Executive Summary

Key Cost Drivers of Mobile Wireless Services in Canada: Implications for Pricing

Christensen Associates

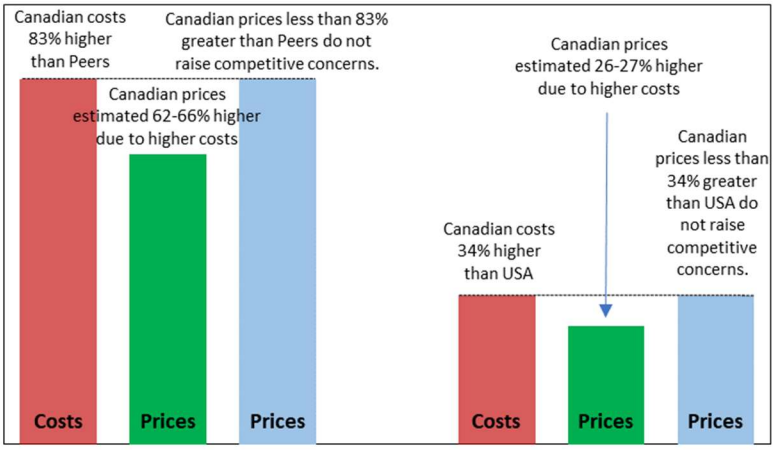
March 17, 2020

In Phase I of our analysis, Christensen Associates measured the individual differences in key mobile wireless service cost drivers between Canada and a set of Benchmark (peer) Countries and the US. That analysis revealed that, for each primary cost driver examined, the cost was often higher in Canada than in these countries (and in certain cases significantly so). Differences in select environmental factors, including the number of days below freezing, annual snowfall, and customer density, also contribute to higher costs in Canada.

In Phase II of this analysis, we build on the individual cost driver results from Phase I to determine the aggregate impact of these cost differences between Canada and the Benchmark Countries. We also assess the aggregate impact of these differences between Canada and the Benchmark Countries on prices. We find that Canadian costs are approximately 83 percent higher than average Benchmark Country costs and 34 percent higher than US costs. If prices are in lockstep with costs and the same price-cost margins apply to Canada and the Benchmark Countries (and the US), Canadian prices would be 83 percent higher than Benchmark Country prices and 34 percent higher than US prices. However, since the actual degree of cost pass-through is not known, it is reasonable to expect that the difference between Canadian wireless costs and those in Benchmark Countries (and the US) would engender Canadian prices that are between 62 and 66 percent higher than those in the Benchmark Countries and between 26 and 27 percent higher than US prices as a direct result of the markedly higher costs in Canada. This represents a cost pass-through of 75 percent and 80 percent, respectively.

The cost disadvantage faced by Canadian mobile wireless service providers is pronounced and has direct implications for the pricing of wireless services. As a matter of public policy, it is not possible to draw any meaningful conclusions about "competitiveness" without benchmarking prices against the underlying costs of the services in question. This Phase II analysis provides the requisite economic framework to properly evaluate Canadian mobile wireless prices.

Figure ES.1
Cost-Price Relationships Between Canada and Peer Countries and US



Key Cost Drivers of Mobile Wireless Services in Canada: Implications for Pricing

By
Christensen Associates
March 13, 2020

Introduction

In the first phase of our analysis, Christensen Associates measured the individual differences in key mobile wireless service cost drivers between Canada and a set of Benchmark (peer) Countries (Japan, Germany, France, UK, Italy, and Australia) and the US. The analysis revealed that, for each primary cost driver examined, the cost was often higher in Canada than these countries (and in certain cases significantly so).[1] We also identified significant differences in a number of environmental factors, including the number of days below freezing, annual snowfall, and customer density, that contribute to higher mobile wireless service costs in Canada.[2, 3]

While these Phase I results are descriptive and informative, they are not definitive because they do not assess the overall impact of these differences in costs between Canada and the Benchmark Countries. In this second phase of the analysis, which we refer to as Phase II, we build upon the individual cost driver results from Phase I to determine the impact of these cost differences on prices. We find that Canadian costs are approximately 83 percent higher than average Benchmark Country costs and 34 percent higher than US costs.[4] If prices are in lockstep with costs, and the same price-cost margins apply to Canada and the Benchmark Countries, Canadian prices would be 83 percent higher than Benchmark Country prices and 34 percent higher than US prices. However, given the actual degree of cost pass-through is not known, it is reasonable to expect that the difference between Canadian wireless costs and those in Benchmark Countries (and the US) would engender Canadian prices that are between 62 and 66 percent higher than those in the Benchmark Countries and between 26 and 27 percent higher than US prices as a direct result of the markedly higher costs in Canada. This represents a cost pass-through of 75 percent and 80 percent, respectively.

[1] "Key Cost Drivers of Mobile Wireless Service in Canada," Christensen Associates, January 31, 2020.
[2] The values for the Benchmark Countries represent a subscriber-weighted average of those countries. Appendix I describes the data sources.
[3] To render this report self-contained, Appendix II contains the Phase I report (excluding the appendix).
[4] The primary cost drivers for which we have data on the difference between Canada and the Benchmark Countries and the US (capital, labor, materials, services, and spectrum) account for **91.6** percent of total wireless expenses (excluding devices) for TELUS. The remainder of expenses pertain to marketing costs for acquiring and retaining wireless customers.

When assessing the competitiveness of markets and, in particular, whether wireless firms are exercising undue market power,[5] cost differences such as these are an essential consideration.[6] As a matter of public policy, it is simply not possible to draw any meaningful conclusions about the "competitiveness" of markets without benchmarking prices against the underlying costs of providing the services in question.[7]

The substantial cost disadvantage borne by Canadian mobile wireless carriers implies that Canadian mobile wireless prices are significantly higher than if Canadian mobile wireless costs were aligned with costs in Benchmark Countries. The cost disadvantage faced by Canadian mobile wireless service providers is pronounced and has direct implications for pricing. Any comparison of prices that fails to take this cost dimension into account cannot be credibly relied upon to inform public policy.

Description of Methodology and Data Sources

The production of mobile wireless service is comprised of four primary factors of production (what we refer to as the primary cost drivers in our Phase I report): capital (K), labor (L), materials and services (M), and spectrum (S).[8] Each factor is comprised of the following:

- Capital: annual capital costs of backhaul + cell site + fixed network equipment + other wireless capital expenditures
- Labor: salaries and benefits expenses

[5] For the distinction between market power and substantial market power, see Competition Bureau Canada, ABUSE OF DOMINANCE ENFORCEMENT GUIDELINES, 2019, Section 1.C.

[6] In network industries, such as mobile wireless services, prices significantly above underlying marginal cost are to be expected as they are necessary to recover the large, upfront cost of network infrastructure. See *Antitrust Modernization Commission, Report and Recommendations*, Washington D.C. 2007, pp. 40-41. ("For these reasons, firms with low marginal costs but large fixed costs, for research and development and other innovative activity, for instance, often need to price significantly above marginal costs simply to earn a competitive return in the long run."). Hence, it is not absolute price-cost margins that are informative in assessing competitive discipline in a market, but relative price-cost margins.

[7] As the Competition Bureau observes:

> Direct indicators of market power, such as evidence of supra-competitive profitability or pricing, are not always conclusive or indeed possible to assess; practical difficulties can arise in defining the "competitive" price level and the appropriate measure of cost to which prices should be compared (footnote omitted).

Competition Bureau Canada, ABUSE OF DOMINANCE ENFORCEMENT GUIDELINES, 2019, Section 1.C., ¶ 25. The Bureau's reference to comparing prices to costs to draw inferences about market power is noteworthy.

[8] As described in our Phase I analysis, *Operating Environment Impacts* are characteristics of a service provider's service territory that are outside the control of the service provider (i.e., exogenous) but nonetheless affect the magnitude of primary factors of production. The impact of differences in these operating environment impacts, such as climatic factors and density of service territory, between Canada and the Benchmark Countries (and the US) are already reflected in the differences in the primary factors of production and therefore are not included here as independent cost drivers.

- Materials and services: total administrative and general expenses (non-labor) + network operations expenses (non-labor) + net external labor expenses
- Spectrum: spectrum annual amortization expenses + annual license expenses

In addition, device costs (discussed below) are purportedly a significant expense for TELUS.

The percent difference in the cost of each of these factors of production between Canada and the Benchmark Country average is given by:

> $\%\Delta K$ = Percent difference in annual capital costs between Canada and Benchmark Country average.
>
> $\%\Delta L$ = Percent difference in annual labor costs between Canada and Benchmark Country average.
>
> $\%\Delta M$ = Percent difference in annual materials and services costs between Canada and Benchmark Country average.
>
> $\%\Delta S$ = Percent difference in annual spectrum costs between Canada and Benchmark Country average.

The (percent) cost share of each of these factors of production in the firm's overall cost structure is defined as follows:

> S^K = Annual capital cost share.
>
> S^L = Annual labor cost share.
>
> S^M= Annual materials and services cost share.
>
> S^S = Annual spectrum cost share.

These cost shares add up to 100 percent of total annual costs unrelated to device subsidies and marketing:

> $S^K + S^L + S^M + S^S = 100\%$.

The shares represent an average of the 2018 and 2019 shares provided to us by TELUS. Data sources are described in Appendix 1.

Multiplying the percent difference in cost for each factor of production by its cost share and summing across all four factors of production yields the overall cost difference ($\%\Delta C$) between Canada and the Benchmark Countries and between Canada and the US:

> *$\%\Delta C$ = Overall Percentage Cost Difference Between Canada and the Benchmark Countries/US*
>
> $= \%\Delta K * S^K + \%\Delta L * S^L + \%\ \Delta M * S^M + \%\Delta S * S^S$.

Device Costs

Device costs are another factor of production necessary to produce mobile wireless service. It is our understanding from discussions with TELUS personnel that device costs in Canada may be significantly higher due to (1) Canadian service providers exercising considerably less buying power over device manufacturers due to the lower number of subscribers in Canada; and (2) the regulatory mandate in Canada that device costs be amortized over a period no longer than 24 months. Because comparable information from other countries is not available to compute a difference between Canada and the Benchmark Countries or between Canada and the US, differences in device costs are not included in the analysis. The implicit assumption is that there are no differences in device costs across countries.

Cost Results

As described above, the overall weighted average difference in mobile wireless costs between Canada and the Benchmark Countries (and the US) is a product of the individual cost factor differences developed in Phase I of our analysis and the cost shares provided by TELUS for this phase of the analysis.[9] Using the cost differences from Phase I of our analysis, Table 1 shows that,

[9] In Phase I, we segmented spectrum into two different bands, a "capacity" band and a "coverage" band. The capacity band is in the neighborhood of 2.6 GHz, while the coverage band is approximately 700 MHz. In general, lower frequencies provide extended coverage at lower cost as fewer base stations are required to achieve greater geographic coverage, whereas higher frequencies are primarily used by mobile operators to cover urban and suburban areas where data traffic is dense and substantial network capacity is required. The rationale for including both capacity and coverage bands, therefore, is that a coverage band might be expensive in a large landmass country like Canada or the United States, but relatively inexpensive in Europe. The reverse may be true with respect to capacity bands. The 261 percent spectrum cost difference reported here relative to the Benchmark Countries (206 percent relative to the US) is a weighted average of the capacity band (424 percent for the Benchmark; 65% for the US) and coverage band (201 percent for the Benchmark; 556% for the US) cost differences we calculated in Phase I. A weighted average, based on subscriber count, was calculated for capacity and coverage spectrum by country. This cost was averaged across all Benchmark countries, once again weighted by subscriber counts, resulting in a single average spectrum cost for Canada and a single average spectrum cost for the Benchmark. To further validate the reasonableness of this range of spectrum costs, and because the actual spectrum bands used by the various carriers are not known, we cross-checked these results against a set of articles that reported spectrum auction outcomes in Canada and each of the benchmark countries. The costs cited in these articles fall within the range for Canadian and benchmark spectrum costs calculated using GSMA Intelligence data. See: http://atu-uat.org/wp-content/uploads/2016/06/day-1-session-4-presentation-1-by-scott-mckenzie-coleago-for-gsma-english-version.pdf;https://ecfsapi.fcc.gov/file/7521096774.pdf; https://www.acma.gov.au/theACMA/auction-summary-700-mhz-digital-dividend-2013; https://frankrayal.com/2013/02/20/uk-4g-spectrum-auction-concludes-a-brief-analysis/; https://frankrayal.com/2015/06/20/german-spectrum-auction-overview/; http://www.cramton.umd.edu/papers2010-2014/cramton-spectrum-screen-declaration.pdf; http://www.lya.com/index.php/2015/05/12/canadian-2500-mhz-auction-results/; http://www.coleago.com/australian-spectrum-auction-failure/;

overall, Canada has **83.0 percent higher costs** than the average of the Benchmark Countries and **34.1 percent higher** costs than the US for the four primary factors of production.

Table 1
Overall Cost Difference Between Canada and Benchmark Countries and the US
Changes Relative to Benchmark and US Costs[10]

Factors of Production	Phase I Canada v. Benchmark Difference	Phase I Canada v. USA Difference	TELUS Cost Share	Phase II Results - Weighted Difference	Phase II Results – Weighted Difference (USA)
Capital	48%	-10%	63%	30.2%	-6.1%
Labor	12%	-23%	5%	0.5%	-1.0%
Materials	0%	0%	12%	0.0%	0.0%
Spectrum	261%	206%	20%	52.3%	41.3%
Overall Difference				**83.0%**	**34.1%**

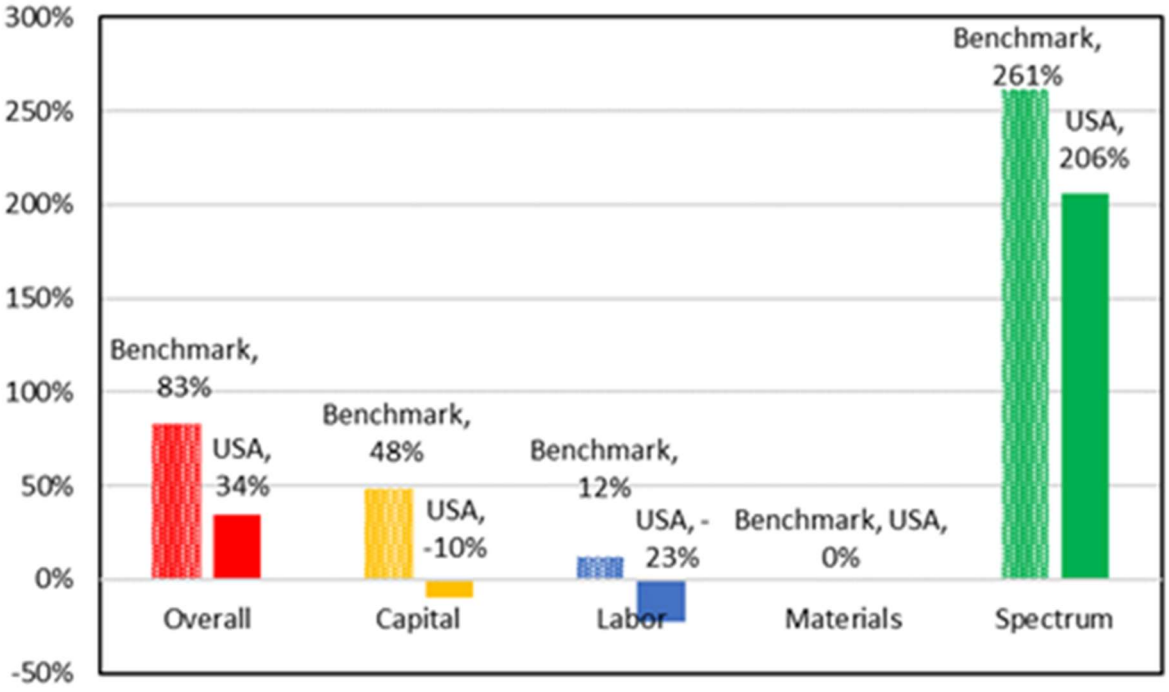
*Materials and Services costs are not available for the Benchmark Countries. Therefore, it is assumed there was no difference in these costs between Canada and the Benchmark Countries.
**Weighted average of capacity and coverage spectrum from Phase I.

Figure 1 provides a graphical representation of the information in Table 1. It illustrates the overall difference in costs between Canada and the Benchmark Countries and between Canada and the US, as well as the individual cost difference for each of the four primary factors of production.

https://www.econstor.eu/bitstream/10419/106846/1/816841810.pdf;
https://www.brandeis.edu/economics/RePEc/brd/doc/Brandeis_WP121.pdf.

[10] Cost differences are based on Phase I results. As described above, this entails the use of two spectrum bands: capacity and coverage. The cost shares are based on information provided by TELUS, and are assumed to be representative, as comparable information is not available for Benchmark Countries. This assumption is reasonable given the limited degree of substitution between key inputs in the production of wireless services—i.e., the substitution of labor for spectrum is not pervasive, if possible at all.

Figure 1
Overall Cost Difference Between Canada and Benchmark Countries
Changes Relative to Benchmark Country Costs



Pricing Implications

Given the cost disadvantage of Canadian mobile wireless firms, what are the implications for the prices charged by Canadian firms? If prices are in lockstep with costs (i.e., 100 percent cost pass-through) and the same price-cost margins apply to Canada and the Benchmark Countries, Canadian prices would be 83 percent higher than Benchmark Country prices and 34 percent higher than US prices.[11] However, since the actual degree of cost pass-through is not known, it is reasonable to expect that the cost difference between Canadian wireless produces and those in Benchmark Countries (and the US) would engender prices in Canada that are between 62 and 66 percent higher and between 26 and 27 percent higher than US prices than they would be if Canadian costs were in parity with those in Benchmark Countries. This represents a cost pass-through of 75 percent and 80 percent, respectively.

Figure 2 provides an illustration of the cost differences between Canada and the Benchmark Countries and the implications for the pricing of mobile wireless services.

[11] Based on the cost assumptions noted above.

Figure 2
Mobile Wireless Service Costs vs. Mobile Wireless Service Prices

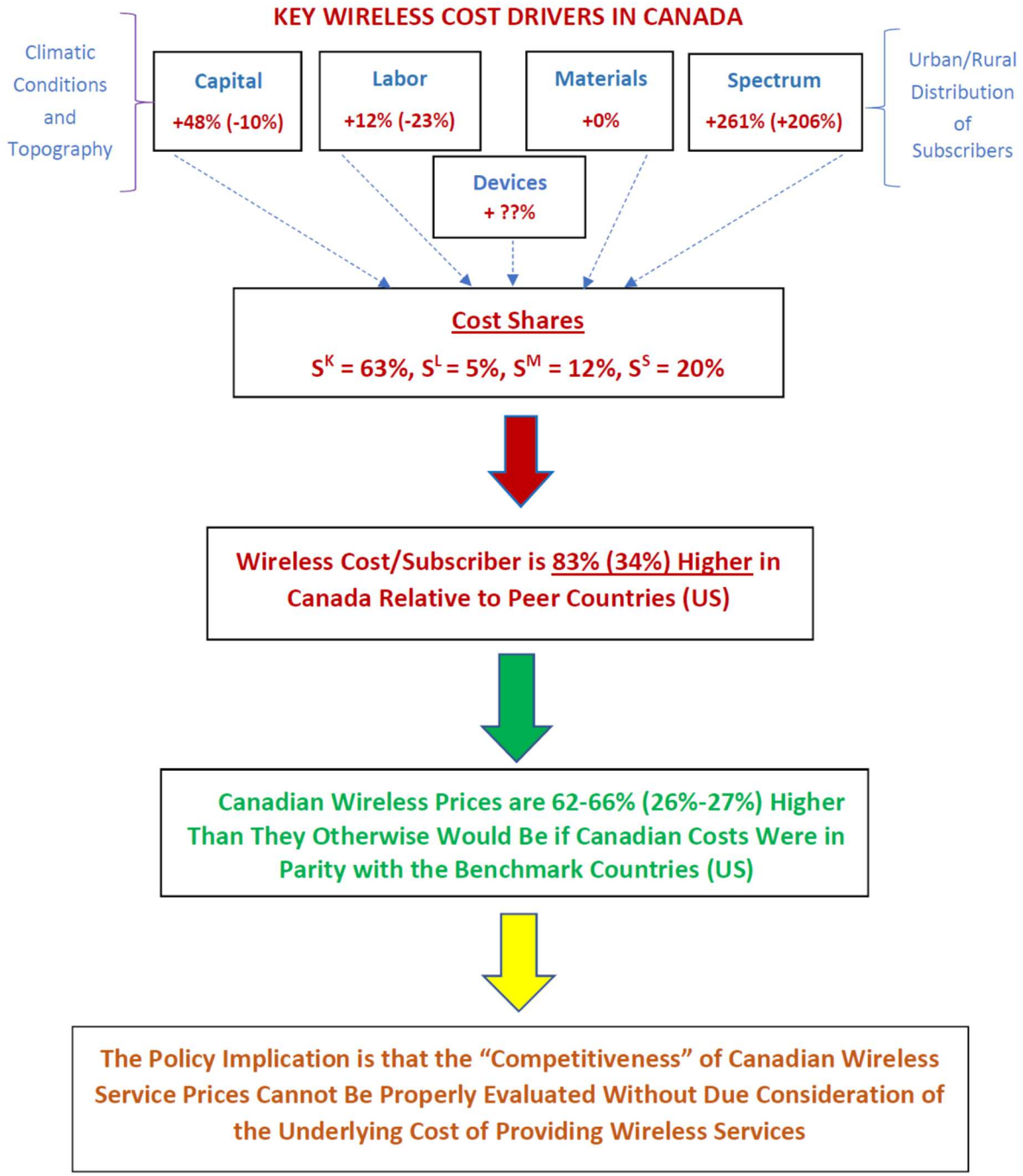
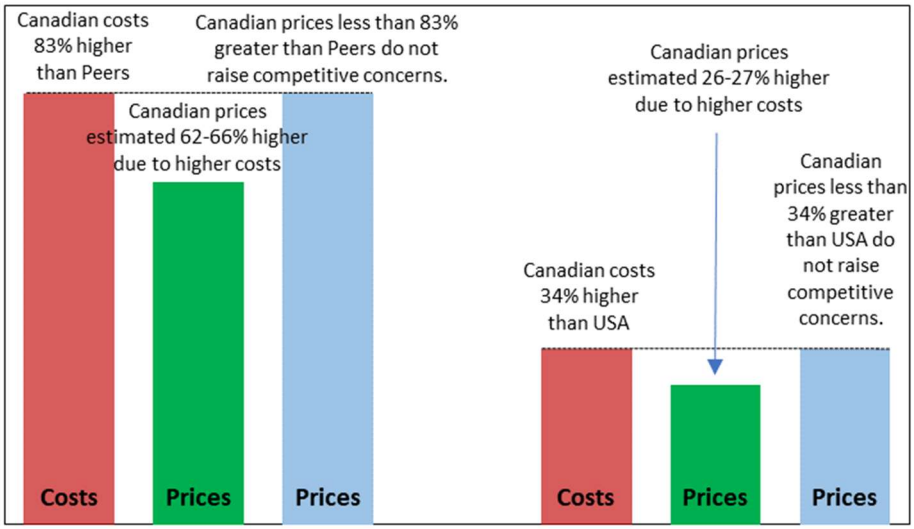


Figure 4 illustrates the cost disadvantage of Canadian mobile wireless firms relative to the Benchmark Countries and relative to the US . This pronounced cost difference explains, in part, why Canadian prices are higher than peer prices and can be substantially higher without raising competitive concerns.

Figure 4
Cost-Price Relationships Between Canada and Peer Countries and US



Policy Implications

Given the cost differences between Canada and the Benchmark Countries in the production of mobile wireless services, what are the implications for pricing and the proper assessment of competitiveness of wireless markets? On one level, we have determined that if Canadian mobile wireless costs were 83 percent higher than Benchmark Country costs, it would be reasonable to expect Canadian prices to be 62 percent to 66 percent higher than prices in Benchmark Countries. If Canadian mobile wireless costs were 34 percent higher than US costs, it would be reasonable to expect Canadian prices to be 26 percent to 27 percent higher than US prices (based on cost pass-through rates of 75 percent to 80 percent).

Given that prices and costs are inextricably linked, this necessarily implies that comparisons of prices across countries without corresponding information on costs cannot provide meaningful information on the relative competitiveness of markets. A simple comparison of prices across countries cannot facilitate a rigorous assessment of the relative competitiveness of markets in these countries. In fact, such a comparison is largely meaningless if not counterproductive. If costs in Canada are significantly higher than those in Benchmark Countries or the US, prices in Canada that are greater than those in the Benchmark Countries or the US, but less than the cost difference are suggestive of greater competitive intensity in Canada than in those in peer countries and the US. This is the case because market forces in Canada would have disciplined prices to reside in closer proximity to underlying costs.

Conclusion

What we find in Phase II of the analysis is that primary mobile wireless cost drivers (capital, labor, materials and services, and spectrum) produce mobile wireless costs that are significantly higher in Canada relative to the Benchmark Countries (+83%) and relative to the US (+34%). If prices track costs (i.e., 100 percent cost pass-through), this means Canadian prices would be 83 percent higher than Benchmark Country prices and 34 percent higher than US prices should the same price-cost margins apply to Canada, the Benchmark Countries and the US. However, since the actual degree of cost pass-through is not known, it is reasonable to expect that the cost difference between Canada and the Benchmark Countries would result in a price difference between 62 and 66 percent. If Canadian mobile wireless costs were 34 percent higher than US costs, it would be reasonable to expect Canadian prices to be 26 percent to 27 percent higher than US prices (based on cost pass-through rates of 75 percent to 80 percent).

When properly assessing the competitiveness of markets and whether wireless firms are exercising undue market power, cost differences such as these are an essential consideration. Canadian Mobile wireless prices in Canada could be markedly higher than the Benchmark Country (or US) average without raising concerns that the exercise of market power in Canadian mobile wireless markets is problematic relative to the exercise of market power in peer countries.

As a matter of public policy, it is simply not possible to draw any meaningful conclusions about the “competitiveness” of prices without benchmarking those prices against the underlying costs of providing the service in question. This Phase II analysis is designed to provide the proper economic framework to begin evaluating the competitiveness of mobile wireless markets in Canada.

Appendix I

This appendix provides definitions and sources for all data used in this analysis of telecommunications cost drivers. This appendix will also detail any changes made to the data for purposes of normalization, inflation adjustment, or scaling.

Telus Cost Data

Telus provided cost data that accounted for capital, labor, materials, and spectrum expenditures in years 2018 and 2019. These data were used to produce an average cost share for each of the four factors of production analyzed in this report. These data were produced to Christensen Associates in the Excel workbook, 2018-1019 TSBT WLS Cost Analysis-2.xlsx. Below is a table containing the source cost shares from that workbook used in this report.

($ M's)	2018	2018 Weighting	2019	2019 Weighting
Capital	895.4	64.2%	889.2	62.6%
Labour	66.3	4.8%	63.2	4.4%
Materials	166.8	12.0%	170.8	12.0%
Spectrum - Annual licensing fees	49.8		49.0	
Spectrum - Acquisition	217.0	19.1%	247.4	20.9%
Total	1,395.2	100.0%	1,419.7	100.0%

Cost Driver Data

Capital Expenditures

GSMA Intelligence supplied a time series of telecommunications capital expenditure data by country and company in nominal dollars. Using the World Bank inflation data, this time series was converted to 2018 dollars.[12]

Climate

Average temperature and precipitation values were obtained for each country using *currentresults.com, degreedays.net, usclimatedata.com, weather-atlas.com,* and *nerdwallet.com*.

Inflation

Certain variables required scaling into 2018 dollars. This calculation requires an accurate measure of inflation. To perform these calculations, we obtained inflation data from the World Bank, which provides inflation data by country since 1960.

Labor

The Organization for Economic Cooperation and Development (OECD) provides average annual wage data by country. The OECD provides this data in terms of 2018 USD by purchasing power

[12] See here for World Bank inflation data: https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG

parity. We used these data as a proxy for the cost of telecommunications labor in each country.[13]

Size

Land area in terms of square kilometers, from a dataset provided by NERA,[14] was modified to reflect the actual amount of land with wireless coverage. This modification mirrors the adjustment to Canada, the United States, and Australia performed when calculating the teledensity measure.

Spectrum

GSMA Intelligence provided spectrum auction data by company, with total auction prices by country for the United States, Canada, and Australia. These auction results were converted to 2018 USD/MHz-Pop.

Teledensity

The teledensity value used in the chart above represents the number of customers per square mile (kilometer) of service territory. For the European nations, plus Japan, we assume total wireless coverage and use each country's population density calculated with land mass as reported by in the World Bank. For Canada, Australia, and the United States, we make an adjustment based on research that indicates what percentage of each country's area actually has mobile wireless service.[15]

We obtained land area data from the World Bank and subscriber counts by country from the OECD.[16]

Urban Population Percent

As in the NERA study,[17] this analysis includes a variable that reflects the percentage of each country's population living in an urban environment. This data was obtained from the International Telecommunications Union (ITU) *World Telecommunication/ICT Indicators Database 2019*.

---

[13] See here for OECD Average Annual Wage data: https://stats.oecd.org/Index.aspx?DataSetCode=AV_AN_WAGE

[14] The NERA dataset pertains to a study performed by NERA, which can be found here: https://www.nera.com/publications/archive/2018/nera-economist-identifies-shortcomings-in-the-wall-nordicity-stu.html

[15] See here, for example: https://www.iedm.org/sites/default/files/web/pub_files/cahier0118_en.pdf

[16] See here for World Bank land mass data: https://data.worldbank.org/indicator/ag.lnd.totl.k2; see here for OECD subscriber counts: https://www.oecd.org/sti/broadband/broadband-statistics/

[17] See footnote 15.

Appendix II

Key Cost Drivers of Mobile Wireless Service in Canada

by

Christensen Associates[1]

January 31, 2020

Introduction and Summary

Any credible assessment of the "competitiveness" of a market must examine prices as well as costs. The analysis summarized herein focuses on the cost side of ledger. The difficulty in providing mobile wireless service is largely reflected in the cost of providing the service. The degree of difficulty in Canada is high, as Canadian wireless providers face significantly greater cost pressures on key metrics than carriers in other countries, contributing to resulting price disparities between Canada and other countries.

To better understand mobile wireless service price differences between Canada and other countries, we examined the cost of providing mobile wireless service in Canada and a group of Benchmark Countries (Japan, Germany, France, UK, Italy, and Australia). In principle, we know that there is a direct connection between the cost of delivering services and the price to obtain those services. If costs go up, so to do prices. Where there are differences in the price of mobile wireless service between Canada and the Benchmark Countries, there are also differences in the cost of providing that service.

What we found is that the cost of *Primary Cost Drivers* is higher in Canada compared to these countries. We also found that differences in a number of environmental factors contribute to higher mobile wireless service costs in Canada. The table below summarizes the information contained in the following charts, providing values for Canada and the Benchmark Countries.[2]

Cost Driver	Canada	Benchmark Countries	Percent Difference - Canada vs Benchmark
Primary Cost Drivers			
Capital Expenditures (USD/Subscriber)	78.8	53.4	48%
Average Labor Costs (USD)	$48,849	$43,750	12%
Spectrum Costs (Capacity)	$1.32	$0.25	424%
Spectrum Costs (Coverage)	$2.55	$0.85	201%
Operating Environment			
Days Below Freezing	127	32	297%
Annual Snowfall (cm)	137.4	13.9	887%
Service Area (square km)	1,996,934	469,863	325%
Population per Square Km (Teledensity)	15.6	314.1	-95%
Percentage Population in Urban Area	82%	83%	-1%

[1] Christensen Associates has consulted with TELUS on the matter of wireless service costs.

[2] The values for the Benchmark Countries represent a subscriber-weighted average of those countries. Appendix I describes the data sources.

The percent difference between Canada and the Benchmark Countries illustrates the differential impact of these cost drivers on mobile wireless service prices between Canada and the Benchmark Countries.[3] As shown in the table, overall, this set of cost drivers contribute to higher wireless costs in Canada relative to the Benchmark Countries.[4] Note that the two negative percent differences reported in the table also indicate higher costs in Canada as relatively lower teledensity and percent urban population in Canada both contribute to higher costs. In competitive markets, higher costs result in higher prices of output (mobile wireless services in this case), all other factors held constant.

Key Mobile Wireless Service Cost Drivers

The following charts offer a useful, visual perspective on the relative magnitudes of important wireless telecom cost drivers. The charts compare Canadian values to a subscriber-weighted average of the Benchmark Countries. Cost drivers are categorized as primary cost drivers and operating environment impacts.

Primary Cost Drivers

Primary Cost Drivers have a direct impact on mobile wireless service costs. They include capital expenditures ("capex"), labor costs and spectrum costs. Capital expenditures represent the cost of building and adding to the wireless network, and also represent the costs of upgrading to the latest technologies. Labor costs represent costs of operating and maintaining the network. Spectrum costs represent the cost to license and use the government regulated radio waves through which information (e.g., calls, data) is transmitted over a wireless network.[5]

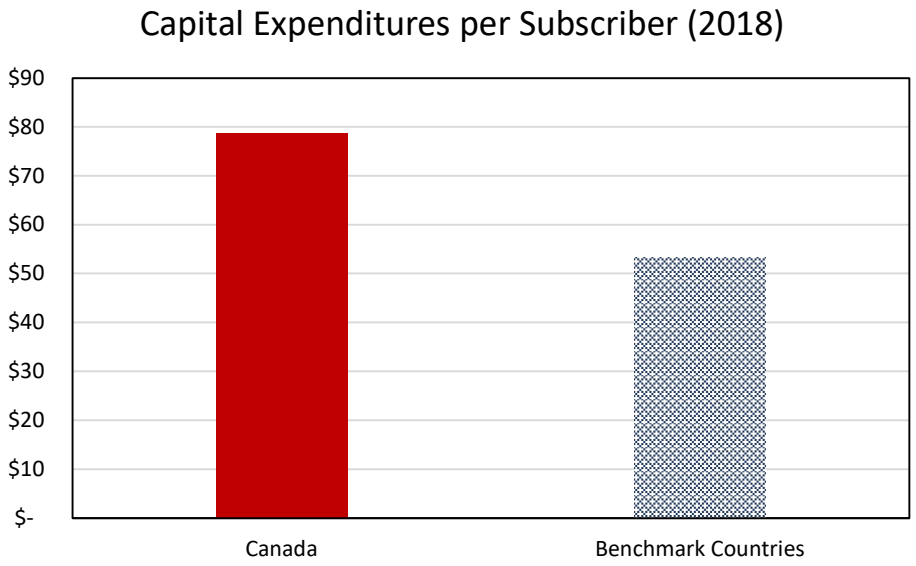
Capital Expenditures

Canadian capex per subscriber exceeds all Benchmark Countries by almost 50 percent. The graph below illustrates how Canada compares to these Benchmark Countries. Higher capital costs—representing the costs of building, adding to and upgrading the network—may contribute to the higher prices that consumers pay in Canada. However, higher capex is associated with higher service quality and the most modern technological platforms.

[3] In general, oligopolistic competition models indicate that a determinant of the retail price (p) is the underlying marginal (incremental) cost of the service. See, for example, Dennis W. Carlton and Jeffrey M. Perloff, MODERN INDUSTRIAL ORGANIZATION, Boston MA: Pearson, 2005, Fourth edition, chapter 6. The cost drivers identified herein are key components of the incremental cost (c) of wireless service. A key issue for public policy is whether the exercise of market power (for example, measured by the Lerner index, L = [(p - c)/p]) is higher for Canada than it is for Benchmark Countries. See Abba P. Lerner, "The Concept of Monopoly and the Measurement of Monopoly Power," *The Review of Economic Studies*, Volume 1, Number 3, June 1934, pp. 157-175.

[4] However, as noted below, these graphs are suggestive rather than definitive in evaluating the effects of these cost drivers on wireless service prices. This is necessarily the case because the specific impact of each of the cost drivers (as well as possibly others not included in this analysis) in determining the overall cost and final price of wireless services has not been determined at this time.

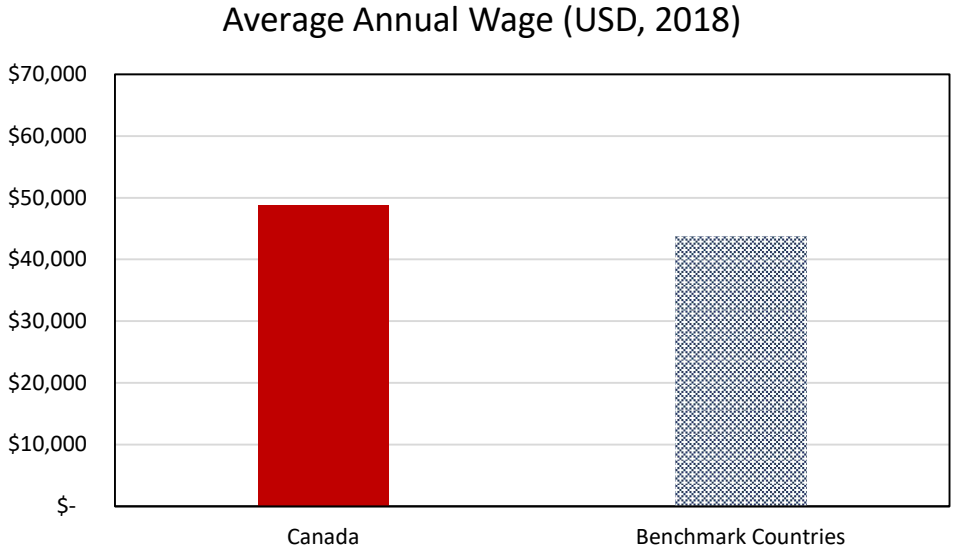
[5] Adequate data for other primary cost drivers—materials and services and device costs—were not identified at the time this memo was produced. In the case of devices, we understand that device costs in Canada are significantly higher due, in part, to the regulatory requirement that device costs be amortized over a period of 24 months and no longer.



Labor Costs

Labor costs drive industry expenses, much like capital costs. In the case of mobile telecommunications, we expect higher labor costs (which represent the cost of operating and maintaining the network) to place upward pressure on retail plan prices. The OECD provides an average annual wage for each country, but does not produce data by industry.

The graph below indicates that Canadian wages are, on average, higher than all other nations in the sample. Across all industries, Canadian companies face higher labor costs than the Benchmark Countries by an average of over 10 percent.

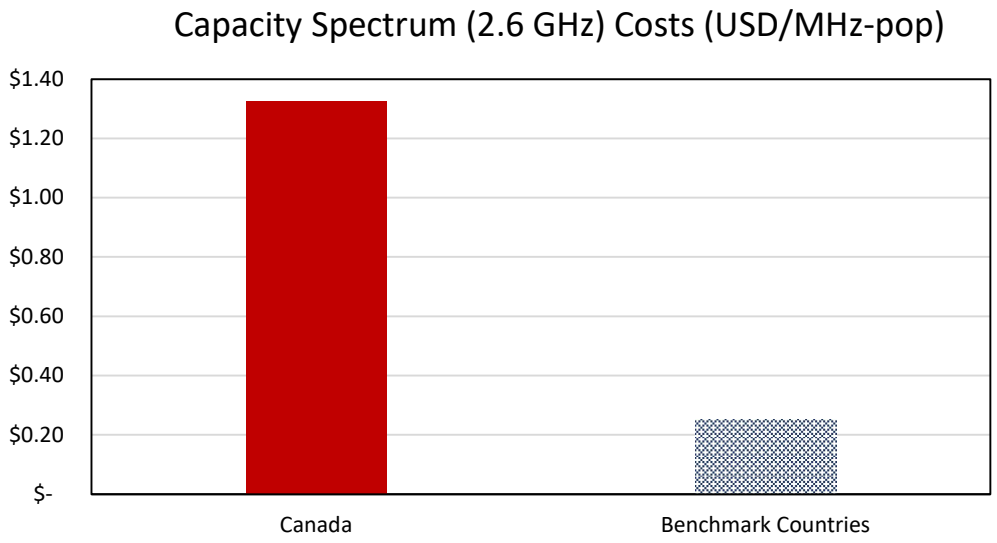


Spectrum Costs

Spectrum costs represent the cost to license and use the government regulated radio waves through which information (e.g., calls, data) is transmitted over a wireless network. Canadian spectrum prices are significantly higher than the average of the Benchmark Countries, meaning that the cost of transmitting information over Canadian wireless networks is higher than in Benchmark Countries.

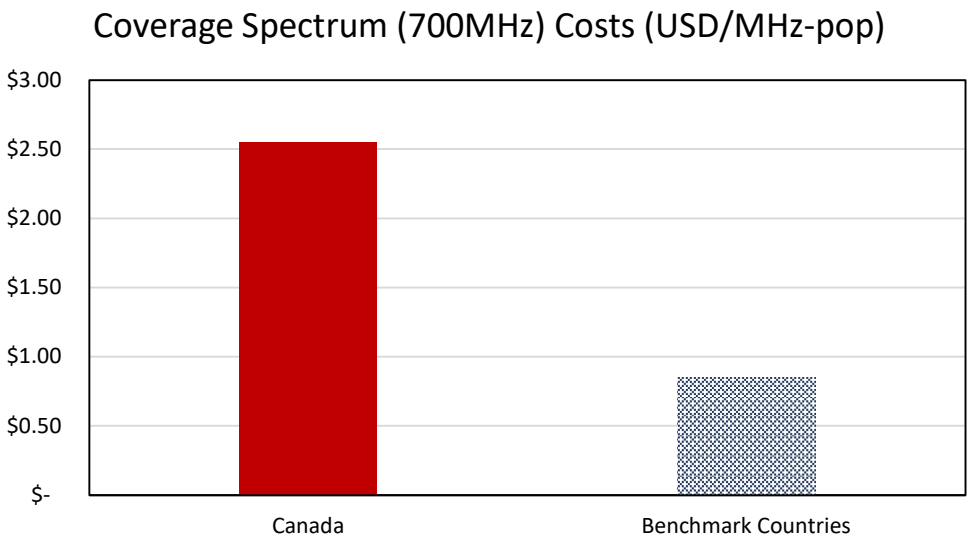
The graphs below illustrate prices for a "capacity" band and a "coverage" band. The capacity band is in the neighborhood of 2.6 GHz, while the coverage band is approximately in the 700 MHz range. In general, lower frequencies provide extended coverage at lower cost as fewer base stations are required to achieve greater geographic coverage, whereas higher frequencies are primarily used by mobile operators to cover urban and suburban areas where data traffic is dense and substantial network capacity is required.[6] The rationale for including both capacity and coverage bands, therefore, is that a coverage band might be expensive in a large landmass country like Canada or the United States, but relatively inexpensive in Europe. The reverse may be true with respect to capacity bands.

In fact, for both capacity and coverage, Canada appears to have the most expensive spectrum—i.e., the most expensive transmission medium— among countries in the study.[7] Canadian capacity spectrum is five times as expensive as the average of the Benchmark Countries and Canadian coverage spectrum is three times as expensive.



[6] GSMA Intelligence provides an intuitive explanation here: https://www.gsmaintelligence.com/research/?file=c12ea515e04188c7acdbfc35afca6b23&download

[7] Note that spectrum price data does not exist for Japan, which may be due to the difference in that country's method of assigning spectrum. Japan uses a "beauty contest" methodology for assigning spectrum, rather than auctions. In a beauty contest, a committee typically sets a number of criteria. The committee selects the plan that has the best "mix" of those criteria.

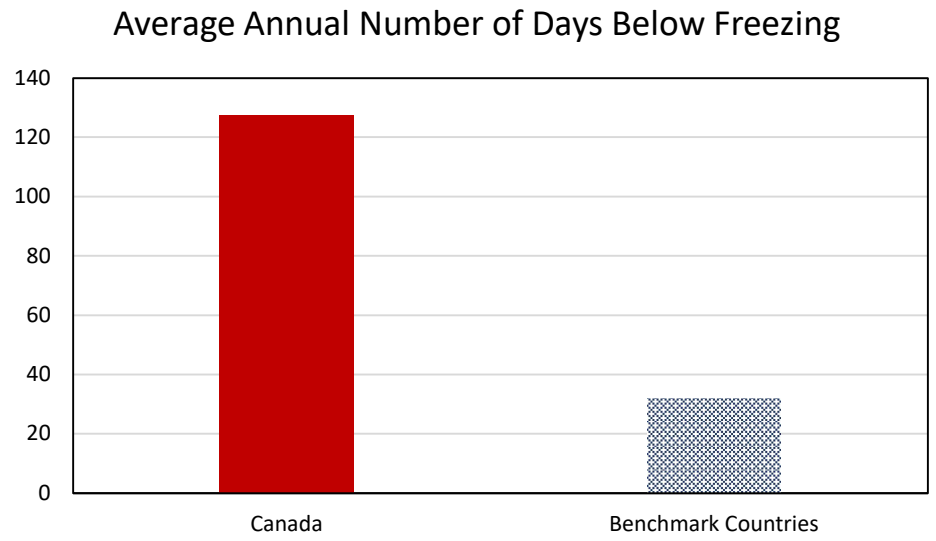


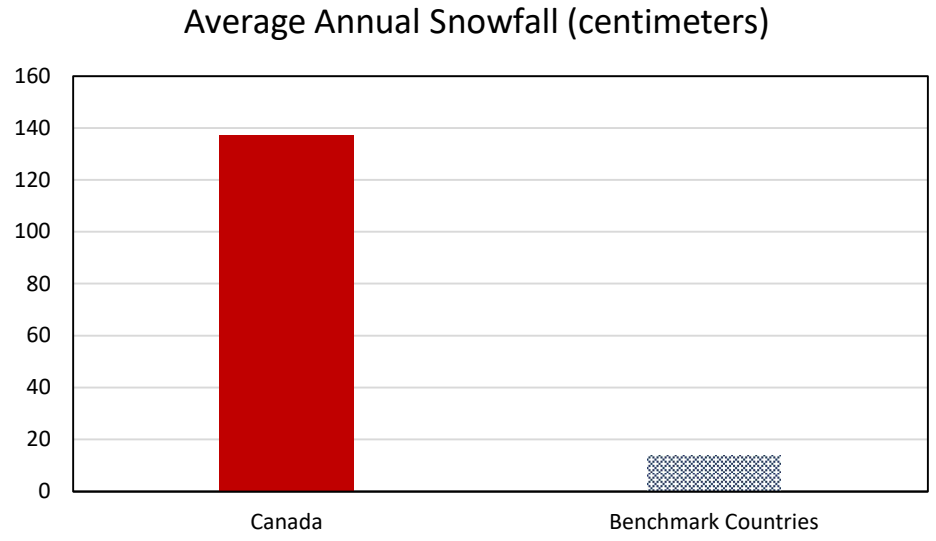
Operating Environment Impacts

Operating environment cost impacts are due to characteristics of the service provider's service territory that are outside the control of the service provider but affect the magnitude of primary cost drivers described above. For example, a smaller population size spread out over a large area is far more costly to cover than a high population size in a small geographic area – it is significantly less costly to connect downtown Tokyo than it is to cover rural Alberta. Other operating environment impacts include climatic variables (winter), size of service area, teledensity (the number of subscribers per square kilometer), and urban population.

Climate

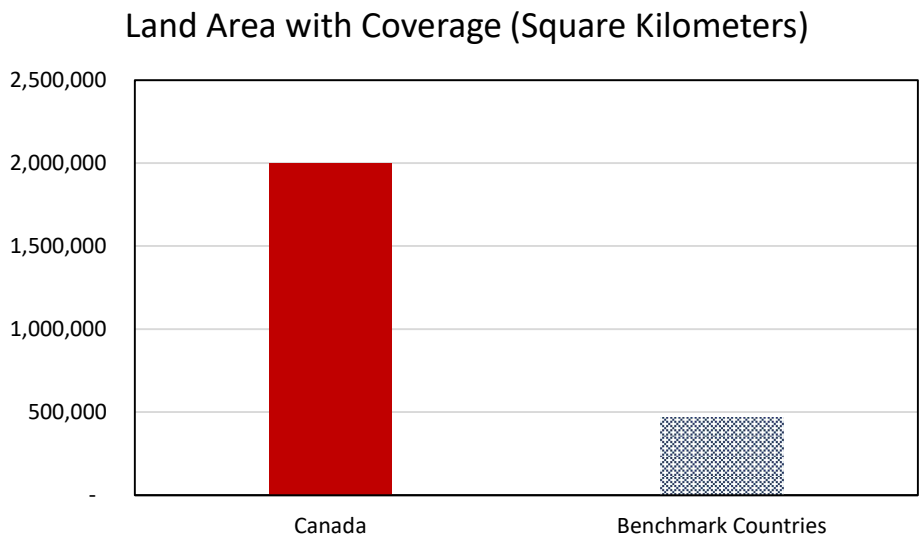
Extreme weather can result in both higher investment requirements and higher operating expenses. Global weather data suggests that Canadian cities experience more extreme temperatures than other locations in the study as is evident from the difference in average annual number of days below freezing in Canada compared to an average of the Benchmark Countries. On average, Canada has almost four times the days below freezing than the Benchmark Countries. Similarly, wireless companies in Canada experience significantly more snowfall each year compared to wireless companies in the Benchmark Countries—almost 10 times as much on average. This is significant to the extent that it drives both higher capital costs and higher labor and maintenance costs.





Service Area

In comparison to Benchmark Countries, Canada has a much larger land mass to cover with mobile wireless service as Canada's land mass is four time the average of these countries. With greater land mass for its number of subscribers, we would expect this differential to result in higher input costs for Canadian telecoms. Note that the Canadian land area has been adjusted to reflect the percentage of land with mobile wireless service.

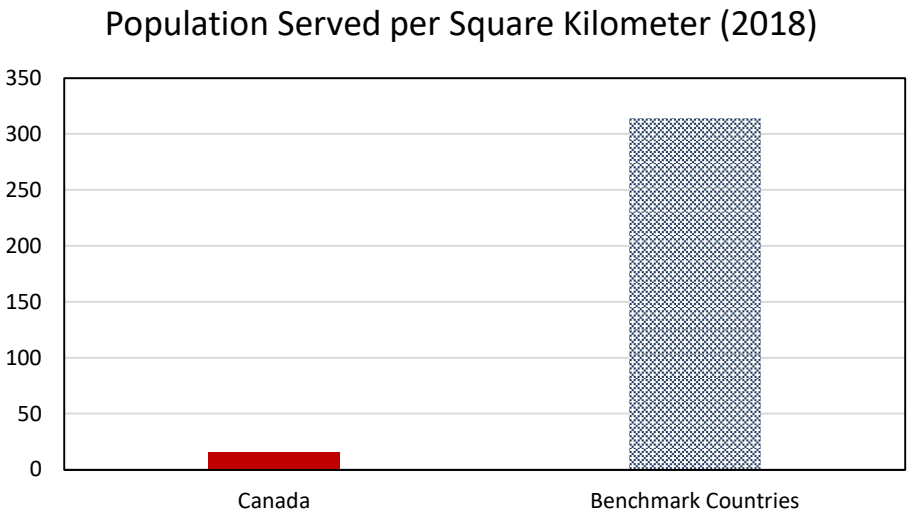


Teledensity

Except for Australia, Canadian companies serve the fewest number of customers per square kilometer of all countries in the study. This empirical fact may contribute to the higher wireless prices in Canada.[8]

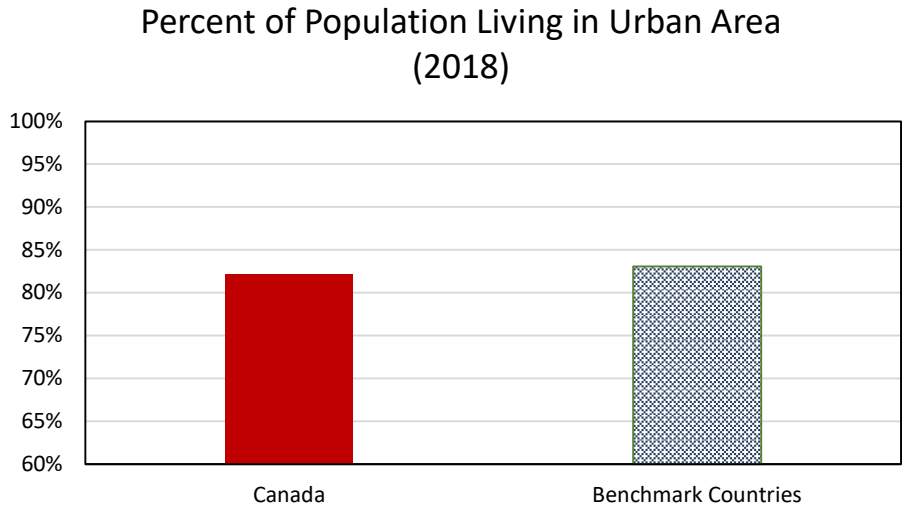
The chart below, which groups Benchmark Countries by a weighted average, illustrates the stark difference in teledensity between Canada and the other countries in the study. Even with Australia included in the benchmark average, and even with an adjustment made to account for unserved wilderness, Canada faces a teledensity metric several orders of magnitude lower than other western nations. Compared to the Benchmark Countries, customers per square kilometer are 95 percent less in Canada. This substantially lower teledensity in Canada results in a higher cost to serve customers.

[8] The impact of density on costs is discussed in David M. Mandy and William W. Sharkey, "Dynamic Pricing and Investment from Static Proxy Models," *Review of Network Economics*, Vol. 2, Issue 4, January 2003. See also Douglas W. Caves and Laurits R. Christensen, "The Importance of Economies of Scale, Capacity Utilization, and Density in Explaining Interindustry Differences in Productivity Growth," *Logistics and Transportation Review*, Volume 24, Number 1 (1988). For a discussion of cost proxy models in telecommunications, see William W. Sharkey, "Representation of Technology and Production, 2002, in "Price Regulation" in Martin Cave, Sumit Majumdar, and Ingo Vogelsang, eds. HANDBOOK OF TELECOMMUNICATIONS ECONOMICS, Amsterdam: North-Holland, Chapter 6, 179-222.



Percent of Population Living in Urban Area

The chart below illustrates a variable specifying the percent of each country's population living in an urban area. The data suggests that while Canada's teledensity is relatively low, its population is fairly urbanized.



Compared to the weighted average of Benchmark Countries, Canada has a slightly less urbanized population. However, this difference is just over one percentage point, which indicates that Canada is similarly urbanized relative to the Benchmark Countries, notwithstanding its low overall population density.

Conclusion

Canada presents a challenging and forbidding operating environment for wireless carriers. Simple comparisons of wireless prices across countries that fail to account for the cost differences in providing wireless service offer a distorted picture of the competitive landscape. This makes for bad economics

and even worse public policy. We have identified a number of cost drivers that indicate a significant cost disadvantage for Canadian service providers relative to providers in Benchmark Countries. Moreover, we understand that other important cost drivers for which we were not able to obtain information (for example, device costs) would exacerbate this cost disadvantage.