market and regulatory environment creates the rules within which firms compete, thereby determining winners or losers and rewards or punishments. When determining the health of an industry, therefore, PwC defines it as a combination of the firms' health and the market's health.

Firms are considered healthy when they have competitive investment in infrastructure, a sustainable value proposition for consumers, and the financial strength to continue investing in the future. In the case of telecommunications, historical investment in technology and the quality of the existing network are reliable measures of existing infrastructure. Similarly, top-line revenues, free cash flows and ultimately return on investment determine the financial strength of the players.

Markets are said to be healthy if they offer appropriate incentives and structure to the players, so that the latter continue investing and their investments pay off as expected, with a certain level of predictability. One key component of this structure is a level of competition that is conducive to balancing the level of quality and innovation with consumer affordability. The second major component is transparent, predictable and fair regulations that support incumbents and entrants in a manner that is clear, stable, and reliable.

Collectively, a healthy telecommunications industry has the ability to fund the up-to-date network infrastructure required to support the technological success of the economy. Positive attributes of the firms and markets that make up a healthy telecom industry also enable the industry to achieve a high quality network that:

- meets consumer and business needs at an affordable price;
- supports the technology of the future;
- creates significant employment opportunities;
- brings in meaningful tax revenue for the federal and regional governments; and
- offers positive and stable returns for shareholders.

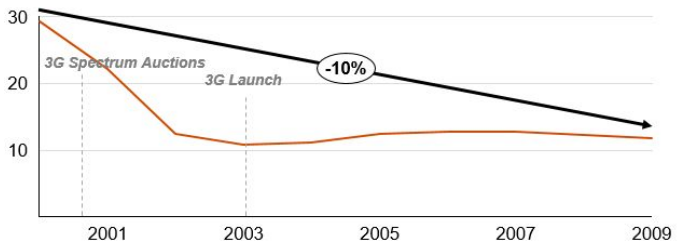


1.2 The impact of an unhealthy industry: The European 3G experience

While a healthy telecommunications industry would facilitate investment in future technology that would enable a modern economy to sustain its competitiveness and consequently the standard of living of its residents, an unhealthy telecommunications industry with unclear policies can be equally harmful to investment, adoption, and firms.

During the 2000s, a number of European regulators, including in Austria, France, Germany and Spain, incentivized service-based competition, i.e., encouraged the entry of new telecom operators who could purchase / lease network from incumbents at relatively low rates, and offer their services to consumers. Through mandated wholesale pricing or capacity sharing, regulators intended for service-based competitors, including Mobile Virtual Network Operators (MVNOs), to offer relatively inexpensive services to consumers and increase price-based competition in the market. This approach had mixed effects on pricing, but in most instances, reduced the average revenue per user (ARPU), directly impacting incumbent network operators' ability to generate free cash flows and invest in network infrastructure, i.e., in 3G (Figure 1).

Figure 1: CapEx as a % of revenues for large incumbent telcos - Europe (%, 2001-2009)



Source: Capital IQ for historical CapEx and Revenues of large incumbent telcos in Austria, Germany, France, Italy, Spain and the UK

Moreover, these regulators tied each technology generation to separate spectrum bands, forcing network operators to wait for a specific 3G auction, rather than being able to repurpose their 2G spectrum (as was the case in the US). This drove up investment in purchasing spectrum - roughly 190 billion USD was spent in the summer of 2000 alone on spectrum auctions, which forced many firms to take on excess debt. Heavily indebted and uncertain of the business case for 3G, many incumbents chose a slow deployment for this new technology, leading to a slow adoption - for both consumers and businesses. As a result, European 3G adoption lagged behind the US'. Although the UK entered the market early and had a lead on the US in 3G adoption rates between 2003 and 2008, by 2011, the US had 65% higher adoption than the UK[6].

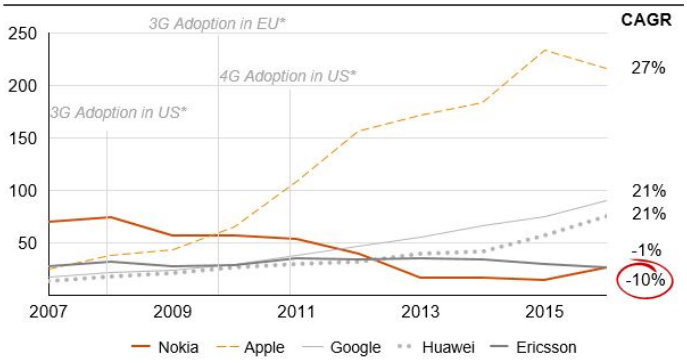
It also caused industry disruption. For example, 2,000 European business leaders signed a petition demanding governments in Germany, UK, France, Italy, and other European countries return the cash, and re-sell spectrum again in a cheaper and fairer way. Declan Ganley of Growth Plus, a European business association and a sponsor of the petition, was quoted saying: "Most of the spectrum winners are financing the auction fees by going to the capital markets. British Telecom, for example, is undergoing an initial public offering. Other spectrum auction winners have sought the cash on the bond markets. That money is dead money. It's not creating jobs. It's not funding the growth of new business".[5]

The impact of this mismanaged auction and reduced future investment affected adoption of 3G across Europe. Reduced investment in networks led to frequent latency, quality, and availability issues surrounding 3G, which slowed down user adoption. In contrast, the US launched 3G well after Europe and experienced instant adoption and rapid uptake.

Not only did the telecom industry face the consequences, but so did other related industries like wireless device manufacturers and software developers. In the 2G era, Nokia, a Finnish device manufacturer and software developer, was the leader in both these markets. However, the lag in 3G launch coincided with Nokia's decline in both revenues and market share. For example, Symbian, Nokia's operating system and computing platform, experienced a significant fall in market share from 63% in 2007 to 12% in 2011.[6]

In contrast, the US' uptake of 3G in 2007 allowed Google and Apple to access high quality networks earlier than their European counterparts, and utilize those to build flexible platforms with innovative functionalities that were more user-friendly, encouraging a consumer preference shift towards American manufacturers (Figure 2).

Figure 2: Revenues of large device and software manufacturers (Billions USD, 2007-2016)



Source: Macrotrends revenue data

5. Europe protests pricey 3G auctions, ZD Net, March 27, 2001
6. Recon Analytics: How America's 4G leadership propelled the US economy, Recon Analytics LLC, 2018

With the launch of 4G, mobile device content revenues increased and have remained high and stable, as consumers have shifted preferences from stationary (e.g., desktops) to instant consumption devices (e.g., mobile phones, tablets, smart watches).

However, Nokia never fully recovered its lost market position and was acquired by Microsoft in 2013. Unable to revive the once-iconic brand, in 2015, Microsoft wrote off USD 7.6 billion (which was greater than the acquisition price of USD 7.2 billion) from the Nokia deal and announced 7,800 job cuts.[7]

Europe's loss of technology leadership can be attributed to multiple factors including a lack of network investment, a lack of a unitary wireless market, the relocation of manufacturing jobs and innovation centers to the US, and the evolution to a software-driven ecosystem. However, the US' leadership can be attributed to its ability to build powerful smartphones, operating systems, and app ecosystems, which relied on the strength of the telecom networks. Having the right networks in place at the right time was critical to the US' technology sector – and came at the expense of its European counterparts, notably Nokia and Ericsson.

1.3 Benefits of a healthy industry in Canada: The 5G revolution

5G is expected to be the next big revolution in wireless services, benefiting consumers through high speeds, low latency, and its numerous IoT applications, while allowing industries to innovate at a rapid pace. Deploying 5G, however, requires an investment that may be significantly higher than was made in LTE deployment, a cost that will be largely borne by telecom operators. A prerequisite for timely 5G deployment would be a healthy industry, where operators have the financial strength (revenues and costs), and incentives to invest (regulatory policy).

In 2018, the Canadian Wireless Telecom Association (CWTA) commissioned a report which estimated that by 2026, Canadians will experience benefits of 5G[8] through:

- 40 billion CAD in annual additional GDP;
- 250,000 sustained jobs created through direct and indirect impacts of 5G; and
- 154,000 short-term jobs for network build-out.

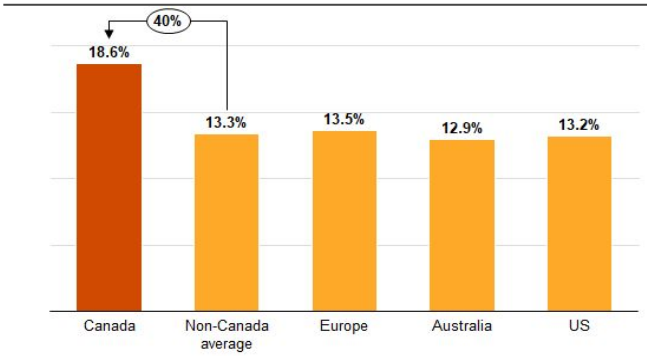
5G is also expected to have tremendous social benefits. Precision agriculture can reduce input prices by 32 CAD per acre of produce, and increase gains by 55 CAD per acre, creating 3.3 billion CAD in potential annual benefits, which can be passed on to consumers through reduced food prices. Telemedicine is expected to grow as rural and remote areas get access to 5G, allowing patients to get timely access to healthcare practitioners and improving health outcomes.[8]

Remote learning is expected to increase quality of education in areas where expert educators are not available, and to students who cannot travel to schools due to disabilities or household responsibilities, improving outcomes for communities with limited access. Intelligent transportation is expected to optimize driving, pedestrian, and other routes to reduce traffic congestion and the associated air and noise pollution.

5G success demands investment. Canadian telcos make higher infrastructure investments than international peers (Figure 3), with capital investment as a percentage of revenue being 40% higher than international peer telecom operators (2016-18 average). However, this investment needs to be supported by a market structure and regulatory environment that is conducive to innovation and rapid adoption of technology.

Further, the type of competition encouraged by regulations affects investment incentives to invest. Infrastructure-based competition directly incentivizes development of competitive infrastructure and increased access for users. On the contrary, service-based competition applies significant pressures on incumbents to develop infrastructure that is sufficient for all players in the economy (including those that utilize the incumbents' cell towers and other network equipment), although the returns would be split amongst all players - those that build network, and those that don't. This is likely to discourage investment by incumbents in the absence of other motivations to build more capacity, thereby applying downward pressure on network deployment.

Figure 3: CapEx as a % of revenues by large players representing domestic market per region (%, '16-18)



Source: Capital IQ for CapEx and Revenues of large incumbent telcos in Canada, Austria, Germany, France, the UK, Australia and the US

7. The Verge, Microsoft writes off $7.6 billion from Nokia deal, announces 7,800 job cuts, by Tom Warren, Jul 8, 2015
8. CWTA and Accenture: Fuel for Innovation, Canada's Path in the race to 5G, 2018

2. Factors of production: International comparison

2.1 Study framework

In order to understand what drives capital investment levels for telecom in Canada, PwC undertook a study into the different factors of production that impact the costs of producing telecommunications services in Canada. Multiple hypotheses around population density, regulation, scale, labour costs, and other factors are evaluated (See Table 1).

Table 1: Hypotheses around factors of production in Canada

Factor of production	Explanation of the factor	Expected impact on costs
Population density and dispersion	• Geographic area of network investment, relative to the population size	• Higher investment per subscriber to ensure coverage
Regulations	• Spectrum prices and licenses	• Higher investment in assets that may not correlate with the expected asset value
Scale	• Economies of scale to reduce input costs	• Higher input costs (notably, devices and network equipment)
Labour costs	• Cost of labour for capital projects and on-going operations	• Higher per unit labour costs, increasing project related expenses
Others	• Weather and extreme weather events • Insurances • Input costs (i.e. electricity costs) • Taxes	• Limited infrastructure development periods • Higher maintenance and insurance costs • Higher input costs (electricity etc.) • Higher tax burden

These factors were compared to a set of six other countries, some of which were identified in a previous report by PwC (titled: *Understanding affordability of consumer mobile wireless services in Canada*, December 2019), while others were added to compare against European countries, which have a significantly different regulatory environment. In doing so, a mix of countries was chosen to represent different sizes (population density) and regulations.

Table 2: Selected international comparison countries

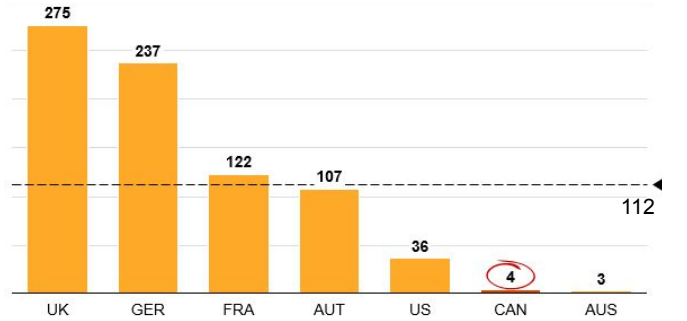
Country	Canada	Austria	Australia	France	Germany	UK	US
Region	North America	Central Europe	Australasia	Southern Europe	Central Europe	Western Europe	North America
Total Population (in millions)	38	9	25	67	83	67	329
GDP per capita (2016 USD PPP)	$49,651	$51,592	$52,373	$42,878	$47,662	$45,705	$62,606
GINI coefficient (measure of inequality)	34	31	35	33	32	34	42

Source: World Economic Outlook Database - International Monetary Fund, Australian Bureau of Statistics, Statistics Canada, United States Census Bureau, Office for National Statistics - UK, WorldAtlas, World Bank

2.2 Population density and dispersion

A large part of telecom success relies on pervasive network coverage and access to the latest technology across the subscriber base. Serving a smaller geographic area with a densely populated subscriber base offers higher returns on network infrastructure. However, operators in countries like Australia and Canada face a significant challenge in serving a small population spread across a large landmass. In contrast, most European operators have relatively small countries with a much higher population density (Figure 4).

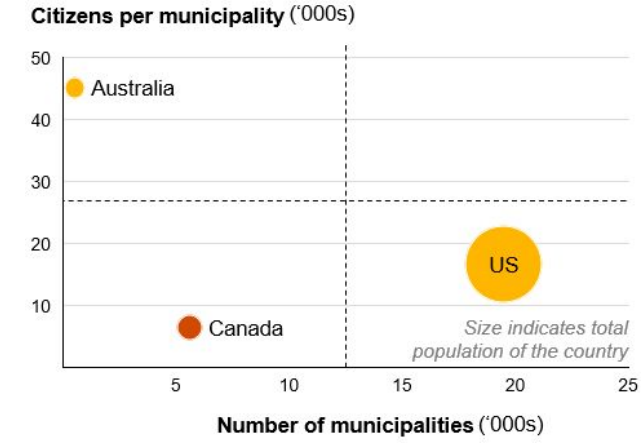
Figure 4: Population density based on total land area (Individuals per square kilometer, 2018)



Source: The World Bank, World Development Indicators, Population density 2018 (people per sq. km of land area)

The chart above includes parts of these countries that are not populated at all, particularly for Canada and Australia. However, another metric, population dispersion takes that into account, and only further highlights the low population density problem. Australia is marked by a few large, densely populated towns, which can be more easily served with fewer towers and less fibre. On the contrary, Canada has multiple small towns dispersed across its geography, which all need to be served by a dispersed network infrastructure. (Figure 5)

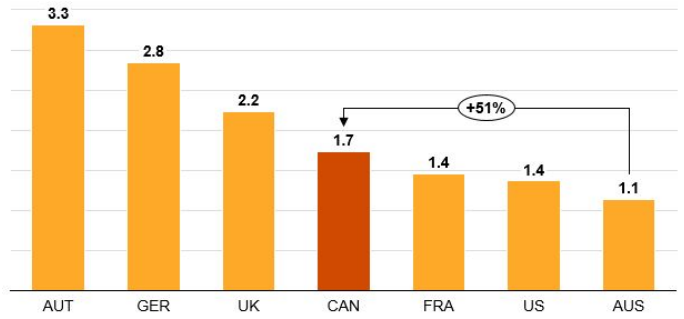
Figure 5: Average population concentration per city and town (Individuals per city, 2016)



Source: Australia Bureau of Statistics, Australian Local Government Association, Statistics Canada, United States Census Bureau

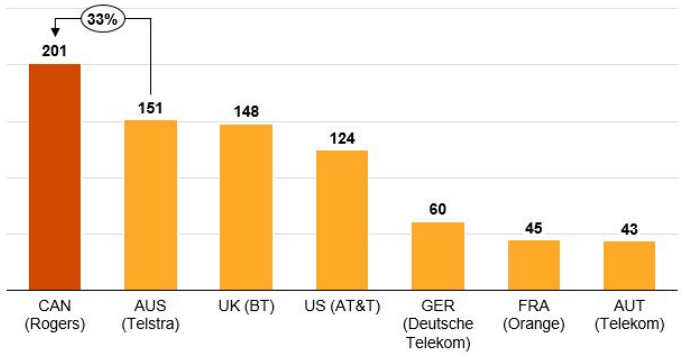
The higher population dispersion has led Canadian telecom operators to build approximately 50% more cell towers per capita compared to Australia (Figure 6), resulting in the need to invest 33% more on capital (excluding spectrum) per wireless subscriber (Figure 7). To compare CapEx between countries, the report uses one telco per country with a large market share in order to avoid, to the extent possible, the impact of complex international operations on a country-specific industry analysis.

Figure 6: Cell towers per 1,000 people (Number of towers, 2019)



Source: Cellmapper.net (all network types) - as in December 2019, World Bank

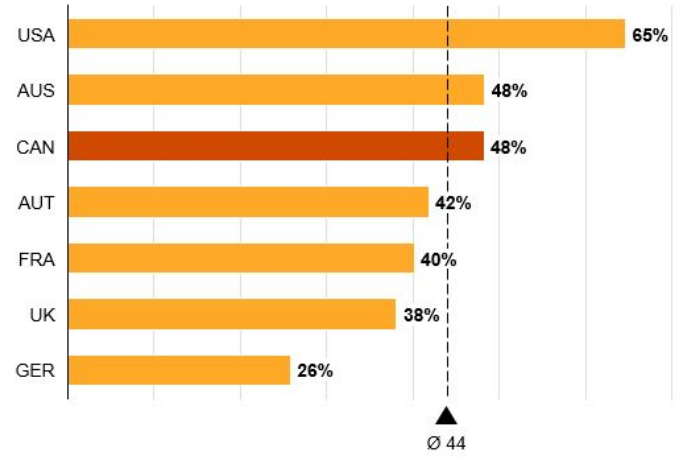
Figure 7: CapEx per wireless subscriber - 1 large representative telco per country (USD, 2018)



Source: Computations on data from Capital IQ

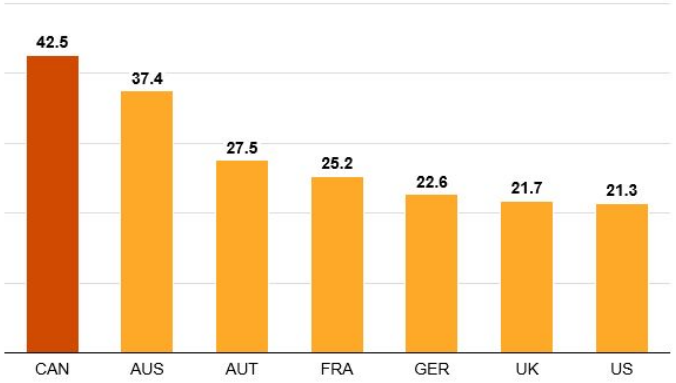
Along with maintaining a comparable base of cell towers per capita, Canadian telcos have been able to develop and maintain some of the most up-to-date towers. According to Cell Mapper's consumer-reported data, 48% of Canada's cell towers were 4G / LTE towers, which is equivalent to those in Australia, and only second to the US (Figure 8). Meanwhile, the European countries explored had more cell towers per capita but had significantly fewer that support 4G / LTE, which are capable of a higher quality of service. Notably, on the metric of download speeds, Canada performs best amongst comparison countries, despite its population dispersion (Figure 9).

Figure 8: 4G / LTE towers as a % of total towers (% of total towers, 2019)



Source: Cellmapper.net (all network types) - as in December 2019

Figure 9: Download Speeds (Mbps, 2019)



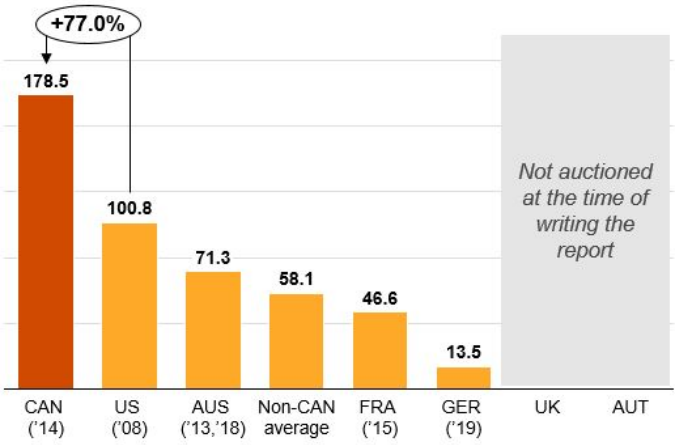
Source: Open Signal

2.3 Regulation: Spectrum

Wireless spectrum forms a significant cost to telcos, both in the form of a one-time fees paid at auction, and as an ongoing license cost. Spectrum fees act as a tax paid to the government that allows usage of specific spectrum bandwidths. This affects the cost structure of telcos and ultimately is reflected in the price of wireless service for the consumer. Canada has the highest spectrum costs across comparison countries, as a result of factors including the bidding process, and the auctioning authority's decision to limit availability. In order to encourage entrants, the regulator, government, and auctioning authorities restrict the incumbent network operators' bandwidth access to a certain proportion of the total available, setting aside the remaining to be distributed amongst new entrants at a lower cost. This scarcity increases prices. During the 2014 auction of the 700 MHz bandwidth, Rogers alone paid nearly 3.3 billion CAD for 12 MHz of paired bandwidth, which is about 3.5 CAD per MHz per unit population served[9], one of the highest paid globally.

PwC compared the price paid across spectrum auctions globally for the 700 MHz spectrum to estimate what it costs telcos to cover a citizen. Canadian telcos paid around 179 USD per capita in 2014, as compared to US telcos that paid around 100 USD. The UK and Austria have yet to auction this bandwidth, but the non-Canadian average excluding these countries is around 60 USD, around a third of the Canadian price (Figure 10). This trend is largely consistent across spectrum auctions.

Figure 10: USD spent on spectrum per person covered – 700 MHz (USD, varying years)



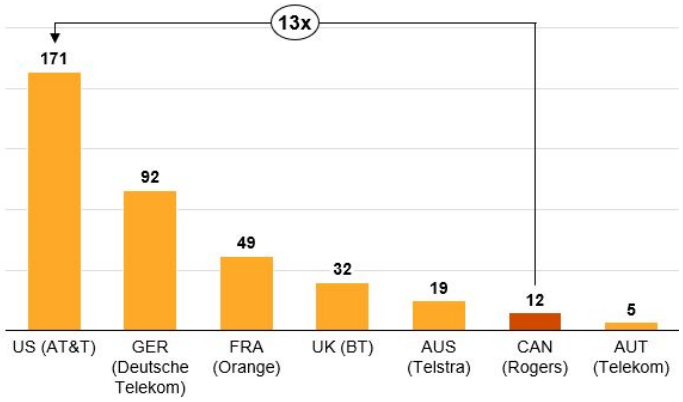
Source: Computations on Spectrum auctions database from Policy Tracker

9. Based on computations on data provided by Policy Tracker

2.4 Economies of scale

Economies of scale in terms of subscriber-base or the size of a telco generate efficiencies, including bargaining power with suppliers of goods and services. When compared to peer companies in other countries, the three largest telcos in Canada (Rogers, Bell, and TELUS) are smaller than the largest representative firms in comparison countries. In fact, AT&T, which represents the US in this study, is approximately 13 times larger than Rogers (Figure 11).

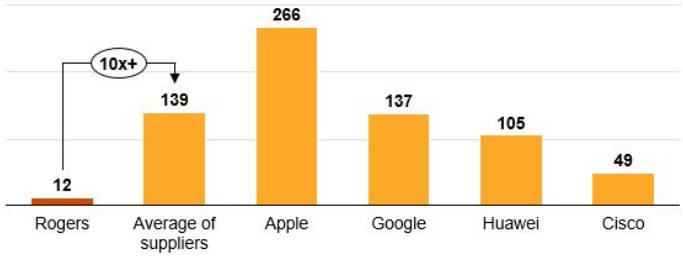
Figure 11: Large representative telcos' total revenues by country (Billion USD, 2018)



Source: Capital IQ, OECD exchange rates

Moreover, Canadian telcos are significantly smaller than the suppliers they rely on for key products and services. These include network-related suppliers like Cisco and Huawei, and device suppliers like Google, Samsung, and Apple. A smaller size results in lower bargaining power, which often results in higher costs for key inputs, or harsher contractual terms. (Figure 12)

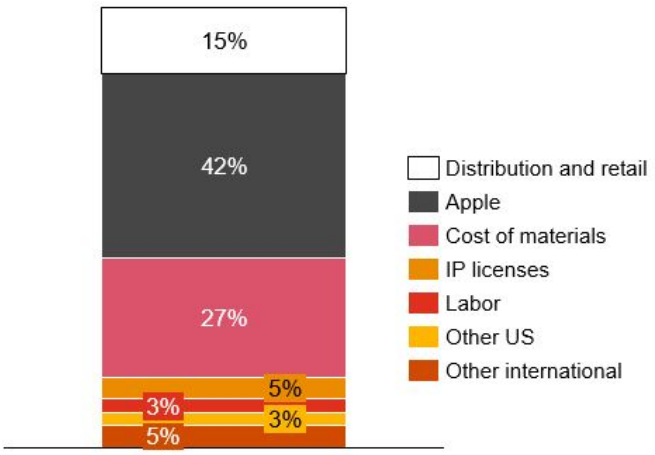
Figure 12: Rogers' revenues vs. likely suppliers' revenues (Billion USD, 2018)



Source: Capital IQ, OECD exchange rates

Notably, a study conducted by the World Intellectual Property Report in 2017 broke down the price of an iPhone 7 into the cost of materials, IP licenses, labour and other international costs, and the value retained by Apple in the US.

Figure 13: Value captured at each stage of the chain as a % of smartphone sale price – iPhone 7 (% of price, 2017)

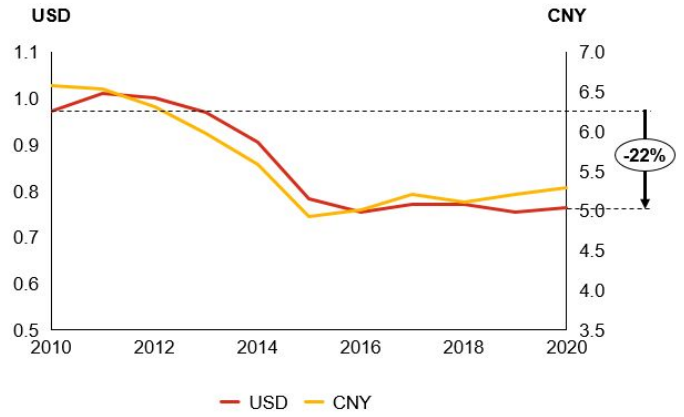


Source: Computations on data from the World Intellectual Property Report 2017 - Intangible Capital in Global Value Chains

As seen in Figure 13, Apple captured 42% of the price of an iPhone 7 (device only) as gross profit margins - the value of the device to Apple. Only 15% was captured in distribution and retail, which includes international distribution, inter-country distribution, as well as business-to-consumer distribution and retail activities. This highlights that telcos capture a small proportion of the price of the device, as their bargaining power against Apple is limited. Notably, North America has 24% higher penetration of more expensive iPhones than Europe, increasing the average device cost. Numerous factors including device subsidies and consumer preference could be responsible for this trend.

A key driver of device prices in Canada, and other network-related supplies, is Canada's depreciating exchange rate relative to the US and China, which not only has a direct impact on prices, but is often indirectly built into long term B2B contracts between telcos and suppliers. Over the last 10 years, between 2010 and 2020, the Canadian dollar has depreciated by around 20% as compared to both the US dollar (USD) and the Chinese Yuan (CNY) (Figure 14).

Figure 14: CAD vs. USD and CNY (Annual average, CAD, 2010-2020)

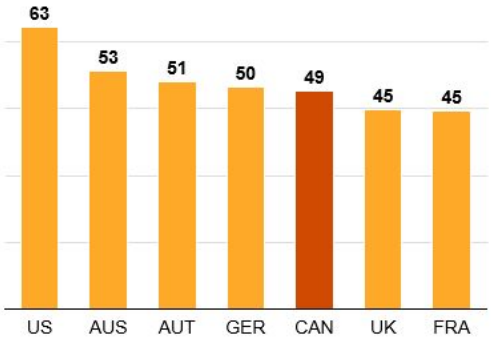


Source: Excel rates, using historical exchange rates from the European Central Bank

2.5 Labour costs

Labour costs directly impact the network infrastructure build-out costs for telcos, along with affecting day-to-day operating expenses. Sector-wise data on labour costs is not internationally available, but based on average wage in the economy, it appears that Canadian telcos may be benefitting from relatively lower average wages (USD PPP). While these may not be entirely representative of wages in infrastructure construction or telecom, more generally, they are the closest internationally available benchmark (Figure 15).

Figure 15: Average wage ('000 USD PPP, 2018)

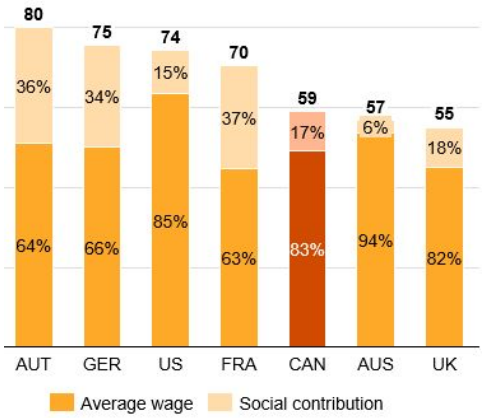


Source: OECD Statistics data

Another key component of labour costs is the social security contributions made by employers and employees. While European telcos benefit from relatively lower wages, they do end up paying significantly more in social security contributions. Consequently, overall labour costs also tend to be lower in Canada than in most of the comparison countries (Figure 16).

Labour costs affect both operating expenses (through day-to-day contribution of labour) and capital expenses (through labour hired specifically during capital infrastructure development). Based on our understanding, lower total labour cost is unlikely to offset the overall impact of the factors previously discussed in this report.

Figure 16: Total annual labour cost ('000 USD PPP, 2017-18)



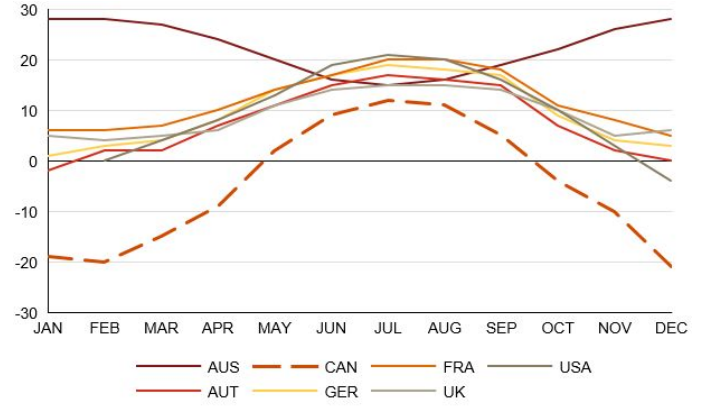
Source: OECD Statistics data

2.6 Other factors: Weather, electricity, tax

While labour costs in Canada are generally lower, Canadian telcos face a unique challenge - during parts of the year, parts of Canada experience extreme cold, to the extent that underground construction work needs to be halted. This means that any underground fibre that needs to be laid for wireline or wireless (backhauling), can be done only during those parts of the year that are conducive to construction. This may result in higher labour costs during peak construction period.

Average temperatures in Canada can be a good indicator of such parts of the year. On average, Canada has only 5-8 months of above-freezing temperatures in a year, depending on geography. On the contrary, every other country compared in this report experiences above freezing weather for the majority of the year (Figure 17).

Figure 17: Average monthly temperature (°C, 2016)



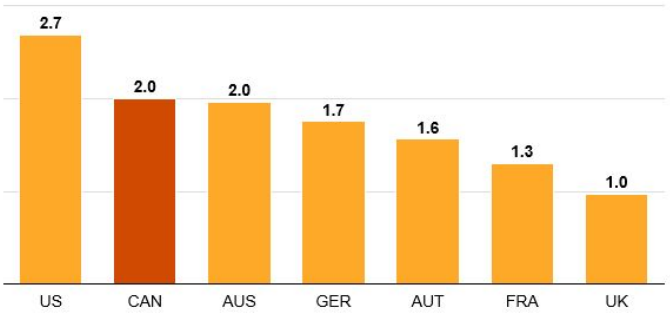
Source: World Bank

Further, Canada experiences high catastrophic losses as a result of extreme weather events. Canada recorded a total of 2 billion USD in catastrophic losses triggered primarily by windstorms, hail storms, and flooding in 2018 alone.[10] As a result, non-life insurance premiums per capita in Canada are one of the highest in the world, only second to the US, and somewhat comparable to Australia (Figure 18).

Another factor that impacts telecom factors of production is electricity costs. Canada has good availability of low-cost hydroelectricity. European countries are at a relative disadvantage in electricity costs, paying some of the highest electricity prices. Unfortunately, comparable data for Australia was unavailable at the time of the research (Figure 19).

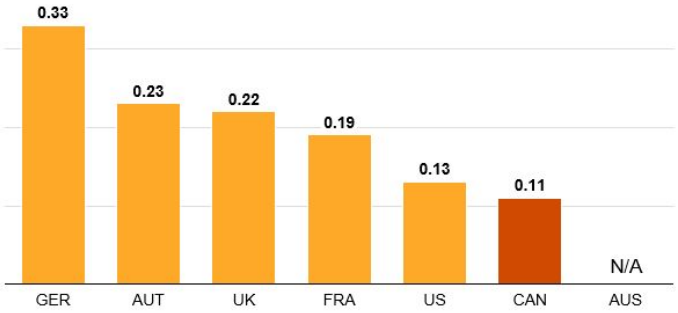
Finally, the corporate tax rate in Canada is comparable to the peer group at just near the average of 27%. The Statutory Corporate Tax Rate is usually defined as a combination of the Federal, State / Provincial, and local tax on corporate income.

Figure 18: Non-life insurance premiums per capita ('000 USD, 2018)



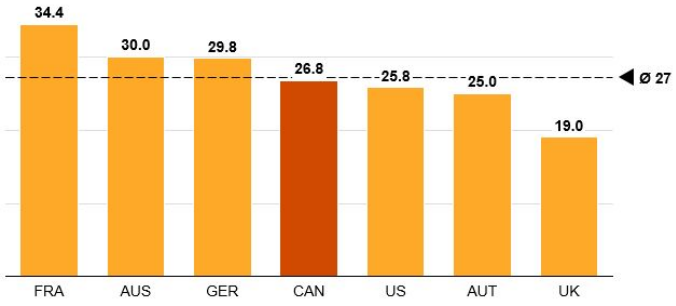
Source: Swiss Re Institute

Figure 19: Electricity prices (USD per kWh, 2018)



Source: World Energy Council

Figure 20: Statutory corporate tax rate (%, 2018)



Source: OECD Statistics data

10. Insurance Bureau of Canada

2.7 Overall Impact

Population density and dispersion, or the implied cost of coverage, spectrum costs, and scale are likely to have the largest impact on the factors of production for network investment, while labour costs, weather, electricity prices and corporate tax rates have a relatively smaller impact. Therefore, when considering all factors, and weighting coverage, spectrum, and scale relatively more heavily, Canada ranks as having the highest factors of production for network deployment versus comparison countries.

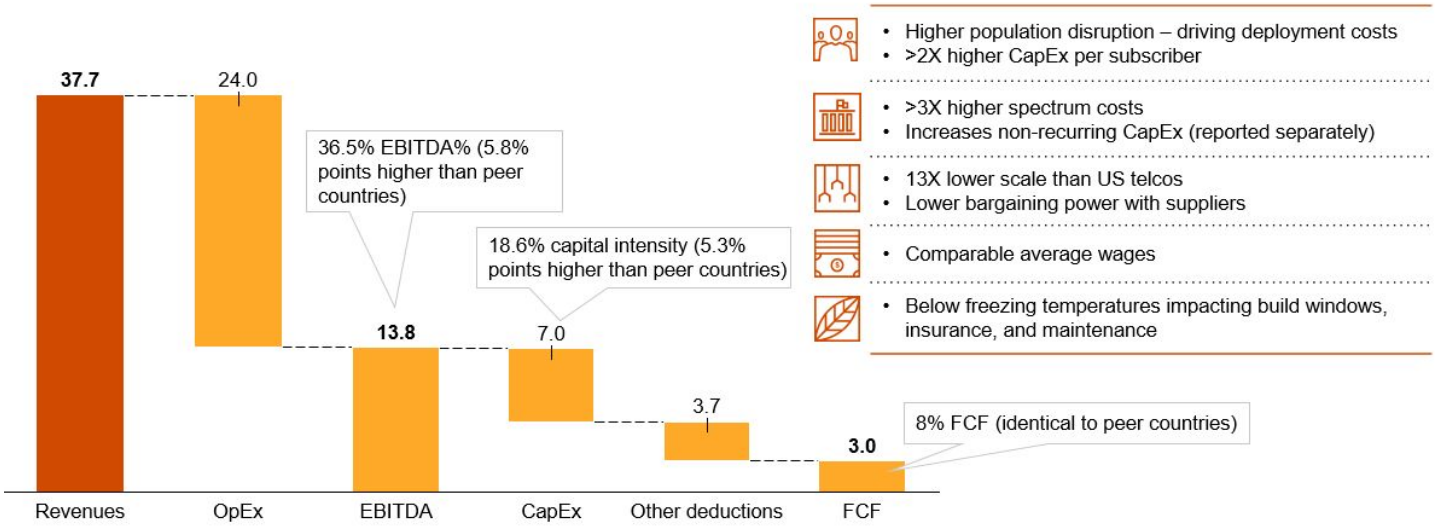
Table 3: Summary of the international comparison of factors of production

	Primary			Secondary				Highest to lowest adverse impact on costs	
	Implied cost of coverage	Spectrum	Scale	Other					
	The implied cost associated with connecting the population (notably, population dispersion)	*The cost associated with spectrum purchases*	*The scale companies have to leverage economies of scale*	*Average wages*	*Impact of weather*	*Corporate tax*	*Electricity price*	Total impact	Rank
CAN									1
AUT									2
AUS									3
FRA									4
USA									5
UK									6
GER									7

Unfavorable — *Favorable*

Canadian telecom capital expenditure as a percentage of revenue is 5.3 percentage points higher than telcos in comparison countries. 'Other deductions', which include spectrum, are also higher due to higher factors of production in Canada. As a result, Canadian telcos maintain 5.8 percentage points higher EBITDA as a percentage of revenue than comparison countries to maintain on par free cash flows. This implies that Canadian telcos need to maintain either higher prices or higher operational efficiency, or a mix of both, to maintain higher EBITDA percentages than comparison countries to maintain on par free cash flows.

Figure 21: Free cash flow bridge for Canadian telcos (Total of top 3 players, CAD, 2016-18 Average)

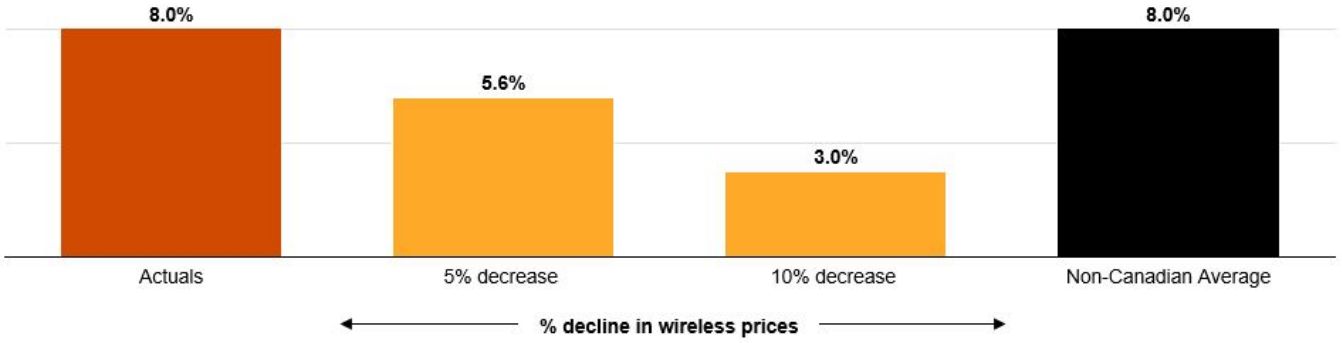


Source: Capital IQ

Notably, a 5.0% decrease in Canadian wireless revenues, would result in free cash flow as a percentage of revenue for the Canadian telecom industry of 5.6%. This is well below the average of comparison countries at 8.0% free cash flow as a percentage of revenue, and well below the US' 8.8% free cash flow as a percentage of revenue (Figure 22).

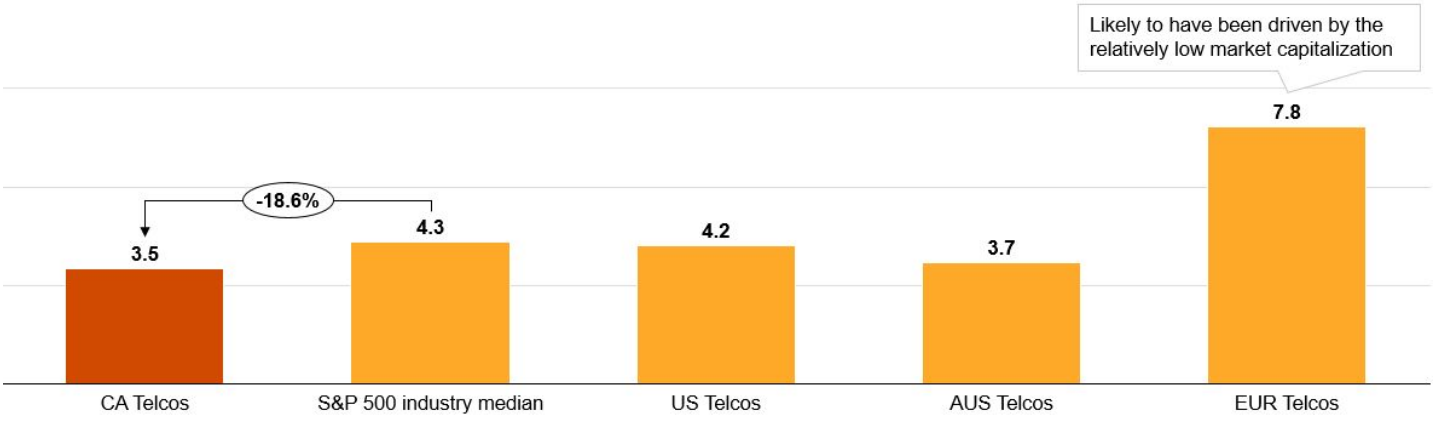
A commonly used metric while analyzing and comparing companies is free cash flow yield, a measure of financial solvency. Quantitatively, this metric is a ratio of the free cash flows made by the firm to its market capitalization. The S&P 500 average across industries for free cash flow yield is 4.3%, 26% higher than the average for Canadian telcos over the past 5 years. Notably, the Canadian average is also lower than that of comparison countries. This suggests that existing Canadian free cash flows are not comparatively high (Figure 23).

Figure 22: Variation in free cash flow as a % of revenues (%, 2016-18 Average)



Source: Capital IQ

Figure 23: Free cash flow yield (Canadian vs. S&P 500 5-year averages vs. comparison country telcos)



Source: Capital IQ, Siblis Research

3. Global comparison of telecom health

3.1 Who pays for network infrastructure?

Broadly, PwC's research has noted three different models used across geographies outside of Canada, to determine who pays for network infrastructure.

The first scenario involves direct government participation in designing, building, and operating telecommunications networks, serving as a monopoly wholesale provider to service-based private players, i.e., structural separation. Australia is an example of this approach, where the National Broadband Network (NBN) is the government-owned wireline network. While it offers low-cost nationwide coverage to consumers, it has already exceeded budgets by 25% and has low probability of becoming profitable and self-sufficient in the coming years.

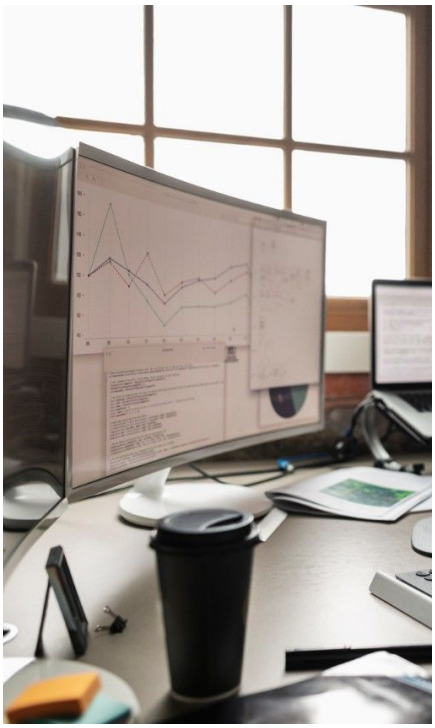
The second alternative involves heavy regulatory intervention through service-based competition, resulting in insufficient incentives and cash flows to keep pace with technology generation roll-outs. A number of European countries have adopted this approach, where pro-MVNO regulations and unsupportive spectrum policies have historically reduced the incentives and ability of operators to invest in network infrastructure. This has, in turn, resulted in Europe going from being a technology leader during the 2G era, to lagging in 3G and 4G.

Finally, the third alternative is letting consumers pay for network investment through retail prices. The US has followed this approach in both its wireline and wireless markets, with facilities-based competition and no direct government intervention. Network operators compete according to market forces, and commercially negotiating access to service-based providers.

In any of these situations, network infrastructure does not come for free - consumers pay either through tax-dollars, through poor network quality, or through high retail prices. However, each alternative has resulted in different outcomes for the players, consumers, and the overarching economy.

3.2 Consumers pay for network investment through tax dollars: NBN in Australia (Structural separation)

The Australian telecommunications regulatory framework focuses on wireline and wireless services. Historically, Telstra, the dominant player in the country, owned the wireline network. However, this changed with the introduction of the National Broadband Network, or the NBN, when the Australian government purchased all of Telstra's wireline network, and placed itself as the monopoly infrastructure-based player. All operators in the country were required to purchase wireline services from the NBN at low wholesale rates, and pass that on to consumers through a service-based competitive model.



The NBN was intended to be a government promise to deliver 'super fast' national broadband to over 90% of Australian homes. Under the NBN Co corporate plan, it was estimated that the NBN would require 27.5 billion AUD in government equity and 13.4 billion AUD in debt funding. By 2019, the NBN had already cost 51 billion AUD, around 25% above the original government estimates.[11] Notably, the NBN's leadership has admitted that current ARPUs are not generating sufficient revenue for a positive return on investment.

The NBN also failed to deliver on its promise of 'super fast' speeds. The Speed Test Global Index for January 2020 revealed that the average fixed broadband download speed in Australia was 42.2 mbps, which is over 65% lower than that in Canada (124.6 mbps). Similarly, the average upload speed was 19.1 mbps, which is 63% lower than that in Canada (51.8 mbps). While the NBN delivered on the commitment to provide fixed broadband access to close to 90% homes, the majority of homes now experience significantly lower speeds than most of the developed world.

11. New York Times, June 2011; ABC News, August 2018

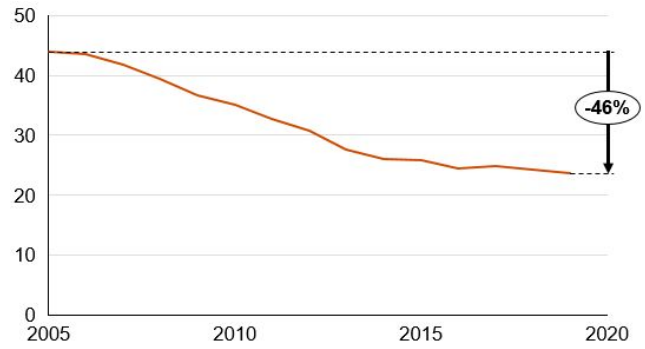
3.3 Consumers don't pay, and network investment lags: European Regulations (Service-based competition)

Europe was a world leader during the 2G era, with around 80% 2G penetration by the mid-1990s[12] - being ahead of the network technology adoption curve allowed the region to incubate and grow national technology champions like Nokia and Ericsson.

However, in the early 2000s, the European Commission recommended countries open up to Mobile Virtual Network Operators, or MVNOs, that could leverage networks built by incumbents and purchase / lease network access. Around the same time, European regulators limited 3G use to those incumbents that re-purchased spectrum at an auction that turned out to be one of the most expensive bandwidth sale, globally.

As described in section 1.2, expensive spectrum, price competition from MVNOs, and low incentives to invest in network infrastructure reduced the ability and incentives for incumbent telcos to fund the capital required to keep pace with the US in 3G network deployment. This slowed down infrastructure development with Europe continuing to lag behind the US through the 4G network deployment era. Thus, while consumers accessed low cost services as a result of service-based competition, they paid through poor network quality.

Figure 24: Wireless ARPU - Europe (€/month, 2005-19)



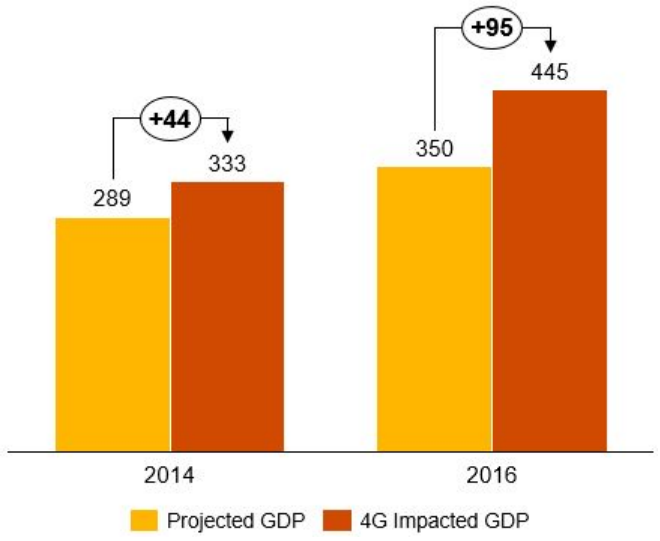
Source: GSMA Intelligence

3.4 Consumers pay for network investment through retail prices: US' 4G Leadership (Facilities-based competition)

The stated objective of the US telecommunications regulation is "to provide for a pro-competitive, de-regulatory national policy framework designed to accelerate rapidly private sector deployment of advanced information technologies and services to all Americans by opening all telecommunications markets to competition."[13] This objective is enacted through a pro-competition framework focused on facilities-based competition. While MVNOs exist in the US, these service-based operators only access network capacity through commercial negotiation processes.

The US' flexible, pro-business, regulatory regime, along with flexible spectrum policies, allowed operators to repurpose spectrum for future technology generations as the need developed and the technology was available. This helped US-based network operators to accelerate their shift from 2G to 3G, and from 3G to 4G where the US took a global leadership role. The most advanced network globally had a significant impact on the US economy. It is estimated that the economic benefits of 4G leadership to the US economy was 44 billion USD of increased GDP in 2014, and 95 billion USD in 2016.[14]

Figure 25: GDP impact of 4G leadership for the US (Billion USD, 2011-2016)



Source: Recon Analytics

12. Recon Analytics, 2018
13. Congress.Gov, 104th Congress, (1995-96), H.Res.353
14. Recon Analytics, 2018

4. Future implications of a healthy telecom industry

4.1 Industry 4.0 and the benefits of 5G

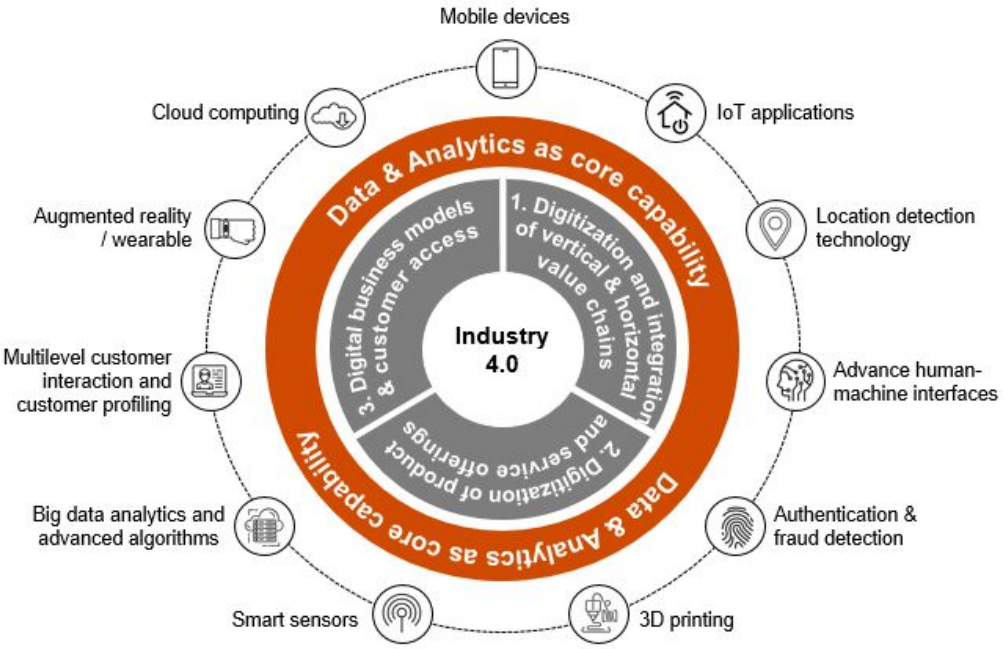
5G is expected to be a step change in connectivity. From a technology perspective, as compared to 4G, 5G is expected to:[15]

- Be 20x faster
- Have 10x lower latency, of about 1 ms, offering ultra-reliable communication
- Enable 10x higher traffic capacity, enabling hyper-densification
- Enable 10x higher connection density, connecting up to 1 million devices per square kilometre

These step changes in technology are expected to deliver significant economic and social benefits. Economic benefits are forecasted to be 40 billion CAD in incremental annual GDP contribution to the Canadian economy by 2026 as well as around 250,000 additional permanent jobs.[16] Social benefits are forecasted to include better healthcare and wellbeing, enhanced infrastructure, higher innovation, sustainable cities and communities, and higher employment.

A lot of these benefits will be realized through 'Industry 4.0', that is, the fourth industrial revolution. The first industrial revolution occurred between 1760 and 1820, which marked the transition from hand production methods to machines. The second revolution, better known as the technological revolution, took place between 1870 and 1940 and was marked with faster transfer of people and ideas, enabled by the telegraph and railways. The third revolution occurred in the late 20th century after the two world wars, was also known as the digital revolution, and was enabled through extensive use of computers. Industry 4.0 is expected to enable end-to-end digitization and automation of physical assets, creating a step change in productivity and innovation.

Figure 26: PwC's Framework for Industry 4.0



Source: PwC Strategy&

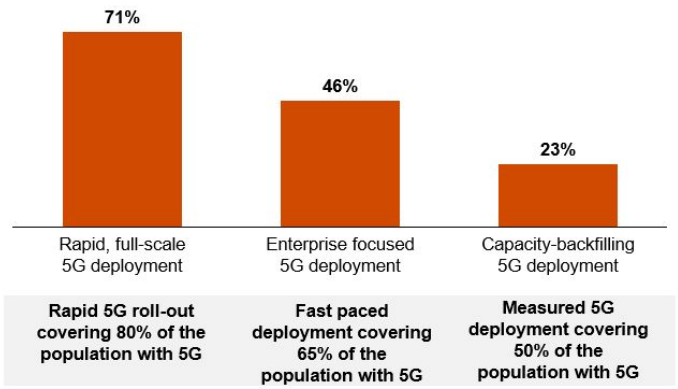
15. PwC Strategy& research
16. CWTA and Accenture: Fuel for innovation

The use cases for Industry 4.0 are spread across the major economic sectors in the Canadian economy, including production, manufacturing, and freight.

For example, production asset management could benefit from maintenance alerts through a combination of artificial intelligence, machine learning and predictive analytics. Further, IoT (Internet of Things) sensors could be used to control production assets and take asset readings. Manufacturing operations could be optimized through machine learning to enable adaptive decision.

5G networks, a key enabler of Industry 4.0, is expected to cost Canadian telecom operators anywhere between 23% to 71% more than 4G networks, largely driven by increased radio access network (RAN) infrastructure and energy requirements (Figure 27).

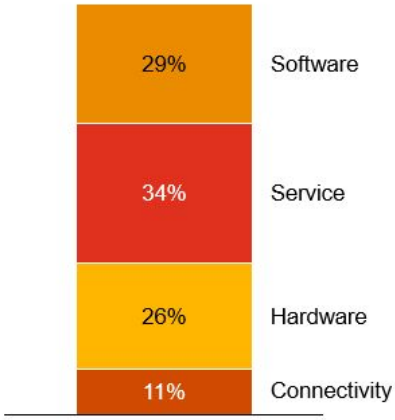
Figure 27: Total cost of ownership (TCO) of 5G vs. 4G (%)



Source: GSMA

Compounding the impact of these higher costs, the majority of the benefit of 5G is expected to be realized by the Canadian economy in aggregate, and not by the telecommunications sector. Connectivity is only expected to account for 11% of the direct value generated from 5G, with the remaining direct value being split between services (34%), software (29%), and hardware (26%) (Figure 28).

Figure 28: Value of 5G along the digital value chain (%, by 2026)



Source: IDC, Strategy& analysis

Based on PwC's work with the World Economic Forum (Table 4) on the deployment, market size, and use cases of 5G, deployment requires an ecosystem approach due to the economics of a 5G roll-out; the ecosystem must bring together relevant stakeholders and encourage collaboration. The 5G stakeholder roles and challenges table below (Table 4) represents the need for stakeholder collaboration and alignment throughout the ecosystem. Stakeholders identified are grouped into four categories - (1) regulators and policy-makers, (2) enterprises, organizations, and associations, (3) service and technology providers, and (4) public-private partnership organizations. It is imperative for the roll-out of 5G that all four of these stakeholders work together to support the deployment of 5G and enable Industry 4.0.

Table 4: 5G - Key stakeholders and expected challenges

Component	Regulator	Enterprise / Associations	Service / technology providers	Public-Pvt. partnership organizations	Challenges
Spectrum: across high and low band for 5G	✓	✓	✓		• Local permits and planning for spectrum usage • Auctions and high fees for spectrum procurement • Fragmentation during allocations of spectrum
Infrastructure: coverage, bandwidth, latency and reliability	✓	✓	✓	✓	• Fiber backhaul: capacity, availability, cost, and reach • New funding models for fiber deployment/ownership • Small cell deployments: local permits and planning
Devices: connected devices in multiple forms, supporting high performance needs		✓	✓		• Availability of devices compatible with local spectrum allocation and in line with harmonized global standards • Lack of clear roadmap for device manufacturers
Services: competitive network providers supporting B2B needs (not just subscribers) through the right partnerships	✓	✓	✓	✓	• Standards related to data cross-border exchange • Use cases arising from integration with new technologies (artificial intelligence, big data, internet of things) • Lack of incentives for cross-industry collaborations • Skills upgrade of service provider resources
Security: end-to-end secure infrastructure for complete transition of activities to 5G	✓		✓	✓	• Security of personal data collection • Device vulnerability • Network data transmission vulnerabilities

Source: The Impact of 5G: Creating New Value across Industries and Society - PwC Strategy& and World Economic Forum

Notably, countries that are moving first in 5G network deployment have done so with regulatory cooperation. For example, the US and South Korea first launched 5G between 2018-2019, firstly through pilots and then with commercial roll-out. In addition, China launched trials in 2019.

The US', South Korea's, and China's regulators all focused on an early distribution of 5G spectrum, allowing network operators to deploy 5G early. Further, these governments have encouraged early 5G deployment. For example, the US' 5G Fast plan focuses on streamlining 5G regulation to focus on three strategic objectives: (1) making more spectrum available, (2) updating infrastructure policy, and (3) updating regulations. Most notably, efforts are being made to free up spectrum for licensed auctions and use. The South Korean government has offered tax credits to any mobile operators investing in 5G networks until 2020. The government has also allocated 35% of its R&D budget to 5G equipment, particularly supporting small and medium-sized businesses.

For Canada to maintain competitiveness against major trading partners such as the US, South Korea, and China, all stakeholders in the ecosystem - telecom operators, the regulator, the government, software and hardware manufacturers and other industries, as well as consumer support organizations, will need to cooperate to create a market environment that enables 5G network investments, and Industry 4.0.

Study limitations

Receipt of new data or facts: PwC reserves the right at its discretion to withdraw or make revisions to this report should we receive additional data or be made aware of facts existing at the date of the report that were not known to us when we prepared this report. The findings are as of January-February 2020 and PwC is under no obligation to advise any person of any change or matter brought to its attention after such date that would affect our findings.

By its nature, forward-looking information used in this report will not occur as forecasted and unanticipated events and circumstances may occur that may materially alter our assumptions. We have not undertaken any review of whether the future-oriented data provided comply with existing standards, such as those issued by the CPA Canada or any other relevant accounting body.

Data limitations: PwC has relied on the information sourced from OECD, World Bank, Recon Analytics, World Economic Forum, Government of Canada, CWTA, Statistics Canada, Capital IQ, Policy Tracker, among others. PwC has relied upon the completeness, accuracy, and fair presentation of all information and data obtained from participating business and the various data sources, which were not audited or otherwise verified. The findings in this report are conditional upon such completeness, accuracy, and fair presentation, which have not been verified independently by PwC. Accordingly, we provide no opinion, attestation or other form of assurance with respect to the results of this study.

This report and related analysis must be considered as a whole: Selecting only portions of the analysis or the factors considered by PwC, without considering all factors and analysis together, could create a misleading view of our findings. The preparation of our analysis is a complex process and is not necessarily susceptible to partial analysis or summary descriptions. Any attempt to do so could lead to undue emphasis on any particular factor or analysis.

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