Key Cost Drivers of Wireless Service in Canada

discussion prepared for

TELUS Communications

by

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Introduction and Summary

Christensen Associates was retained by TELUS to assess the effects of wireless service cost drivers on wireless service prices between Canada and a peer group of other countries.[1] The first stage in that analysis, which we report here, illustrates how Canada compares to select **Benchmark Countries** (Japan, Germany, France, UK, Italy, Australia) and the United States in terms of major mobile telecom cost drivers. 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	United States	Percent Difference - Canada vs Benchmark	Percent Difference - Canada vs US
Primary Cost Drivers					
Capital Expenditures (USD/Subscriber)	78.8	53.4	87.1	48%	-10%
Average Labor Costs (USD)	$48,849	$43,750	$63,093	12%	-23%
Spectrum Costs (Capacity)	$1.32	$0.25	$0.80	424%	65%
Spectrum Costs (Coverage)	$2.55	$0.85	$0.39	201%	556%
Operating Environment					
Days Below Freezing	127	32	72	297%	76%
Annual Snowfall (cm)	137.4	13.9	29.9	887%	359%
Service Area (square km)	1,996,934	469,863	7,772,556	325%	-74%
Population per Square Km (Teledensity)	15.6	314.1	64.2	-95%	-76%
Percentage Population in Urban Area	82%	83%	82%	-1%	0%

The percent difference between Canada and the Benchmark Countries illustrates the differential impact of these cost drivers on wireless service prices between Canada and the Benchmark Countries. As shown in the table, overall, this set of cost drivers contribute to higher wireless costs in Canada relative to the

[1] 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 Lerner index, L = (p - c)/p, is higher for Canada than it is for peer countries. L is a standard measure of market power. 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.

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

Benchmark Countries.[3] Note that the two negative percent differences reported in the Canada vs. Benchmark column also indicate higher costs in Canada compared to the Benchmark Country average 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 (wireless services in this case), all other factors held constant.

Key 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.[4] Cost drivers are categorized as primary cost drivers and operating environment impacts.

Primary Cost Drivers

Primary cost drivers have a direct impact on wireless service costs. Primary cost drivers include capital expenditures, labor costs and spectrum costs.[5]

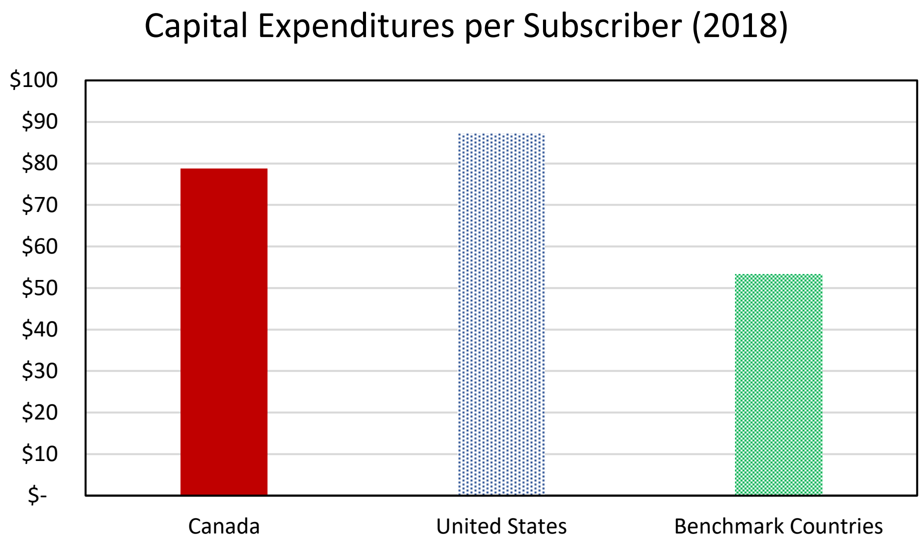
Capital Expenditures

Canadian capex per subscriber exceeds all Benchmark Countries, but is slightly below the US. The graph below illustrates how Canada compares to these Benchmark Countries. Higher capital costs may contribute to the higher prices that consumers pay in Canada.

[3] 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 is not known at this time.

[4] These graphs are only suggestive of the effect of these cost drives on wireless service prices as the impact of each of the cost drivers in determining the final price of wireless services is not known at this time. It may be possible to canvass TELUS engineers to determine the precise input composition for wireless services and employ this information to establish a link between the cost drivers and the final price for wireless service.

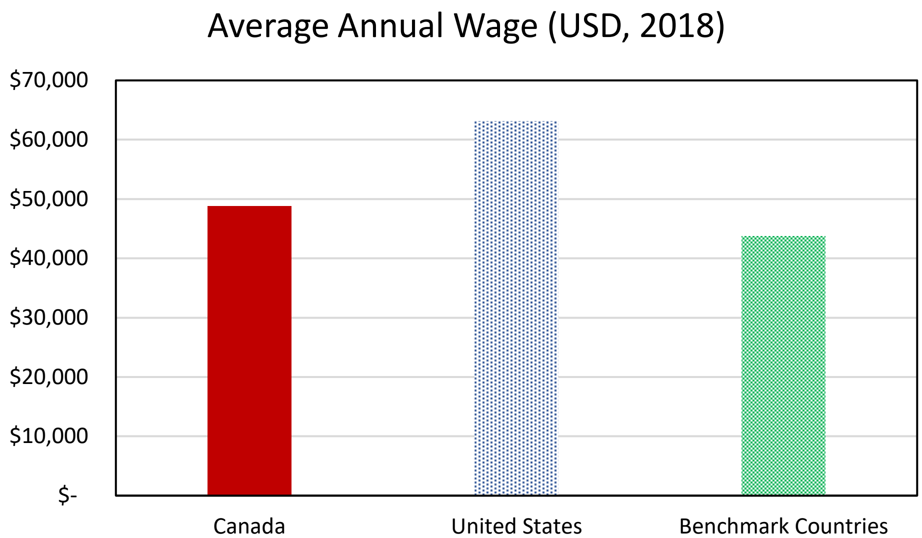
[5] Adequate data for another primary cost driver, materials and services, was not located at the time this memo was produced.



Labor Costs

Labor costs drive industry expenses, much like capital costs. In the case of mobile telecommunications, we expect higher labor costs to drive up retail plan prices. The OECD provides an average annual wage for each country, but does not produce data by industry.

Across all industries, Canadian companies face higher labor costs than Benchmark Countries, though lower costs than the United States. The graph below indicates that Canadian wages are, on average, higher than all other non-U.S. nations in the sample.



Spectrum Costs

Canadian spectrum prices are significantly higher than the average of the Benchmark Countries and the US.[6]

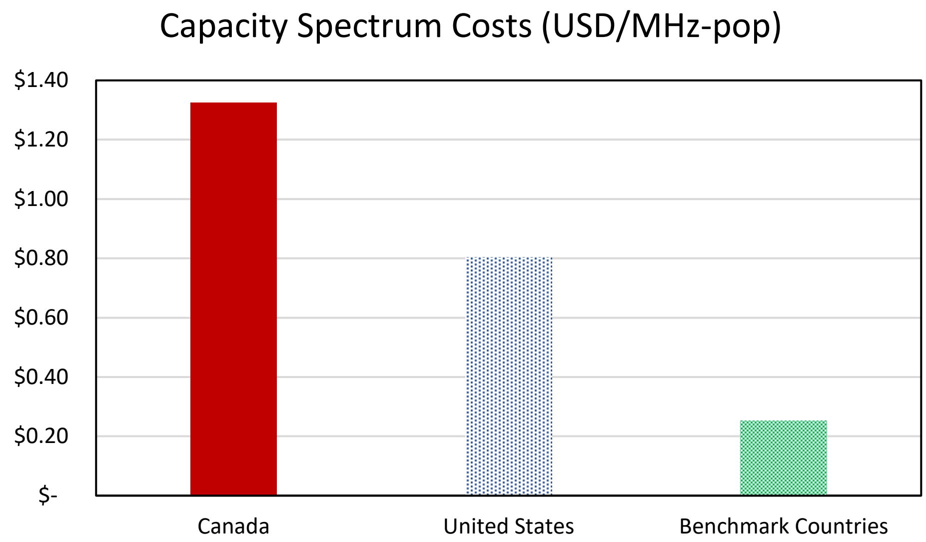
The graphs below illustrate prices for a "capacity" band and a "coverage" band. We define the coverage band as approximately 700 MHz, while the capacity band is in the neighborhood of 2.6 GHz. In general, lower frequencies provide extended coverage at lower cost as fewer base stations are required to 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.[7] 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.

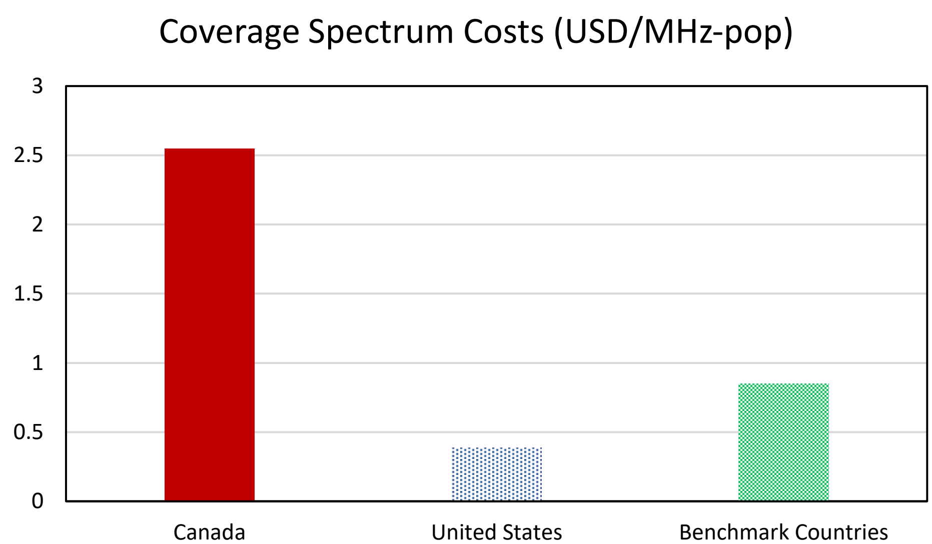
In fact, for both capacity and coverage, Canada appears to have the most expensive spectrum among countries in the study.[8]

[6] While spectrum prices in Canada are significantly higher than benchmark countries in terms of price per MHz-pop, GSMA Intelligence data in conjunction with company-level annual revenue data indicates that spectrum accounts for a small fraction of annual revenues (for benchmark countries, spectrum costs are an estimated 0.4% of annual revenue). This may indicate that spectrum is not a major cost driver among benchmark countries. See also "Awarding Spectrum with a Focus on Improved Mobile Services," Oliver Chapman, GSMA Presentation, November 21, 2019.

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

[8] 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.



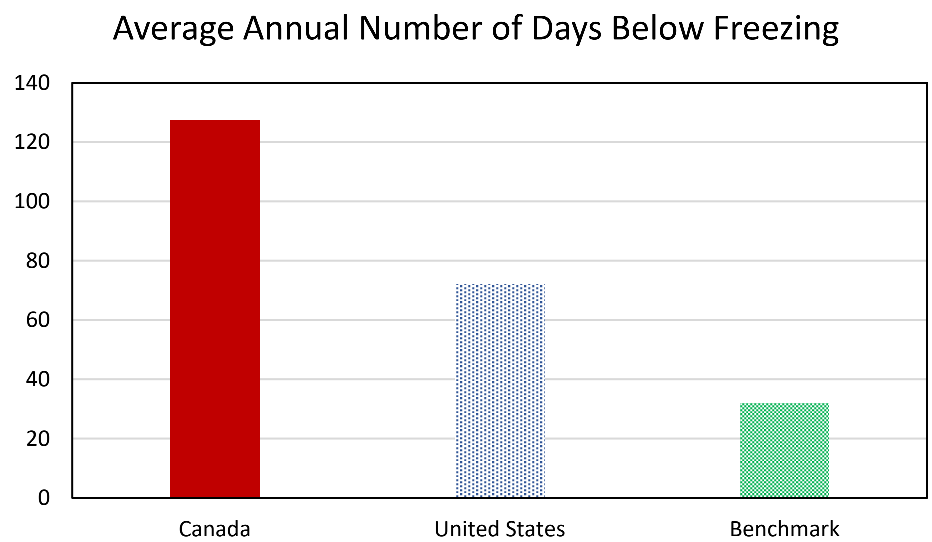


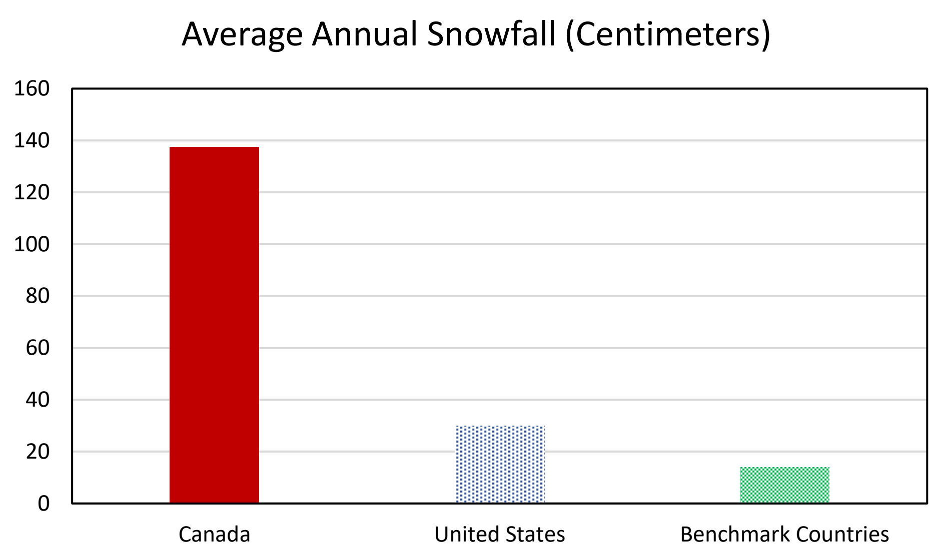
Operating Environment Impacts

Operating environment cost impacts are due to exogenous features of the service provider's service territory (i.e., not under the control of the service provider) that affect the magnitude of primary cost drivers. For example, lower subscriber density leads to higher capital per subscriber. Operating environment impacts include climactic variables, size of service area, teledensity and urban population.

Climate

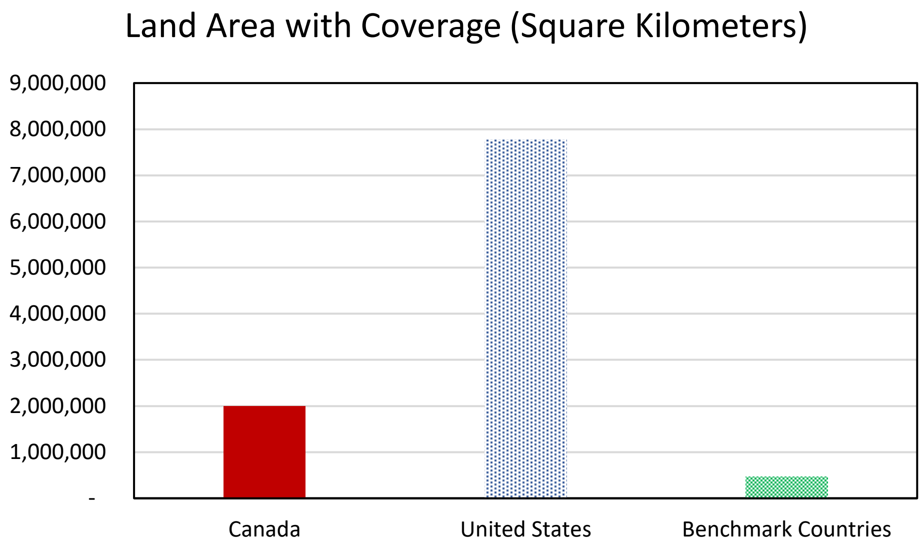
Extreme weather can result in both higher investment requirements and higher operating expenses. Global weather data suggests that Canadian cities experience more extreme temperatures than other locations in the study as is evident from the difference in average annual number of days below freezing in Canada compared to the US and an average of the Benchmark Countries. Similarly, wireless companies in Canada experience significantly more snowfall each year compared to wireless companies in the Benchmark Countries. 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 wireless service. However, both Canada and the Benchmark Counties have less land mass than the US. With greater land mass for its number of subscribers, we would expect this differential to yield higher input costs for Canadian telecoms. Note that the Canadian and United States land area has been adjusted to reflect the percentage of land with wireless service.

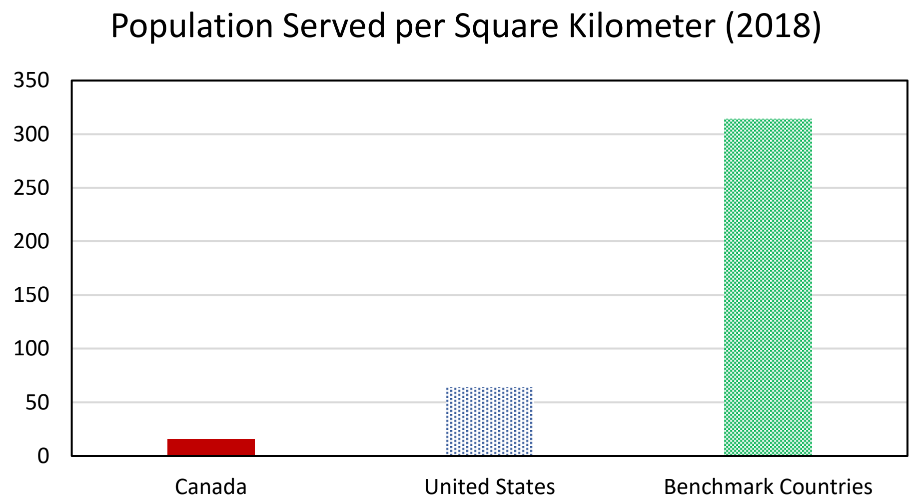


Teledensity

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.[9]

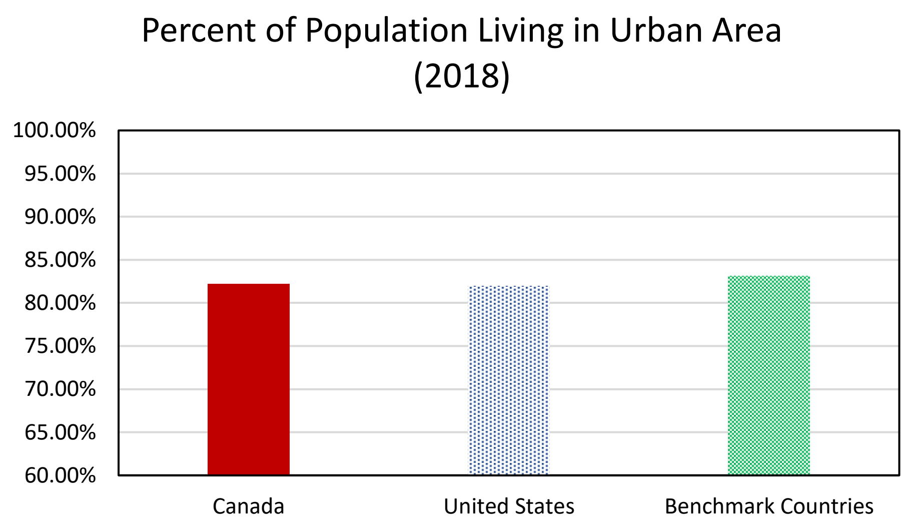
The chart below, which groups Benchmark Countries by a weighted average, illustrates the stark difference in teledensity between Canada and the other countries in the study. Even with Australia included in the benchmark average, and even with an adjustment made to account for unserved wilderness, Canada faces a teledensity metric several orders of magnitude lower than other western nations.

[9] 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 to the Benchmark Countries, notwithstanding its low overall population density.

Conclusion

This stage of the analysis established the difference in key wireless service cost drivers between Canada and a select group of Benchmark Countries. In general, these cost drivers indicate higher costs in Canada. The next stage of the analysis would establish how these cost drivers affect wireless service incremental costs and prices in Canada relative to the Benchmark Countries.

Appendix I – Data Sources

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.

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.

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 parity. We used these data as a proxy for the cost of telecommunications labor in each country.[10]

Size

Land area in terms of square kilometers, obtained from the NERA dataset 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 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 wireless service.[11]

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

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

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

Urban Population Percent

As in the NERA study, 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*.