

Prepared for:

Bell Canada
160 Elgin Street
Ottawa, Ontario

Delivering Better Broadband Performance: Facilities Competition vs. Access Regulation

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Date: December 27, 2018

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The conclusions set forth herein are based on independent research and publicly available material. The views expressed herein are the views and opinions of the authors and do not reflect or represent the views of Charles River Associates or any of the organizations with which the authors are affiliated.

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EXECUTIVE SUMMARY

- 1 In today's digital age, ubiquitous access to high-speed Internet services at reasonable prices is equivalent to the public switched telephone network of the past. Governments around the globe have policies in place to attain this objective. Canada is no exception. In an April 2018 funding announcement for high-speed Internet infrastructure in Indigenous communities in Northern Ontario, Minister Navdeep Bains confirmed Canada's position on Internet access:

Access to high-speed Internet is not a luxury; it's essential. High-speed Internet service is a basic tool that all Canadians should have access to, regardless of where they live. Our communities need this service to do business, upgrade their education and build stronger communities. Thanks to our Connect to Innovate program, more people will be able to participate fully in the digital economy.¹

- 2 How best to achieve this objective (at lowest cost to the taxpayer) is a key concern of policymakers. While regulators agree that competition among fixed broadband service providers is critical to achieving widespread adoption of advanced broadband technologies offered at reasonable prices, countries have adopted different policy paths to reach this goal. Some of the different policies reflect the network "base" from which each country started to build advanced fixed broadband networks. For example, Canada had extensive competing Internet-enabled cable and telco infrastructure available to most households from an early stage.² Other countries did not have extensive cable infrastructure, and instead relied on competition among carriers using the incumbent telco's infrastructure.
- 3 Where end-to-end facilities competition was lacking, regulatory regimes were used to provide competitors with wholesale access to incumbent providers' network inputs at mandated rates in order to have multiple broadband providers available to consumers. By assisting entrants with ready access to inputs for portions of their network, it was argued that entrants would be better placed to expand their investments in other parts of the network, thereby climbing the "ladder of investment" to become a competitor with their own end-to-end facilities. Under the ladder of investment theory, mandated wholesale access is a temporary phenomenon which "jump starts" end-to-end facilities-based competition as new entrants make additional investments when competing end-to-end facilities competitors do not already exist. This has not proven to be the case, in part, because it is very difficult to set access rates at the "right" levels that provide incumbents

¹ Cison (April 20, 2018). Federal funding to bring high-speed Internet to Indigenous community in northern Ontario. Retrieved from <https://www.newswire.ca/news-releases/federal-funding-to-bring-high-speed-internet-to-indigenous-community-in-northern-ontario-679283953.html>.

² Throughout this report, we refer to "telco infrastructure" to identify the fixed broadband networks deployed by telecommunications providers, which are typically those of the incumbent local exchange carriers ("ILECs") within a given jurisdiction.

with adequate returns for their network investments and entrants with sufficient incentives to invest.

- 4 The empirical research of the last decade has shown that providing subsidized access to inputs reduces – rather than increases – investment levels by entrants and incumbents. Here, we summarize the findings of 15 academic papers that have studied investment levels in telecommunications services.³ In 11 of these academic papers, wholesale access regimes have been found to either reduce entrants' investment levels or reduce incumbents' investment levels. The reduction in investment can be very large, particularly with respect to next generation networks. In four academic papers, access regulation has been found to lower prices and increase the diffusion of broadband; however, these papers do not consider next generation access networks and the investment required to build them. On balance, the academic literature studying investments in telecommunications finds more favourable outcomes are achieved when access regulation is limited – notably, higher investment levels and higher speed networks are achieved with generally no worse outcomes for pricing. In light of the negative effects on investment, countries relying on extensive wholesale access regimes have often ended up making substantial public investments in broadband as an alternative way to expand next generation networks.
- 5 Using recent data for the G7 countries plus Australia,⁴ we reach similar conclusions to the academic literature. This sample is informative as it provides a range of different policy experiences. At its simplest level, this group of eight countries might be divided between those that chose policies advancing end-to-end facilities-based competition (i.e., a “build” group) compared to countries that chose policies with greater use of regulated wholesale access regimes (i.e., a “buy” group). Past policy choices influenced investment levels, which coupled with different public subsidies, have generated different fixed broadband outcomes today.
- 6 We find the following range of policy choices among this country sample:
 - Canada and the United States had the highest levels of end-to-end facilities-based competition a decade ago while the other six countries had varying degrees of wholesale access regulation at that time;

³ In addition to the 15 academic papers, we also refer to an Ofcom-commissioned report that is not from the academic economics literature.

⁴ The eight countries included here are Australia, Canada, France, Germany, Italy, Japan, United Kingdom, and United States. In a prior study that one of the authors was involved with, we compared broadband penetration levels and pricing across 13 countries that included several of the countries studied to prepare this report. See *An international comparison of end-to-end facilities-based competition in telecommunications*, by Moya Dodd, Paul Reynolds, Margaret Sanderson, and Nick Berger-Thomson, CRA International, March 15, 2007, prepared for Bell Canada, as part of Telecom Public Notice 2006-14, *Review of regulatory framework for wholesale services and definition of essential service* [hereafter referred to as the “2007 Facilities Competition Study”]. The 13 countries examined in this report were Australia, Canada, Denmark, Finland, France, Germany, Hong Kong, Korea, Netherlands, Sweden, Switzerland, United Kingdom and United States.

- Germany did not mandate wholesale access to the incumbent telco's next-generation broadband, while the other countries had fairly extensive wholesale access regimes for next generation networks; and,
- Public investments through direct subsidies or other public initiatives in fixed broadband have varied widely.

7 Given this range of different policy choices, the sampled countries provide for an interesting comparison of market outcomes.⁵ We consider how each country has fared with respect to penetration of next generation access ("NGA") networks, using the definition of NGA adopted in the European Commission's *Digital Progress Reports*, which includes all technologies capable of download speeds in excess of 30 Mbps. In addition to comparing NGA network penetration rates, we also compare take-up of high-speed Internet services, average download speeds, and performance-adjusted prices for high-speed Internet services. In particular, we address the following questions.

- ***Did high levels of end-to-end facilities-based competition in 2007 help countries achieve greater deployment of NGA networks a decade later?***
 - **Yes. Countries with higher levels of end-to-end facilities-based competition in 2007 have higher percentages of households passed by Internet-ready cable in 2016 and high levels of NGA network coverage in 2016. Canada and the United States had the highest levels of Internet-ready cable in 2007 and in 2016. Both countries had 2016 NGA network coverage near or over 90 percent.**
- ***Did the countries relying on competition through extensive regulated wholesale access regimes in 2007 achieve similar NGA network deployment to those countries that had high levels of end-to-end facilities-based competition in 2007?***
 - **No. Countries relying on extensive regulated wholesale access regimes in 2007 have not achieved very high NGA network coverage in 2016, with the exceptions of Japan and the United Kingdom both of which have NGA deployment comparable to Canada and the United States.**

⁵ The most current data available on the market outcomes discussed in this study is from 2016.

- ***How have countries without high end-to-end facilities-based competition in 2007 increased their NGA network deployment through 2017, and at what cost?***
 - Large public investments have been made in countries relying more on wholesale access in order to expand NGA networks.⁶ Japan has achieved the highest NGA network deployment through public investments of the equivalent of US\$5 billion. The United Kingdom has achieved over 90 percent NGA network deployment through broadband investments of the equivalent of US\$1.3 billion. Germany achieved over 80 percent NGA network coverage by 2016 with public investments of the equivalent of US\$5.1 billion, and for much of the last decade German regulators did not require mandated wholesale access to the incumbent's investments in new infrastructure. Italy has achieved over 70 percent NGA network deployment through public investments of the equivalent of US\$16.7 billion.

- ***How important is NGA network deployment to high-speed fixed broadband penetration, average download speeds, take-up of high-speed Internet services, and performance-adjusted pricing?***
 - Very important. High NGA network deployment is strongly positively correlated with high-speed Internet services penetration and with having a higher fraction of all broadband subscribers on high-speed plans. High NGA network deployment is associated with higher average actual download speeds and lower performance-adjusted prices for high-speed Internet services.

- ***Moving forward, how important is an extensive wholesale access regime to achieving superior market outcomes for next-generation fixed broadband services?***
 - It is unnecessary. Countries with the *least* extensive wholesale access regulatory regimes today like the United States and Japan have the best broadband market outcomes with respect to NGA network deployment, high-speed Internet services penetration, download speeds and performance-adjusted prices.

8 We elaborate on these findings below. The remainder of this report is structured as follows:

⁶ Public investments have been converted to US dollars using the OECD's purchasing power parity index.

- Section 1 presents the economic framework for mandating regulation of access to wholesale inputs in respect of fixed broadband services.
- Section 2 reviews the academic literature on access regulation and investment decisions.
- Section 3 compares broadband outcomes and wholesale regulations across the eight study countries.
- Section 4 provides a brief conclusion.
- Appendix A sets out relevant information regarding each country in the study.
- Appendix B summarizes the data and sources used in the study.

1. ECONOMIC FRAMEWORK FOR MANDATING REGULATION OF ACCESS TO WHOLESALE INPUTS

- 9 Policymakers do not require firms to make their inputs available to their rivals as a general principle. This is true even if an input is scarce or unique. In fact, our legal and economic policy framework is oriented towards supporting the exclusive use of inputs in order to encourage firms to expend resources to acquire or build the “best” that they can to service their customers.⁷
- 10 In the following subsections we discuss the economic theory behind granting access to what the regulator deems to be an essential facility and the environment in which sufficient competition between providers — namely a cableco and a telco — can be achieved. We also discuss the investment decisions of firms and how they can be negatively affected by improper regulation.
- 11 Requiring firms to grant access to their internal resources to their rivals only occurs under limited circumstances. In particular, regulated access to inputs is only sought when it is deemed necessary in order to provide for healthy competition in downstream services. In the telecommunications sector where competitors and new entrants are granted access to the incumbent’s wholesale facilities at mandated prices, three conditions are typically necessary: (i) the infrastructure to which wholesale access is granted is essential to providing a service; (ii) the infrastructure cannot be duplicated by the competitor; and (iii) without mandated wholesale access at regulated prices, there would be insufficient competition to the incumbent telecommunications provider in downstream retail markets.
- 12 In Canada, since the late 1990s the Canadian Radio-television and Telecommunications Commission (“Commission”) has used the concept of “essential facilities” when deciding whether to mandate access.⁸ Thus, the objective is to only require mandated access when the inputs are “essential” for rivals to compete in downstream retail markets with the incumbent and the input is not duplicable or available from others.⁹ In other words, without mandated access to these essential services, effective competition in downstream retail markets between the incumbent and competitors would not be possible.

7 “Property” is generally held by parties on an exclusive basis, allowing owners to determine the extent of access to their private property by others. In some policy spheres, exclusive rights to property for a period of time is encouraged, such as occurs under patent policy, in order to incentivize investments by firms.

8 CRTC Decision 2008-17 establishes the essential services test that is used today.
<https://crtc.gc.ca/eng/archive/2015/2015-326.htm>

9 The Commission also has required telecommunications providers to provide wholesale access to competitors for “near essential” services, which do not meet the more stringent – and we believe appropriate – standard that is captured in the essential services concept.

- 13 A fundamental premise underlying the economic theory is rivals cannot effectively substitute away from the “essential” input if the incumbent firm were to increase the price of the input significantly. In such circumstances, the rivals are either forced to continue to purchase the input at much higher prices, or they must cede share to the incumbent firm in the downstream market if they reduce their consumption of the essential input. An input is essential if competitors cannot duplicate it on a cost-effective basis. Thus, if a sufficiently close substitute for a firm’s infrastructure or facility is available to its rivals, access to it is not likely essential. If there are cost-effective alternatives available to the rival – including “building its own” – then there is no economic case for mandating wholesale access.
- 14 When end-to-end facilities competition exists, there are two (or more) independent providers neither of which requires access to the other’s infrastructure in order to compete. Hence, there is no need for mandated wholesale access. For example, when two carriers like a cableco and a telco have built the facilities required for broadband deployment, any input used by one is clearly duplicable by the other and by definition this input is not “essential” for competition to exist. This sets up the policy choice, which is to encourage and develop end-to-end facilities competition or to require mandated access as a means of creating competition that would not exist without the regulation. In Telecom Regulatory Policy CRTC 2015-326, the Commission described facilities-based competition as the ideal and most sustainable form of competition.
- 15 In many markets, end-to-end facilities-based competition has been limited to two operators in any one area: the telco and cableco. Telcos operate using their own copper and fibre networks while cablecos operate coaxial and fibre cable. As both types of networks moved towards IP-based technology and as access speeds and reliability increased, the networks began to carry a wide variety of services. Market evidence suggests that competition between telcos and cablecos has been intense. Specifically, in relation to broadband competition, inter-platform competition between cablecos and fixed wireline telcos has been a significant driver of broadband penetration.¹⁰
- 16 The investment that is required to enter the market results in sufficient levels of competition between the two networks. Success as a platform provider requires substantial initial and ongoing fixed investments. These facilities require ongoing expenditures both to maintain and to expand the network to enhance coverage. We outline how access-based competition and end-to-end facilities-based competition alter the incentives for incumbents and entrants to invest in Figure 1.

10 See, for example: Bouckaert et al. (2010). Access regulation, competition, and broadband penetration: An international study. *Telecommunications Policy* 34, 661-671.

**Figure 1:
 Investment Incentives under Access-Based and Facilities-Based Competition**

	Access-Based Competition	End-to-end Facilities-Based Competition
Incentives for incumbents to invest and innovate	Investment and innovation on the of the incumbent may be limited by an inability to retain full returns to investment	Competition from rival networks can spur the incumbent to develop and deploy new products at a faster rate
Incentive for entrants to invest	Build/buy decisions may be distorted by regulated access price – if the access price is set below realistic build costs, there is little incentive to invest	Creates efficient build/buy decisions provided there are no distortions elsewhere (e.g. asymmetric regulation)

17 Once the network investments have been made, provided there is sufficient capacity in the system, additional subscribers can be added at low marginal costs. When industries have substantial sunk fixed up-front costs and low marginal costs to add customers, economists expect to find relatively small numbers of firms. What is important is that rivals to the traditional telecommunications companies have already sunk the required investments for entry (as is the case in Canada, where the major cablecos have already sunk costs into networks and telephony investments). As a consequence, more intense competition may be induced.

18 The entrant is more committed to the market after it has incurred investments in its own infrastructure, and its lower variable costs (compared to those that would characterize a resale-based competitor) will provide an incentive for it to expand its output more aggressively: the greater the investment and the lower the variable costs, the more aggressive the entry. Moreover, such an entrant is likely to seek to offer multiple services over its network platform, not simply telephone service, and will seek to achieve a high penetration of these services. As a result, where "network on network" competition is concerned, a very small number of suppliers may be sufficient to generate material competitive tension. As the Competition Bureau has noted, if the services provided over a competing network involve:

...similar or lower incremental costs and provid[e] similar quality service, then if most of the costs of service provision by either the ILEC or the competing network are fixed and sunk, price competition between the two networks is likely to be fairly aggressive. It is not often that two suppliers are sufficient to constrain market power, but these circumstances are suggestive of situations when the

*competitive impact of a second network should be expected to lead to significant downward pressure on prices.*¹¹

- 19 Rivalries in broadband markets are heavily driven by dynamic competition since new telecommunications services are introduced through investment. Service providers seek to introduce innovative new products in order to compete with other firms in the market. The introduction of new and innovative services allows providers to differentiate their offerings from each other, and also provides an opportunity to market complementary offerings that customers are likely to find attractive. In general, the existence in the market of a competitor with a differentiated set of service offerings will tend to discipline an incumbent's pricing to its existing customers. Efficient regulation needs to consider the dynamic nature of this competition since regulatory instruments tend to be static and reflective of the regulator's assessment of market conditions at the time they were introduced.

1.1. ENSURING COMPETITIVE DOWNSTREAM MARKETS

- 20 As noted above, wholesale access to inputs is a means to an end, which is to achieve competitive retail markets. Where end-to-end facilities competition does not exist – and hence there is concern that effective competition does not exist in downstream retail markets – and all of the conditions for infrastructure to be considered “essential” are met, the incumbent firm that controls the essential input may have an incentive to deny access to the input (or charge very high prices for access) as a means of disadvantaging rivals who require access to the essential input in order to compete effectively.¹² In these circumstances, wholesale access to the essential input is the regulator's means of ensuring sufficient competition exists in the downstream market. Without mandated access, the economic concern is the dominant firm would be in a position to raise its rivals' marginal costs through increasing the price of the essential input that it controls. With higher marginal costs, the rivals will be forced to charge higher prices in downstream markets where they compete with the incumbent firm. Consumers are harmed because all firms now charge higher prices. The harm is in the downstream market where the rivals compete with the firm controlling the upstream input.

11 See Competition Bureau, *Evidence of the Commissioner of Competition*, submitted in response to Telecom Public Notice CRTC 2005-2, *Forbearance from Regulation of Local Exchange Services*, June 22, 2005, para. 263.

12 See Steven C. Salop and David T. Scheffman (1983) “Raising Rivals' Costs,” *73 American Economic Review (AEA Papers and Proceedings)*, May, 1983; and Thomas G. Krattenmaker and Steven C. Salop (1986) “Anticompetitive Exclusion: Raising Rivals' Costs to Achieve Power over Price,” *96 Yale Law Journal*, December, 1986.

- 21 The economic framework for determining when a dominant firm (or a group of firms collectively acting like a dominant firm) has the incentive and ability to disadvantage rivals by exploiting an advantage over a wholesale input as a means of substantially reducing competition in downstream markets is well established. This economic framework forms the basis for the study of allegations of “foreclosure” and “raising rivals’ costs” by competition and regulatory authorities in Canada and around the world. For example, as articulated in the *Merger Enforcement Guidelines*: “(a) non-horizontal merger may harm competition if the merged firm is able to limit or eliminate competitor firms’ access to inputs or markets, thereby reducing or eliminating competitor firms’ ability or incentive to compete. The ability to affect competitors in this manner is referred to in these guidelines as ‘foreclosure’.”¹³ Foreclosure concerns arise when the merged firm increases the price of the input to competitors of the downstream entity of the merged firm (‘partial’ foreclosure) or refuses to supply the input to the downstream competitor altogether (‘full’ foreclosure). Even if a foreclosure concern exists, there is only harm to competition when competition among downstream firms is substantially lessened, following the economic framework provided by the theory of raising rivals costs.
- 22 Regulatory and competition authorities need to concern themselves with such actions when they result in higher prices or reduced services to downstream customers. When the incumbent firm has market power, increasing the rival’s costs may reduce the rival’s market share, reducing the rival’s competitive significance, hence allowing the incumbent to charge higher prices in the downstream market for a given product or service than would otherwise have been possible.¹⁴ Raising rivals’ costs can take a variety of forms from refusal to supply (or supply at an extremely high price which is tantamount to a refusal), discriminatory access fees, exclusionary conduct or degrading rivals’ quality of access.¹⁵ While it is not costless to an incumbent firm to undertake a raising rivals’ costs strategy (since it results in fewer upstream essential input services being sold to rivals), these costs may be offset by the benefit to the incumbent firm of protection of its downstream retail market share or dominance.¹⁶

13 *Merger Enforcement Guidelines*, paragraph 11.4.

14 In the extreme, such strategies can render future participation of the rival unprofitable leading to its exit and possible price increases by the incumbent post-exit.

15 The economics literature on vertical restraints recognizes that a variety of strategies may enable the upstream firm to extend its market power in these circumstances. See Janusz A. Ordover and Garth Saloner (1989) “Predation, Monopolization, and Antitrust” Chapter 9 in *Handbook of Industrial Organization*, Richard Schmalensee and Robert D. Willig (eds), Amsterdam, Holland.

16 Hence, it is not necessarily profit maximizing for an integrated incumbent to engage in access discrimination. Thus, a case-by-case analysis is required. However, when access discrimination is profitable, these costs are more than offset by the benefits obtained by the incumbent firm.

- 23 In order for raising rivals' costs (or foreclosure) to be a profitable strategy, several conditions must exist. First, rivals' marginal costs must be raised by a significant amount when the price of the input is increased. Second, the costs that the firm incurs in order to raise its rivals' marginal costs must not exceed the increase in price (otherwise the incumbent is incurring losses and hence the theory reverts to one of economic predation). Third, conditions within the downstream market must be such that the increase in price by the firm engaged in foreclosure is sustainable (e.g., entry barriers are high, and demand is sufficiently inelastic). In other words, the incumbent firm must have market power in the downstream market. In addition to these conditions, in the case of a regulated firm, it must have some control over the wholesale price or non-price aspects of access to its input or infrastructure that it sells to rivals.
- 24 The focus of concern here is on competition in the downstream market. Charging a high price for a scarce input is not a sufficient reason for a market intervention by a regulator. The conduct of concern is that which would cause rivals to be less effective competitors downstream such that downstream market prices are materially increased due to the curtailed access to the upstream input. Regulation of access to the upstream input is only required when the effect of the denied access (or access at very high prices) is insufficient competition in the downstream market.¹⁷ Concerns about a lack of competition are more likely to arise when there is only one facilities-based provider rather than in situations where cablecos and telcos compete against each other.

1.2. REGULATED WHOLESALE ACCESS TO CLIMB THE "LADDER OF INVESTMENT"

- 25 An alternative regulatory theory for mandating access to incumbent's infrastructure is the "ladder of investment" under which some regulators have mandated access as a means of advancing entrants' investments. By providing entrants with access to key components of the network, it was expected they would make investments in other network components while competing with incumbents. Under this approach proposed by Cave,¹⁸ an entrant will climb the rungs—incremental investments to be undertaken by a new entrant—from access-based competition to end-to-end facilities-based competition through additional investments.

17 When foreclosure concerns are being addressed by competition authorities, they focus on whether the foreclosure is likely to lead to a substantial lessening or prevention of competition. A substantial lessening or prevention of competition occurs when an impugned practice enables the incumbent firm to exercise a materially greater degree of market power than in the absence of the practice. Market power is defined to be the ability to raise and sustain prices above competitive levels.

18 Cave, M (2006). Encouraging infrastructure competition via the ladder of investment. *Telecommunications Policy* 30, 223-237.

- 26 Under the ladder of investment model of regulation, access-based competitors are presumed to enter the market at the resale or network element level and build a customer base and brand name before investing in their own networks. Initial entry at the retail level in this manner is seen to be a means to reduce the risk of further investment by the entrant to gradually roll out more of its own infrastructure. Thus access-based entry is seen as representing a 'stepping-stone' to greater network build.
- 27 Academic evidence referenced in Section 2 questions the effectiveness of the ladder of investment model, however. Well-functioning capital markets could be expected to fund the start-up period for entrants to telecommunications markets, as occurs in other industries, without the need for the regulator to reduce investment risks. More critically, if regulators retain regulated access-based products in the marketplace for too long or at too low a price, they will deter entrants from making investments in their own networks.

1.3. NEGATIVE INVESTMENT EFFECTS FROM INCORRECT MANDATED REGULATED WHOLESALE ACCESS

- 28 There is a substantial literature that studies the investment effects of mandating access to incumbent carrier networks for entrants. An important consideration for regulators when determining whether to mandate network access is how competitors will resolve the "build versus buy" decision. Providers that are granted mandated access to national carrier networks may choose to rely on mandated access to those networks ("buy") rather than building their own networks ("build"), or delay building out their own networks. Reliance on access to national networks, or delays in build-outs, runs contrary to the policy adopted by most regulators, including the Commission, of promoting facilities-based competition.¹⁹ Regulators generally seek to discourage excessive "buying" by managing access rates and placing time limits on access to encourage "building" by entrants. Regulated access can also affect the returns to the incumbents and their own incentives to invest in the maintenance and upgrade of their networks. In practice, setting access prices is prone to significant error, with the risk that prices may be set below the economic costs of providing the service, particularly where the measure of costs needs to take into account a reasonable return on risky investments in new technology.²⁰

19 One of the primary policy objectives of the 1996 Telecommunications Act in the US was to promote facilities-based competition in the provision of local telecommunications services.

20 This might occur because the access regulation process tends to result in risk asymmetry for new investments by incumbent operators: if an investment succeeds in the market, the benefits are made available to the rest of industry through lower-than-otherwise access charges driven by low unit costs from high network utilization; whereas if an investment fails and the new network languishes, the investor is left bearing the cost.

29 Since entrants do not bear the sunk costs (making the investments irreversible) incurred during the network build, there is an asymmetric allocation of risk and return that is not properly accounted for in the pricing of network services.²¹ Given that regulated access prices carry a significant risk of error, the presence of access regulation by itself may act as a deterrent to new investment.²² In this regard, there are reasons as to why access regulation should be removed wherever there is the *potential* for effective facilities competition. Retaining regulation until new networks are built may prevent those networks from ever being rolled out without additional subsidy or support.²³

1.4. CONCLUSION

30 The presence of networks from both cablecos and telcos is an asset that is not present in every country's telecommunications sector. Canada is among those countries that are fortunate enough to have two networks which provides a platform upon which aggressive competition in the market for fixed broadband can take place. The two networks are also sufficiently close substitutes as inputs that can be used by downstream rivals and are therefore unlikely to be considered essential. Despite these factors, inputs that have been classified as essential by the national regulatory agency ("NRA") are still required to be provided to competitors through wholesale access regulations. This alters the investment incentives of both incumbents and entrants. In particular, the access prices that affect new entrants' decisions to buy or build are prone to errors that can discourage further investment by incumbents or not provide the incentives required for new entrants to begin building out their own networks. In the next section we will summarize several empirical studies that analyze firms' investment decisions under a regime of access-based wholesale regulation.

21 Pindyke, Robert S. (2007). Mandatory Unbundling and Irreversible Investment in Telecom Networks. *Review of Network Economics* 6(3), 274-298.

22 See, for example: Jean-Jacques Laffont, (1994). Access pricing and competition. *European Economic Review* 38: 1673-1710.

23 For example, the US Federal Communications Commission ("FCC") found that access regulation in relation to broadband service was impeding the development and deployment of innovative broadband access technologies and services because vendors do not create technologies based around providing third-party access. Such technologies may not be implemented under access regulation, or they might be implemented only after they have been re-designed for access (see FCC, *Appropriate Framework for Broadband Access to the Internet over Wireline Facilities*, August 5, 2005, para. 65ff). Access prices that incorrectly account for risk allocation can therefore act as a deterrent to new investment, which is required in order to roll out innovative new products for consumers.

2. EMPIRICAL STUDIES OF ACCESS REGULATION AND INVESTMENT

- 31 The academic literature regarding investment, innovation and adoption of broadband has expanded as governments around the world have prioritized broadband availability and performance in their policy agendas. Much of this research has been published in the last decade, using data from the 1990s and early 2000s running up to about 2012 in some studies.
- 32 The impact that access-based wholesale regulation has had on broadband investment levels has been explored in several studies. We review the results of a number of empirical studies and summarize their implications. Despite the goal of promoting future facilities-based competition by allowing entrants to climb the “ladder of investment”, there is little empirical support in the literature of entrants increasing their investment levels through having access to incumbents’ facilities. Instead, research shows that the lower the prices for access, the less incumbents and entrants invest, which is counter to the regulatory agency’s original objective of spurring competition in fixed broadband. Furthermore, adoption of next generation technologies has been found to be negatively correlated with the extent of wholesale access regulation.
- 33 Grajek and Röller²⁴ study the trade-offs between access regulation and investment incentives in the telecommunications sector. The investment decisions of incumbents and entrants are studied using a large dataset of 70 fixed-line operators in 20 European Union countries over a 10 year period from 1997-2006. Grajek and Röller find that investment by both incumbents and entrants is discouraged by access regulation. For incumbents, investment is deterred since competitors will simply gain access to the new infrastructure. On the other hand, the ability to rent from incumbents at mandated prices reduces the incentives for entrants to invest in new facilities of their own. They estimate that the overall effect of access regulation on total industry investment in Europe was a loss of €16.4 billion over the sample period.
- 34 A regulatory commitment problem is also identified whereby the NRA permits easier access (i.e., lower access prices) to entrants in response to a higher level of incumbents’ infrastructure stock (i.e., higher levels of investment). This relationship further reduces the incentives for incumbents to invest in new facilities. Regulations are dependent on the current objectives of the NRA and are highly relevant to the types of long-term investment decisions that firms in the telecommunications sector make.

24 Grajek, Michal and Lars-Hendrick Röller (2012). Regulation and Investment in Network Industries: Evidence from European Telecoms. *Journal of Law and Economics* 55, 189-216.

- 35 Bacache et al.²⁵ use a panel of 15 European Union member states from 2002 to 2010 to model the number of facility-based lines that are owned by new entrants. Continuous growth in the number of local loop unbundling (“LLU”)²⁶ lines is observed over the time period whereas the number of new lines is low and constant in all of their study countries except for Denmark, Ireland and Sweden. In these three countries growth in the number of new lines is also observed.²⁷ When they test for the presence of a three rung ladder consisting of bitstream access, LLU, and new access facilities, no empirical evidence is found to support the theory that increasing the number of unbundled lines leads to more facility-based lines built by new entrants. The number of LLU lines is not a statistically significant predictor of the number of new lines in the future. A shorter, two-rung ladder consisting of bistream access and LLU is only weakly supported: an increase in bitstream access lines leads to an increase of LLU lines in the next year.
- 36 Cave also published an empirical paper in 2014 testing his ladder of investment theory.²⁸ Like Bacache et al., Cave fails to find evidence of his own theory in the data, concluding: “lines served by access-based entrants were by 2010 predominately reliant on unbundled loops. There were no signs of entrants ‘jumping off the ladder’ to build their own local loops.” Cave further states that access-based competition is less beneficial than full end-to-end competition between a telecommunications operator and a cable company, particularly in terms of investment for fibre deployment across the EU.
- 37 Briglauer²⁹ also studies the effect of regulations aimed at increasing access-based competition in Europe using data on unbundling for a panel of 27 European countries from 2005 to 2011. The extent of service-based competition is measured by the ratio of regulated and actually used wholesale broadband lines (through unbundling, bitstream and resale) to the total number of retail broadband lines. The unbundling access price is also a key explanatory variable in terms of regulation as it is directly set by the NRA. Briglauer finds convincing evidence that previous broadband access regulation imposed on legacy infrastructure has a negative and significant impact on aggregate next generation network (“NGN”) investment.

25 Bacache, Maya et al. (2014). Dynamic Entry and Investment in New Infrastructures: Empirical Evidence from the Fixed Broadband Industry. *Review of Industrial Organization* 44, 179-209.

26 Local loop unbundling refers to providing competitors with mandated access to the incumbent telco’s local exchange point in order to reach the homes and businesses that are served by the incumbent telco’s “last mile” of infrastructure.

27 Denmark, Ireland, and Sweden have high inter-platform competition between digital subscriber lines (“DSL”) — technology that transmits broadband through telephone networks — and cable infrastructure that might be the key driver for the growth in new lines.

28 Cave, M (2014). The ladder of investment in Europe, in retrospect and prospect. *Telecommunications Policy* 38(8-9), 674-683.

29 Briglauer, Wolfgang (2015). How EU sector-specific regulations and competition affect migration from old to new communications infrastructure: recent evidence from EU27 member states. *Journal of Regulatory Economics* 48, 194-217.

38 It is estimated that an increase in service-based competition by 1 percent leads to a decrease in NGN investment of at least 1.58 percent. This supports the hypothesis that stricter access regulation leads to decreased NGN investment. With respect to the effect of access prices on investment, an increase in the unbundling price by €1 increases NGN investment by at least 2.9 percent. An increase in the access price will incentivize both entrants and incumbents to invest in the rollout of new NGN facilities.

39 Yoo³⁰ compares broadband outcomes in Europe and the United States. Where European countries have promoted service-based competition the United States typically left the development of Internet infrastructure to firms and promoted facilities-based competition. From 2007 to 2012, per household investment in broadband more than doubled that of Europe. Yoo attributes weaker broadband investment per household — \$244 in Europe compared to \$562 in the United States by the end of 2012 — to their regulatory differences that distort the incentives for firms to invest.

40 In the Japanese context, Minamihashi³¹ estimates a dynamic entry game to evaluate the effects of regulation on investment levels. Municipal-level data on the construction of fibre-optic networks from 2005 to 2009 is analyzed. Since the early 2000s, the Japanese regulatory authority began unbundling fibre lines which decreased entrants' incentives to build new infrastructure. Minamihashi finds that forced unbundling regulation decreases new entry into infrastructure markets by 24 percent despite the regulator's intention to increase investments made by entrants. This shows that when new technologies are being deployed, regulation designed to increase competition by reducing barriers to entry may actually decrease it.

41 Many countries around the world have implemented broadband plans that set goals for speeds and coverage rates to be achieved within certain timelines. In light of these plans, the effect that regulation has on the diffusion and adoption of NGA technologies is particularly important to study. Under the umbrella of the European Commission's broadband vision, *The Digital Agenda for Europe*, European Union member states have rolled out their own strategies. Both the demand (i.e., penetration) and supply (i.e., coverage) of NGA vary significantly across these countries. Briglauer³² addresses whether or not emerging NGA infrastructure should be subjected to sector-specific *ex ante* access regulation. He studies European Union member states over an eight year period from 2004 to 2012, and finds that NGA adoption (the number of NGA connections divided by the total number of households) is negatively and significantly influenced by the extent and effectiveness of wholesale broadband access regulation (measured as the share of total regulated wholesale broadband lines related to the total retail broadband lines) that is imposed on the incumbent's first-generation DSL infrastructure. In the

30 Yoo, Christopher (2014). US vs. European broadband deployment: What do the data say? *University of Pennsylvania Center for Technology, Innovation and Competition Report*.

31 Minamihashi, Naoaki (2012). Natural Monopoly and Distorted Competition: Evidence from Unbundling Fiber-Optic Networks. *Bank of Canada Working Paper No 2012-26*.

32 Briglauer, Wolfgang (2014). The impact of regulation and competition on the adoption of fiber-based broadband services: recent evidence from the European Union member states. *Journal of Regulatory Economics* 46, 51-79.

context of Europe, the goals for NGA adoption in the European Commission's Digital Agenda conflict with the NRA's expanded access regulations on NGA infrastructure according to the results found by Briglauer.

- 42 Wallsten and Hausladen³³ also study European Union countries but extend their work to consider Japan and Korea and the adoption of next generation technologies. Using data from 2002 to 2007 they find that access-based competition has a negative impact on broadband adoption whereas facilities-based competition has a positive effect. A negative and significant correlation between the number of unbundled DSL connections per capita and the number of fibre connections is found. Furthermore, the lower the price is for LLU or bitstream access, the lower the rate of NGA adoption. On the other hand, infrastructure-based competition has a positive impact on NGA adoption in these countries. This is observed as a positive correlation between the number of DSL connections provided over entrants' own facilities and the number of fibre connections per capita provided by entrants. They also find that incumbents respond more to competition from cable and roll out more fibre when entrants provide broadband over cable networks.
- 43 In an early paper on how regulated access affects investment, Crandall, Ingraham, and Singer (2004) find that "artificially low unbundled network element ("UNE") prices induce competitive local exchange carriers ("CLECs") (i.e., entrants) to defer facilities-based investments because the net present value ("NPV") calculations of UNE leasing are higher than the NPV calculations of sinking capital into on-net assets."³⁴ As well, they found that mandatory unbundling allows the CLEC to wait to see whether incumbent investment choices have been successful, which provides the CLEC with a real option value, and the authors argue that this value tips the balance of the CLECs' investment decision in favour of waiting.
- 44 Hausman and Sidak³⁵ conduct case studies of the effects of mandatory unbundling of voice and broadband services in five countries, including Canada. They evaluate the effects of unbundling against regulators' rationales for mandated access. They find that the hypothesis that unbundling will reduce retail prices and encourage investment and innovation by incumbents and entrants is not supported by the evidence in the five countries included in the study. They also find no evidence in support of the hypothesis that mandatory unbundling enables future facilities-based investment.

33 Walsten, Scott and Stephanie Hausladen (2009). Net neutrality, unbundling, and their effects on international investment in next-generation networks. *Review of Network Economics* 8(1), 90-112.

34 Crandall, Robert W., Allan T. Ingraham, and Hal J. Singer (2014). Do Unbundling Policies Discourage CLEC Facilities-Based Investment? *The B.E. Journals in Economic Analysis & Policy*, at p. 5.

35 Hausman, Jerry A., and J. Gregory Sidak (2005). Did Mandatory Unbundling Achieve its Purpose? Empirical Evidence from Five Countries. *Journal of Competition Law and Economics* 1, 173-245.

- 45 On the other hand, some academic studies have identified access-based regulation as a driver of enhanced broadband diffusion and lower prices. These studies, which we discuss below, are cited in a report commissioned by the Canadian Network Operators Consortium (“CNOOC report”).³⁶ The CNOOC report claims there is “only weak evidence to validate the popular belief that facilities-based competition leads to more sustainable competition in the telecommunications market”, but this claim is made without a fulsome review of the academic literature.³⁷ As the studies described herein indicate, there is an extensive empirical literature discussing the downside of reduced investments from extensive reliance on access-based regulation in order to promote competition. As the rollout of NGA networks requires large capital investments to build new infrastructure, facilities-based competition allows for competitive outcomes without reduced performance. The two sides of the literature reflect the regulatory challenge of simultaneously encouraging investment and competition, yet both can be achieved when there exists healthy levels of facilities-based competition. Below, we discuss the academic papers further.
- 46 Gruber and Koutroumpis³⁸ consider how access regulations affect the diffusion of broadband in 167 markets from 2000 to 2010. They find that intra-platform competition on the incumbent’s DSL network accelerates adoption of broadband, while no such effect is found with respect to inter-platform competition. However, the positive impact that regulatory access is found to have on the diffusion of broadband dissipates after three to four years. Their study does not address the quality and performance of the broadband offered. Since national broadband goals typically consider both the speed and the uptake of broadband access, Gruber and Koutroumpis acknowledge that significant investment in infrastructure is required to develop NGNs, which was not part of their study.
- 47 In a study involving 30 OECD countries using data from 2000 to 2008, Lee et al.³⁹ find that LLU was one of several factors — in addition to income, population density, education, and price — that had a positive impact on fixed broadband penetration. The authors acknowledge that unbundling the local loop favours short-term speed of diffusion over longer-term incentives to invest. Their modelling captures the effect of LLU on the speed of diffusion and does not consider its effect on the long-term total number of subscribers.

36 Ware, Roger (2018). Competition Issues in Facilities Based Versus Service Based Competition and Disaggregated Wholesale HAS Transport.

37 As well, some of the comparisons made in the CNOOC report for Canada use dated information, such as wireline broadband prices from September 2012 at Table 1 of the CNOOC report, or Canadian investments in fibre to the premise from 2013. As we discuss herein, Canada compares favourably to other countries on many fronts, when current information is considered.

38 Gruber, Harald and Pantelis Kouroumpis (2013). Competition enhancing regulation and diffusion of innovation: the case of broadband networks. *Journal of Regulatory Economics* 43: 168-195.

39 Lee, Sangwon, Mircea Marcu and Seonmi Lee (2011). An empirical analysis of fixed and mobile broadband diffusion. *Information Economics and Policy* 23(3-4): 227-233.

- 48 In a more limited case study, Eskelinen et al.⁴⁰ compare Sweden's more interventionist approach to regulating broadband to Finland's market-based approach with respect to rollout speeds and prices. Finland was found to have slower diffusion and higher prices at the beginning of its broadband strategy rollout between 2000 and 2003, but both countries realize similar coverage levels and prices a few years later. Finland's broadband coverage surpassed Sweden's in 2003 and their prices fell to Sweden's levels by 2005. Their study pre-dates the rollout of NGA networks and hence it does not comment on broadband performance.
- 49 In a 2015 report commissioned by Ofcom (the UK telecommunications regulator), the authors study the G7 countries, Australia, Korea, the Netherlands, Spain and Sweden using data from 2014.⁴¹ They do not find evidence that regulatory forbearance on access to NGA networks stimulated NGA deployment in the countries studied. On the other hand, the study does not find evidence that regulations like structural separation provided better outcomes for consumers. Consistent with other studies, the Ofcom-commissioned report finds that, in general, countries with higher levels of LLU had lower NGA deployment.
- 50 A more recent study by Ovington et al.⁴² they find that LLU had a positive impact on broadband uptake for the EU27 between 2004 and 2011.⁴³ Their measure of inter-platform competition (i.e., the percentage of new entrants' non-DSL lines) has a slightly smaller yet statistically equal impact on broadband uptake in their baseline specification but is not robust to alternative specifications.⁴⁴ Both inter-platform competition and LLU are subject to diminishing returns as their shares increase. In areas where there are already higher levels of inter-platform competition, LLU is crowded out and becomes less effective at enhancing broadband penetration. In terms of policy implications, this means that there is little incremental benefit to promoting LLU in areas where there already exists high levels of inter-platform competition, or end-to-end facilities-based competition.

40 Eskelinen, Heikki, Lauri Frank and Timo Hirvonen (2008). Does strategy matter? A comparison of broadband rollout policies in Finland and Sweden. *Telecommunications Policy* 32(6): 412-421.

41 Godlovitch, Ilsa, Iris Henseler-Unger and Ulrich Stempf (July 2015). Competition and investment: An analysis of the drivers of superfast broadband. WIK-Consult.

42 Ovington, Tom et al. (2017). The impact of intra-platform competition on broadband penetration. *Telecommunications Policy* 41, 185-196.

43 The EU27 is the group of countries in the European Union before 2014.

44 There is very little variation in inter-platform competition over time and this could be a reason as to why it is more sensitive to the specification used.

- 51 There are fewer studies addressing investment in wireless infrastructure, but in one recent academic study by Kim et al.,⁴⁵ the authors test the effects of voluntary and mandated mobile virtual network operator (“MVNO”) access on mobile network operator (“MNO”) investment levels for a sample of 21 countries from 2000 to 2008. Their study compares incumbent (i.e., MNO) “investment intensity” which is calculated as capital expenditure on wireless cellular networks divided by wireless revenue, for those MNOs in jurisdictions with mandated MVNO access compared to those jurisdictions with voluntary or no MVNO access, controlling for other factors that would explain differences in carrier investment intensity across countries and over time. Non-mandatory MVNO access includes any form of voluntary provision of MVNO access by MNOs and threats of regulatory intervention. The countries with mandatory MVNO access are Australia, Denmark, Norway, Spain and Sweden. Canada is one of the countries included in the Kim et al. study that has MVNO presence but which is not mandated by regulation.
- 52 Across the sample, MVNOs generally have small market shares.⁴⁶ Nevertheless, the authors directly test whether mandated MVNO access reduces investment levels by MNOs, controlling for other influences on MNO investment intensity. The authors find that mandated MVNO access has a large negative and statistically significant (at the 10 percent level) effect on MNO investment. Mandated MVNO access is associated with 17.1 percent less investment intensity.
- 53 The authors do not find that the mere presence of MVNOs has any statistically significant effect on MNO investment intensity. As well, they do not find that voluntary MVNO access has any statistically significant negative effect on MNO investment intensity. It is therefore the mandated nature of MVNO access that has a negative effect on carrier investment.
- 54 In summary, there are numerous empirical studies on the impact that access-based wholesale regulations have on investment decisions and the adoption of next generation technologies. It is generally accepted by academics and national regulators alike that the best market outcomes are the result of end-to-end facilities-based competition instead of access-based competition. Despite the goal of promoting future facilities-based competition by allowing entrants to climb the “ladder of investment”, there is little empirical support in the literature of new entrants fully climbing the ladder in order to compete against incumbents through the construction of their own facilities. Some studies have found that access regulation improved the initial deployment of broadband, with these benefits dissipating in the years following. However, the empirical literature generally shows that the stronger is access regulation, the less both incumbents and entrants invest, which is counter to the regulatory agency’s original objective of spurring competition in fixed broadband. Furthermore, adoption of next generation technologies is negatively correlated with the amount of wholesale access.

45 Kim, Jihwan et al. (2011). Access Regulation and Infrastructure Investment in the Mobile Telecommunications Industry. *Telecommunications Policy* 35(11), 907-919.

46 Kim et al., supra footnote 10, at p. 915.

- 55 In Section 3 we will survey many of the same measures that have been used in the studies reviewed in this section. By comparing these measures for each country we observe the variance in broadband outcomes and the key relationships between fixed broadband penetration rates, NGA access, average speeds and performance-adjusted prices.

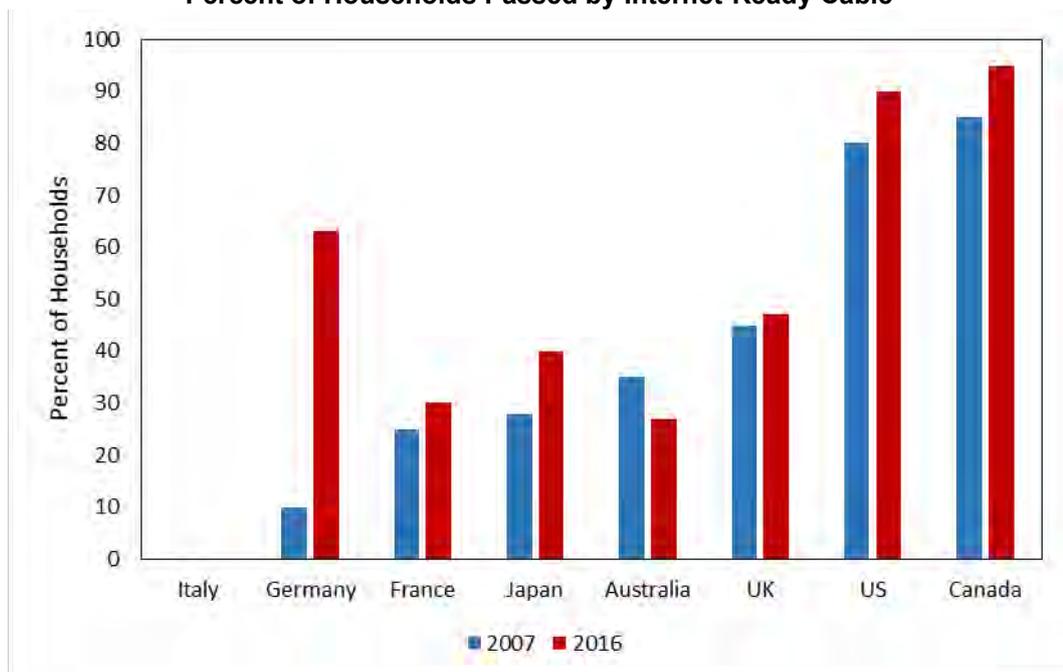
3. CROSS-COUNTRY COMPARISONS

56 In this section, we illustrate the relationships between different measures of broadband performance. Overall, we show that countries that had high levels of end-to-end facilities-based competition in the past generally enjoy favourable broadband outcomes today with less public investment required.

3.1. FACILITIES-BASED COMPETITION AND NGA INVESTMENTS

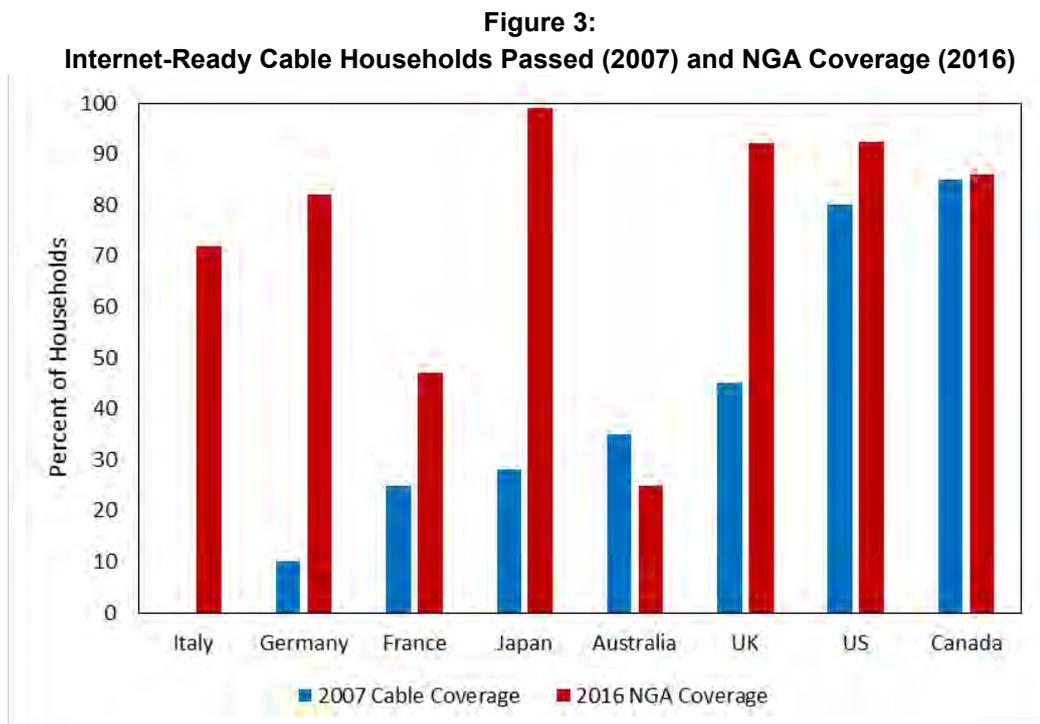
57 In the earlier study, the extent of end-to-end facilities-based competition was measured by the penetration levels for Internet-ready cable. In Figure 2 we provide the percent of households in both 2007 and 2016 that are passed by Internet-ready cable to show how past facilities-based competition are related to current levels.

Figure 2:
Percent of Households Passed by Internet-Ready Cable



Sources: Ofcom's Communications Market Report (December 2016) and Telecom Decision CRTC 2018-44 for 2016 data; An International Comparison of End-to-End Facilities Based Competition in Telecommunications by CRA (March 2007) for 2007 data.

- 58 Using Internet-ready cable penetration rates as the measure of inter-platform competition, Canada and the United States continue to have the largest amounts of end-to-end facilities-based competition. Their lead over other countries in 2007 remains the case in 2016 with both countries exceeding 90 percent coverage. The rest of the countries all had Internet-ready cable coverage below 50 percent in 2007. Of these six countries, only Germany has significantly grown its cable presence from 10 percent in 2007 to 63 percent in 2016. Japan had the next highest growth although it still has not reached 50 percent cable coverage. This weak cable coverage is supplemented by strong fibre optic coverage which drives Japan's performance in broadband outcomes. Australia has had cable infrastructure shrink in the last decade down to 27 percent from 35 percent. Cable coverage in France and the UK has almost remained constant and Italy has remained the only country in our sample with no cable coverage.⁴⁷
- 59 Next we compare how the historical Internet-ready cable coverage in 2007 provided a base for 2016 NGA penetration. As noted earlier, we adopt the definition of NGA used in the European Commission's *Digital Progress Reports* which includes all technologies capable of download speeds in excess of 30 Mbps. Figure 3 compares the Internet-ready cable penetration in 2007 and NGA coverage in 2016.



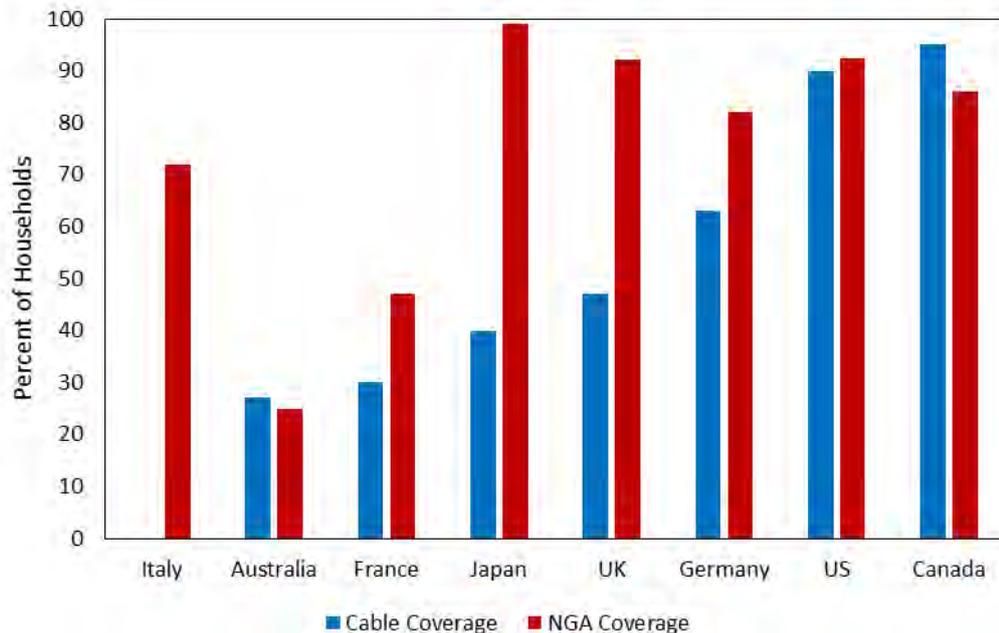
Sources: European Commission's *Europe's Digital Progress Report 2017* for EU countries; 2017 CRTC *Communications Monitoring Report* for Canada; Ofcom's 2017 *International Communications Market: Telecoms and Networks* for Japan; FCC's 2018 *Broadband Deployment Report* for the US; NBN Corporate Plan 2017 for Australia; An International Comparison of End-to-End Facilities Based Competition in Telecommunications by CRA (March 2007) for 2007 data.

47 Of the EU28 countries, only Italy, Greece and Iceland do not have cable broadband networks.

60 We can tell from Figure 3 that NGA coverage in 2016 is only slightly positively correlated with Internet-ready cable coverage in 2007. For countries like Canada and the United States, the high levels of facilities-based competition in 2007 have translated into high levels of NGA coverage. Italy, Germany, Japan and the United Kingdom all had low Internet-ready cable coverage in 2007 but now have NGA coverage of over 70 percent. These four countries can be divided into two groups: (i) Italy and Japan, and (ii) Germany and the United Kingdom. Both countries in the first group had high levels of fibre-to-the-home (“FTTH”) rollout in the early 2000s, which is not reflected in their Internet-ready cable coverage but is certainly a positive influence on NGA coverage. In the case of Japan, significant public investments were made to achieve the high fibre rollout levels. The second group also experienced high levels of public funding towards their next generation networks as well as some degree of wholesale access deregulation over the time period.⁴⁸ Lastly, Australia and France both had low levels of Internet-ready cable coverage and currently experience low NGA coverage.

61 As there has been some growth in Internet-ready cable coverage over the last decade, Figure 4 compares NGA coverage in 2016 with Internet-ready cable penetration in 2016.

Figure 4:
Internet-Ready Cable Households Passed (2016) and NGA Coverage (2016)



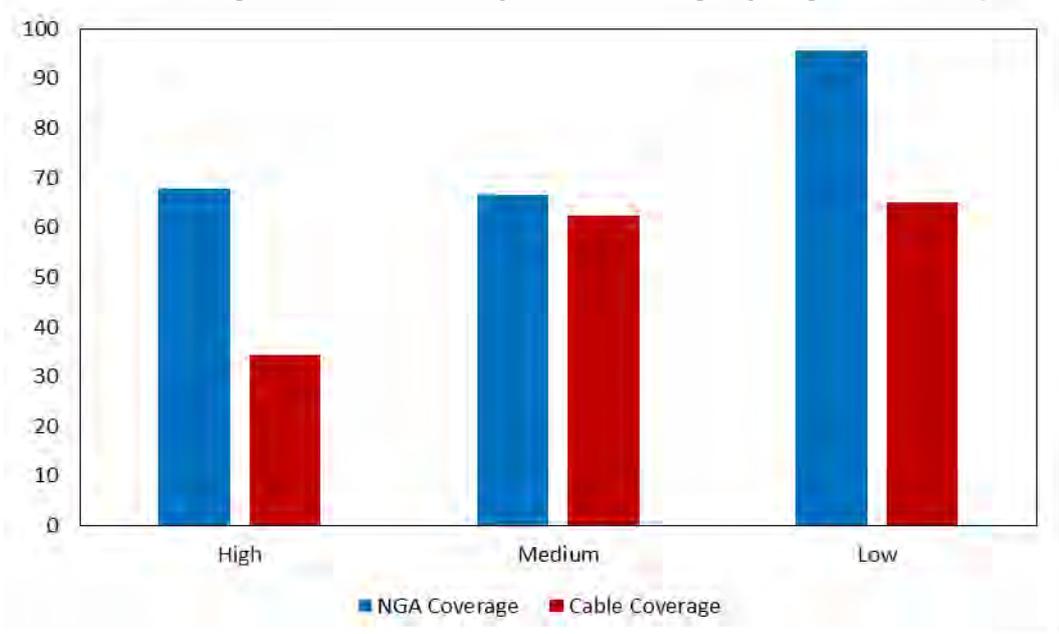
Sources: Refer to Figure 2 sources for cable coverage data; refer to Figure 3 sources for NGA coverage data.

48 Germany experienced unregulated unbundled fibre for a period of time while Deutsche Telekom was building out its fibre network before the European Commission intervened and regulation was re-implemented in a December 2009 ruling. Legislation had been passed to change the rules about the regulation of “new markets” which, in effect, reversed the onus so that the default setting would be “no regulation” unless the absence of regulation could be shown to have harmed competition. Ofcom has eased access regulations in some regions of the UK that are deemed sufficiently competitive.

62 Five countries — Canada, Germany, Japan, the United Kingdom, and the United States— have very high levels of NGA coverage exceeding 80 percent. Out of this subset of countries only Japan and the United Kingdom have relatively low percentages of households passed by Internet-ready cable in 2016. However, both countries have had significant public investments in broadband and Japan also has low levels of wholesale access regulation.⁴⁹

63 Using the regulation levels from Gilbert + Tobin,⁵⁰ we present the average NGA coverage and Internet-ready cable coverage levels in 2016 for each group in Figure 5.⁵¹ We see that the low regulation countries obtain the highest average NGA coverage at over 95 percent and both the high and medium regulation groups have average NGA coverage of around 67 percent. The high regulation group has the lowest levels of facilities-based competition with average Internet-ready cable coverage of only 34.3 percent. The medium and low regulation groups have similar levels of average Internet-ready cable coverage at 62.5 and 65.0 percent respectively.

Figure 5:
NGA Coverage and Internet-Ready Cable Coverage by Regulation Group



Notes: Simple averages are taken across the countries in each group.
Sources: Authors' calculations. See Figure 2 sources for cable and Figure 3 sources for NGA.

49 See Figure 16 in Section 3.3 for wholesale access regulation rankings. Refer to Appendix B.3 for methodologies and results.

50 Gilbert + Tobin is a law firm with considerable international experience and expertise in telecommunications regulations. Gilbert + Tobin were commissioned by Bell Canada to produce a wholesale access regulation index for the countries studied in this report.

51 High regulation countries are the United Kingdom, Australia, Germany, and Italy; medium regulation countries are France and Canada; low regulation countries are Japan and the United States.

64 When studying countries that have both low end-to-end facilities-based competition and high NGA coverage it becomes clear that a large amount of public investment has been incurred to obtain favourable broadband outcomes in those countries without extensive end-to-end facilities-based competition. For example, Japan has made substantial private-public investments in its broadband infrastructure which results in high performance measures yet lacks vast Internet-ready cable coverage. In Figure 6, we provide estimates for the amount of public investment that each country’s government has put into developing their respective broadband networks.

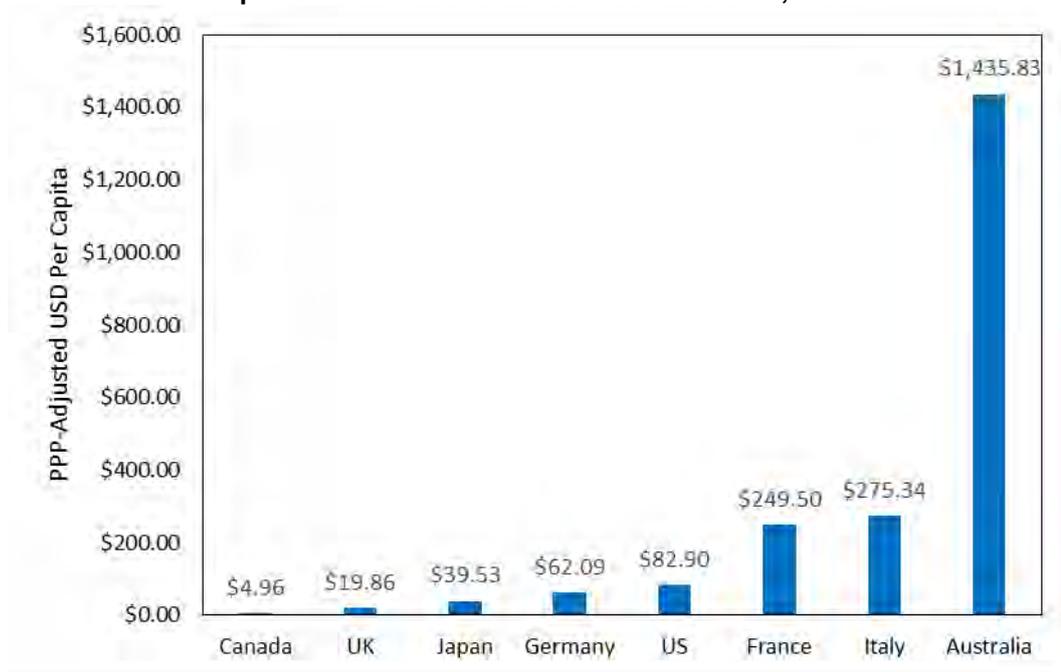
**Figure 6:
 Public Investments in National Broadband Programs**

Country	Program Name	Investment (Billions of USD)
Canada	Connecting Rural Canadians	<\$0.2
UK	Britain’s Superfast Broadband Future	\$1.3
Japan	New Broadband Super Highway	\$5.0
Germany	Digital Agenda	\$5.1
Italy	Piano Nazionale Banda Larga	\$16.6
France	Plan national très haut débit	\$16.7
US	Connecting America: The National Broadband Plan	\$27.0
Australia	National Broadband Network	\$34.6

Notes: Expenditures are for the period from 2010-2016 and are approximations based on several sources. Prices are adjusted using the OECD’s PPP Index.

65 While investments made by Japan in our previous example have been extensive, they are the third lowest on a per capita basis of the eight study countries. Figure 7 compares the per capita public investments made in fixed broadband in each country over the 2010-2016 period. Local spending figures were converted into US dollars per capita using 2016 population and the OECD’s purchasing power parity (“PPP”) index for each country.

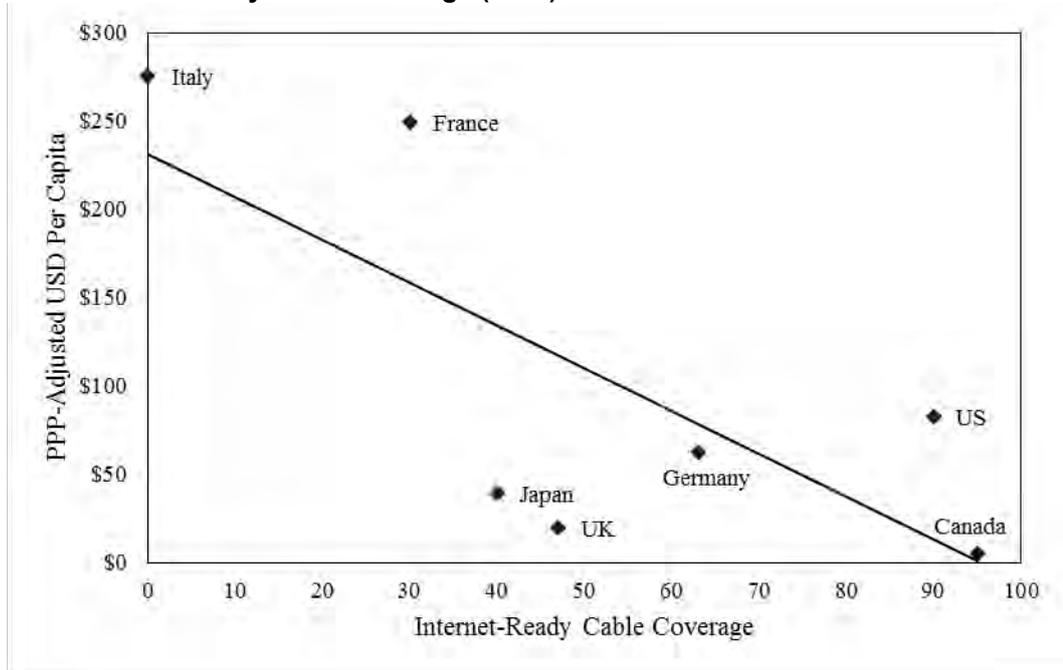
**Figure 7:
 Per Capita Public Investment in Fixed Broadband, 2010-2016**



Notes: OECD PPP and United Nations population data are used to obtain per-capita USD figures.
Sources: Financial Review article (August 2018) for Australia; Market Wired article (September 2009) for Canada; UK Government Policy paper (May 2015) for the UK; European Commission study on national broadband plans for Germany and Italy; Ashurst study (October 2017) for France; MIC 2010 report for Japan; Technology Policy Institute 2017 report for the US.

- 66 Australia is a significant outlier having invested vastly larger sums through its National Broadband Network initiative than any other study country, yet it has the poorest NGA coverage (see Figure 4). Canada is also an outlier, but in the opposite direction with public sector investments in broadband that have been many multiples smaller than any of the other countries, yet Canada has some of the highest rates of NGA coverage. One way to reconcile the dichotomy between Australia and Canada is to look at their levels of facilities-based competition. Australia has a very low level of facilities-based competition at only 27 percent of households being passed by Internet-ready cable whereas Canada has the highest level amongst our study countries at 95 percent. High levels of previously existing network competition have been a positive force for higher levels of private investment in broadband networks which relieves some of the burden on governments to use public funds to build out infrastructure.
- 67 The relationship between Internet-ready cable coverage and public investment in broadband is presented in Figure 8. A strong negative correlation between the two variables is evident even after excluding Australia (an outlier that is consistent with this trend).

**Figure 8:
Internet-Ready Cable Coverage (2016) and Public Broadband Investment**

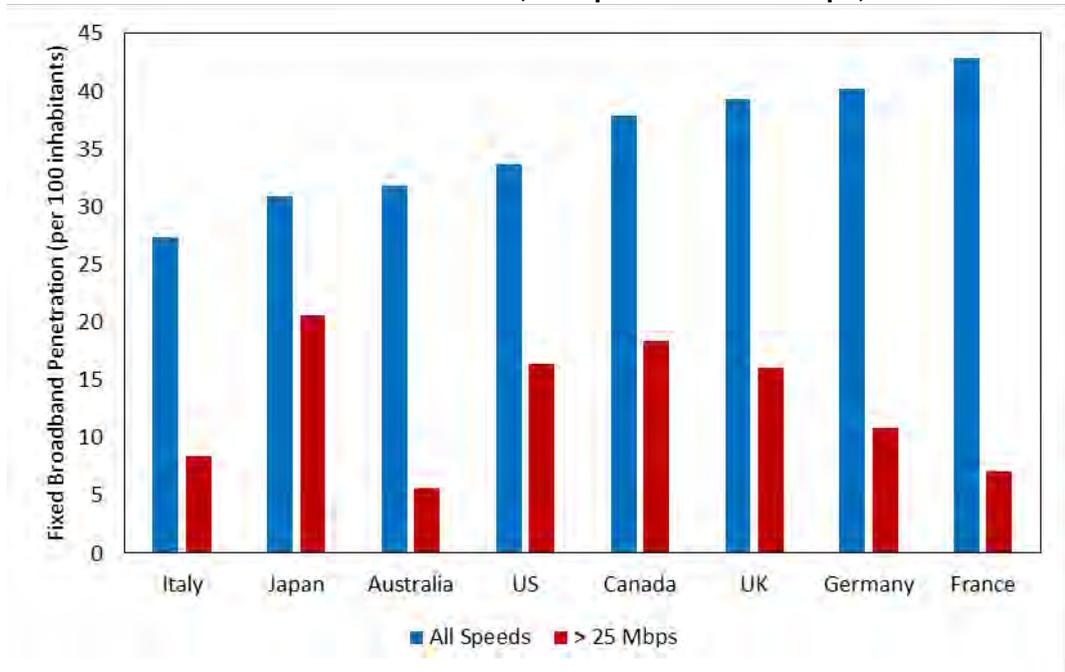


Sources: Refer Figures 7 sources for public investment and Figure 2 sources for cable coverage.

3.2. NGA COVERAGE AND BROADBAND MARKET OUTCOMES

- 68 Governments drive to fund additional NGA penetration when it was not provided through end-to-end facilities-based competition is not an end in itself. Increased NGA penetration is expected to increase subscriptions to higher-speed Internet services, while also allowing for higher speeds to be available to more consumers.
- 69 Figure 9 compares 2016 rates of fixed broadband penetration (per 100 inhabitants) for all speeds and those that are higher-speed (i.e., speeds over 25 Mbps). There is not a strong correlation between overall broadband penetration and that which is high-speed. For example, France has the highest level of fixed broadband penetration and Japan the second lowest in our sample, yet France has the second lowest high-speed penetration and Japan has the highest.

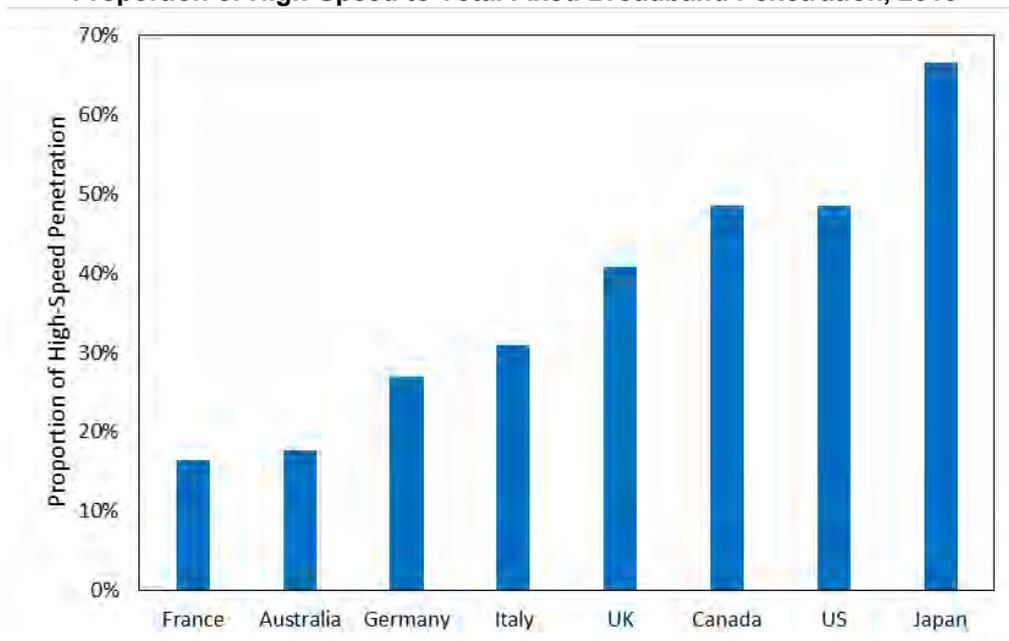
**Figure 9:
 Fixed Broadband Penetration, All Speeds and >25 Mbps, 2016**



Source: OECD Fixed Broadband Statistics, December 2016.

70 Figure 10 provides another depiction of fixed broadband demand in each country by showing the proportion of high-speed penetration to total fixed broadband penetration, which aims to focus on the quality of broadband that we observe in Figure 9.

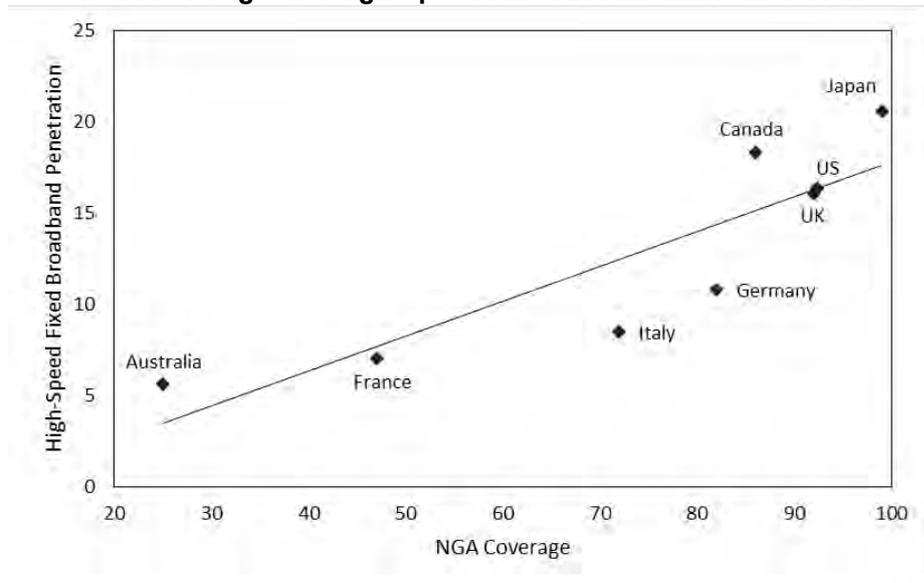
**Figure 10:
 Proportion of High-Speed to Total Fixed Broadband Penetration, 2016**



Source: Authors' calculations. OECD Fixed Broadband Statistics, December 2016.

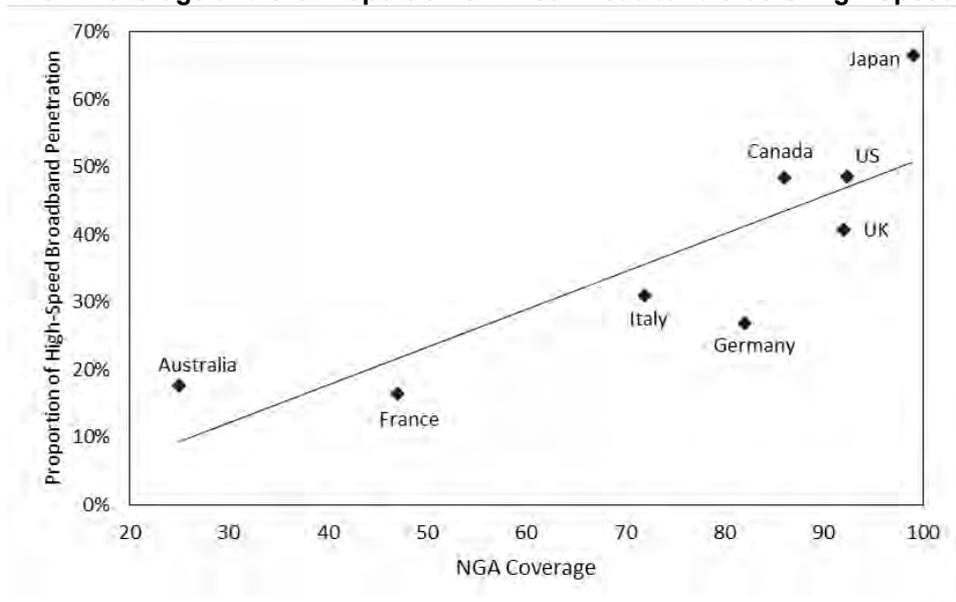
71 Now we can see that France has the lowest proportion of high-speed to overall broadband penetration whereas Japan has the highest. Countries with higher NGA coverage have greater numbers of high-speed Internet service subscriptions (as shown in Figure 11) and higher fractions of their broadband subscriptions as high-speed (as shown in Figure 12).

**Figure 11:
 NGA Coverage and High-Speed Fixed Broadband Penetration**



Sources: Refer to Figure 3 for NGA coverage and Figure 9 for broadband penetration.

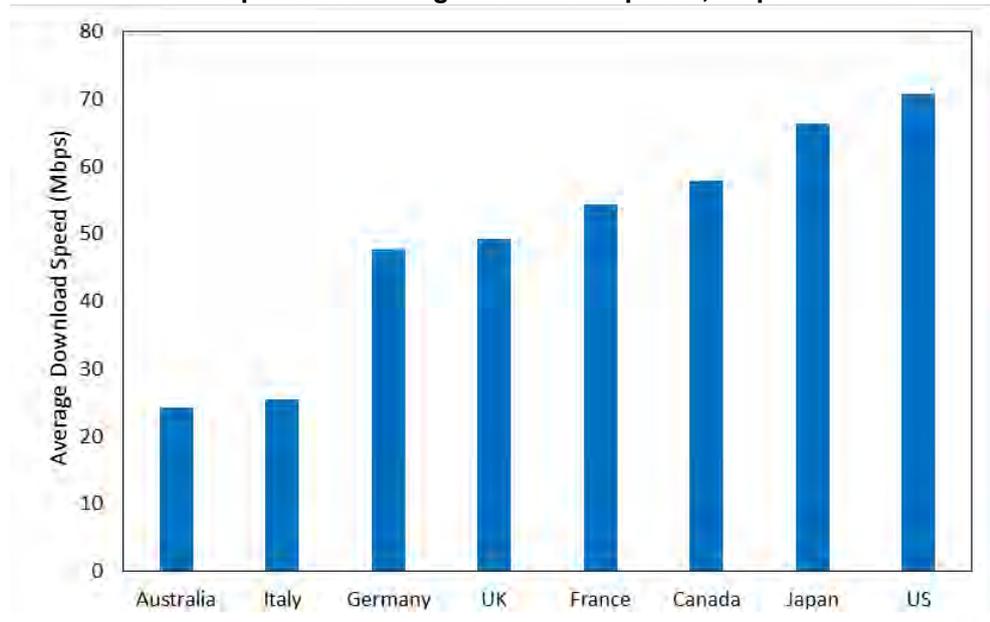
**Figure 12:
 NGA Coverage and the Proportion of Fixed Broadband that is High-Speed**



Sources: Refer to Figure 3 for NGA coverage and Figure 10 for penetration proportions.

72 The quality of broadband being delivered in a country is a key component of many national broadband plans. Download speeds are typically used as a metric to determine the quality of broadband. Using Speedtest survey data from July 2017,⁵² we plot the average download speeds for each country in Figure 13.

Figure 13:
Speedtest Average Download Speeds, Mbps

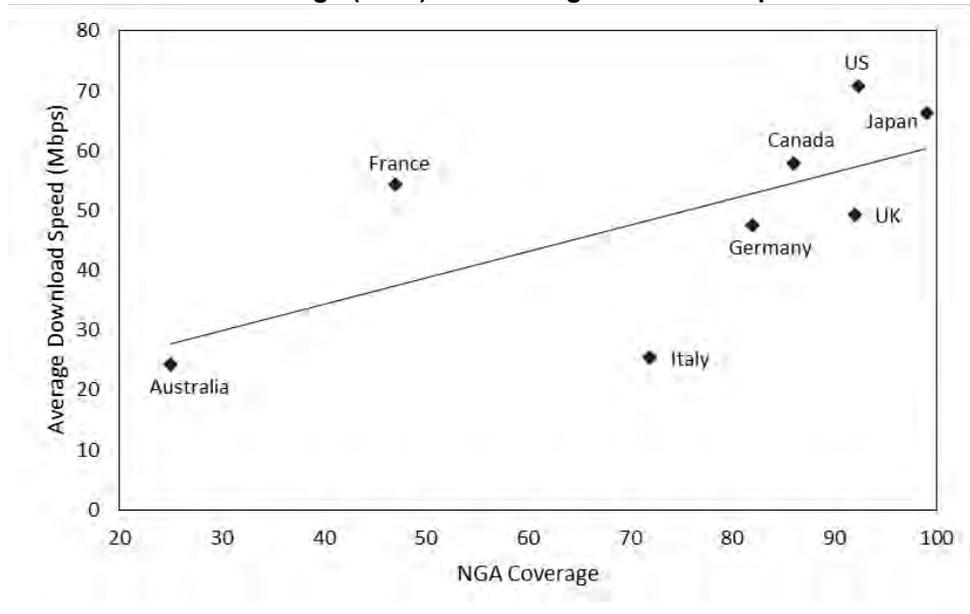


Source: Speedtest Global Index, July 2017.

73 Average download speeds are also positively correlated with the level of NGA coverage, which is observed in Figure 14. This is to be expected as NGA networks provide consumers with higher quality broadband services.

52 We obtained data from the Speedtest Global Index on fixed broadband download speeds. Retrieved from <http://www.speedtest.net/global-index>.

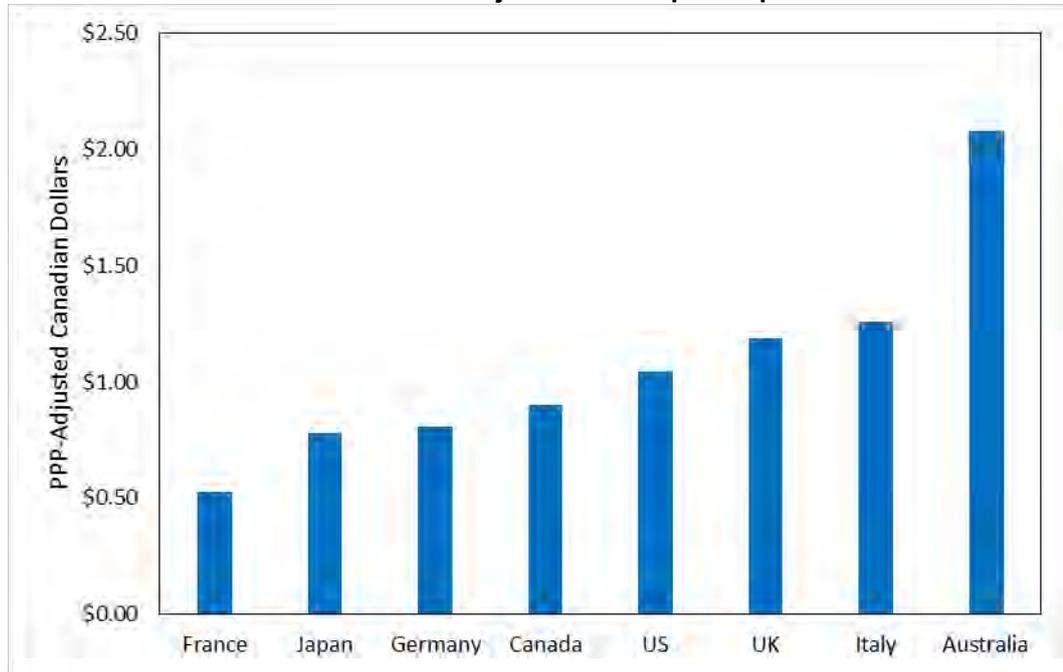
Figure 14:
NGA Coverage (2016) and Average Download Speeds



Sources: Refer to Figure 3 for NGA coverage and Figure 13 for download speeds.

74 Prices are also important to consider in terms of broadband outcomes. We plot the performance-adjusted prices for each country in Figure 15 using average plan prices over the five basket levels in the 2017 Nordicity international pricing comparison report and obtain an average price per Mbps for each country. Australians pay the most whereas the French pay the least. Canada sits in the middle of our study countries at just under \$1 per Mbps.

Figure 15:
Performance-Adjusted Prices per Mbps



Source: Authors' calculations. Nordicity 2017 Price Comparison Study of Telecommunications Services in Canada and Select Foreign Jurisdictions for prices; refer to Figure 13 for download speeds.

3.3. MANDATED WHOLESALE ACCESS AND BROADBAND MARKET OUTCOMES

75 The last decade has seen a general move towards reducing wholesale access regulations. Figure 16 presents the regulation classification for each country as established by Gilbert + Tobin. Italy has the highest levels of wholesale access regulation of the eight study countries. The United Kingdom, Australia, and Germany round out the countries that are considered to have high regulation. France and Canada are medium regulation countries. The United States has the lowest levels of access regulation with Japan being a low regulation country that is on the cusp of being a medium regulation country.

**Figure 16:
 Levels of Wholesale Regulation in Selected Countries**

<i>Low Regulation Countries</i>	<i>Medium Regulation Countries</i>	<i>High Regulation Countries</i>
Japan	France	Italy
United States	Canada	United Kingdom
		Australia
		Germany

Source: Gilbert + Tobin, October 2018.

76 Several factors were taken into consideration by Gilbert + Tobin in order to arrive at the classifications in Figure 16. We present each of these factors used in their classifications below.

3.3.1. The Number of Regulated Services

77 The first factor Gilbert + Tobin considered is what services are regulated under wholesale access regulation in each country. For each country a colour is assigned to each service with red meaning that the service is regulated, yellow indicates that the service is partially regulated, and green means that the service is unregulated. Figure 17 presents these results.

**Figure 17:
Regulated Services by Country**

	LSS	LLU	Unbundled Fibre	VULA ⁵³	Resale	Bitstream	Ethernet	Leased Lines ⁵⁴	Leased Lines ⁵⁵
Australia	Red	Red	Green	Green	Green	Red	Yellow	Yellow	Yellow
Germany	Red	Red	Red	Red	Green	Red	Red	Yellow	Green
France	Red	Red	Green	Green	Green	Red	Green	Red	Green
Italy	Red	Red	Red	Red	Green	Red	Red	Yellow	Green
Japan	Red	Red	Red	Green	Green	Green	Green	Green	Green
UK	Red	Red	Green	Red	Green	Green	Green	Yellow	Green
US	Green	Red	Green	Green	Green	Green	Green	Green	Green
Canada	Green	Green	Green	Red	Green	Red	Green	Red	Green

Source: Gilbert + Tobin, October 2018.

3.3.2. Wholesale Pricing Principles

78 The pricing principles that each country uses for services that are regulated were also considered by Gilbert + Tobin. Figure 18 shows how each service is priced according to the following key: long run incremental cost (“LRIC”) in red, cost oriented standard in yellow,⁵⁶ retail minus or price cap in green, and services that are unregulated in white.

53 Virtual unbundling local access (“VULA”).

54 With wholesale terminating segment.

55 With wholesale trunk segment.

56 This principle may not be as strict as LRIC, may be LRIC with mark up, or may be a hybrid model where the anchor or standard product is LRIC but other tiers are more loosely price controlled, but still broadly cost-related.

**Figure 18:
 Access Pricing Principles by Country**

	LSS	LLU	Unbundled Fibre	VULA	Resale	Bitstream	Ethernet	Leased Lines ⁵⁷	Leased Lines ⁵⁸
Australia	Red	Red	White	White	White	Red	Yellow	Red	Red
Germany	Red	Red	Red	Red	White	Green	Yellow	Green	White
France	Red	Red	White	White	White	Red	White	Yellow	White
Italy	Red	Red	Yellow	Yellow	White	Red	Green	Green	White
Japan	Red	Red	Yellow	White	White	White	White	White	White
UK	Red	Yellow	White	Yellow	White	White	White	Yellow	White
US	White	Red	White	White	White	White	White	White	White
Canada	White	White	White	Red	White	Red	White	Red	White

Source: Gilbert + Tobin, October 2018.

3.3.3. Non-Price Conditions

79 Lastly, non-price conditions were considered by Gilbert + Tobin. This is particularly important in terms of NRAs separating various operations of an incumbent. This factor is classified by Gilbert + Tobin in the following way: high regulation in red, moderate regulation in orange, low regulation in yellow, and no regulation in white.

57 With wholesale terminating segment.

58 With wholesale trunk segment.

**Figure 19:
Non-Price Conditions by Country**

	Service Levels/ KPIs/ SLGs	Regulatory Oversight of Non-Price Terms	Accounting Separation	Equivalence Requirements	Organizational Separation
Australia	Yellow	Yellow	Orange	Red	Orange
Germany	Orange	Red	Orange	Orange	White
France	Red	Red	Red	Red	White
Italy	Red	Red	Red	Orange	Orange
Japan	White	Red	Orange	Yellow	Yellow
UK	Red	Red	Red	Red	Red
US	White	White	White	White	White
Canada	Red	Red	Red	Yellow	Yellow

Source: Gilbert + Tobin, October 2018.

3.4. SUMMARY

80 Canada and the United States hold different classifications from a regulation perspective despite being similar in having the highest degree of end-to-end facilities-based competition. Japan is a low regulation country, like the United States, but with a lower level of Internet-ready cable competition. However, Japan does have extensive NGA network build-out, which has been created with significant public investments.

81 Among the European countries, France is considered to be a medium regulation country but without greater Internet-ready cable competition compared to the other European countries, and with lower NGA coverage than other countries. Germany is classified by Gilbert + Tobin as a high regulation country, although it is only recently classified this way because Germany was required by the European Commission to have mandated access to unbundled fibre. Earlier Germany did not mandate access to next generation services, and hence it would have been considered a medium regulation country without unbundled fibre. Germany has higher NGA coverage and higher Internet-ready cable penetration in 2016 than France even with somewhat similar regulation scores. The high regulation countries that remain – Australia, Italy and the United Kingdom – all have lower levels of NGA coverage.

4. CONCLUSION

- 82 Our comparison of the G7 countries and Australia today reinforces findings obtained from the empirical literature studying investment and competitive outcomes in telecommunications. We find that countries that had limited competition between cablecos and telcos for fixed broadband services in 2007, and hence adopted extensive wholesale access regulatory regimes, have not delivered the same levels of broadband investment and NGA deployment as the United States and Canada that had the highest rates of end-to-end facilities competition in 2007. Countries without the investments driven by facilities-based competition have sought to achieve higher NGA deployment with substantial public sector investments.
- 83 Canada is an outlier in having the lowest level of per capita public sector investments in broadband, yet one of the highest NGA deployment levels with commensurate high levels of high-speed broadband penetration and high average download speeds.
- 84 Performance-adjusted prices per Mbps are highest in many of the highest regulated countries, such as Australia, Italy and the United Kingdom, which is the result of poor speed performances, especially in Australia. Canada's performance-adjusted prices per Mbps are in the middle of the eight country study group, excluding Australia as an outlier. Low regulation countries do not have the highest performance-adjusted prices, as Japan has the second-lowest performance-adjusted prices and performance-adjusted prices in the United States are in the middle, one country higher ranked (in price) than Canada.
- 85 In sum, we find that the Commission's conclusion that facilities-based competition is the best form of competition continues to hold. With higher levels of cableco and telco competition in fixed broadband there is little need for additional wholesale access regulation. Competition between facilities-based competitors results in greater private sector investment, which in turn means reduced need for public subsidy of broadband networks in order to achieve high NGA penetration. High-speed internet penetration rates and higher average download speeds are positively correlated with NGA penetration levels. The result is better broadband performance is delivered with facilities-based competition and not access regulation.

APPENDIX A: COUNTRY SUMMARIES

- 86 This appendix sets out the overall results of our international comparison of the performance of national telecommunications industries. In particular, we have assessed the performance of telecommunications markets in Australia, Canada, France, Germany, Italy, Japan, the United Kingdom and the United States. Refer to Appendix B for sources of headline data for all countries.
- 87 Governments have been setting goals surrounding broadband deployment since the early 2000s. As technology has developed the goals have been modified to promote continued innovation and increasing download and upload speeds. Current national broadband strategies typically set thresholds for coverage at certain speeds. The table below lists the name and year of adoption for the national broadband strategies in each of our sample countries. The substantial government involvement in a number of countries have considerably increased investment levels, supplementing (and perhaps replacing) private sector investments. Below, we provide a summary of the main components of each country's national broadband policy.

**Table A.1:
Summary of National Broadband Plans**

Country	Year	Plan Name, Key Targets & Government Investment
Australia ^{59,60}	2010 ⁶¹	<i>National Broadband Network</i> <ul style="list-style-type: none"> • Connect 93% of households and businesses with FTTP offering speeds of up to 100 Mbps by 2016. • Initial commitment of AUD\$40.7 billion.
Canada ⁶²	2010 ⁶³	<i>Broadband Canada: Connecting Rural Canadians</i> <ul style="list-style-type: none"> • Successful providers received federal support equal to up to 50% of their one-time costs. • Providers were expected to provide broadband service of at least 1.5 Mbps to currently underserved households. • Investment of CAD\$225 million through Canada's Economic Action Plan.
France ^{64,65}	2013	<i>Plan national très haut débit</i> <ul style="list-style-type: none"> • Aims to bring very high-speed broadband service to every home, business and government office by 2022. • €20 billion investment shared by private sector providers, local authorities and the Government. • The goal was revised to 2025 with a focus on finalizing the roll out of FTTH throughout the whole country.⁶⁶

59 James, Matthew (n.d.). National Broadband Network (NBN). Retrieved from https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/BudgetReview201314/NBN

60 Medina and Sorensen (2016). The End of Australia's National Broadband Network?

61 The network was first announced by the Labor Government in April 2009.

62 Broadband Canada: Connecting Rural Canadians Launches its Call-For-Applications Process (2009, September 1). Retrieved from <http://www.marketwired.com/press-release/broadband-canada-connecting-rural-canadians-launches-its-call-for-applications-process-1038385.htm>

63 Announced by Prime Minister Stephen Harper on July 30, 2009.

64 The French Very High-Speed Broadband Plan. Retrieved from <https://agencedunumerique.gouv.fr/en/the-french-high-speed-broadcast-plan/>

65 Pineau, Elizabeth. (2013, February 20). France launches 20 bln euro fibre broadband rollout. Retrieved from <https://www.reuters.com/article/france-broadband/france-launches-20-bln-euro-fibre-broadband-rollout-idUSL6N0BKDWT20130220>

66 Rosemain, Mathieu and Gwénaëlle Barzic. (2017, September 27). France sees 2025 as new goal for ultra-fast broadband roll-out. Retrieved from <https://www.reuters.com/article/us-france-telecoms/france-sees-2025-as-new-goal-for-ultra-fast-broadband-roll-out-idUSKCN1C220U>

Germany ^{67,68,69}	2009	<i>Digital Agenda 2014-2017</i>	<ul style="list-style-type: none"> • Provide at least 50 Mbps download speeds countrywide by 2018 in both rural and urban areas. • A comprehensive national funding programme worth more than €4 billion was established. • <i>Digital Strategy 2025</i> focuses on rolling out gigabit-capable coverage infrastructures by 2025.
Italy ^{70,71,72}	2010	<i>Piano Nazionale Banda Larga (PNBUL)</i>	<ul style="list-style-type: none"> • There is a separate broadband plan for rural areas. • Goals of the plan included 100% coverage with 30 Mbps access and 50% household penetration of 100 Mbps, both by 2020. • The “best case scenario” requires an investment of €12 billion to fully implement the plan. • Another plan, the €4 billion <i>Italian National Ultra-Broadband Scheme</i>, will run from 2016 to 2022.
Japan ⁷³	2010	<i>New Broadband Super Highway (Hikari no Michi)</i>	<ul style="list-style-type: none"> • The goal was to achieve 100% broadband coverage and 90% ultra high-speed FTTH coverage by March 2011.

67 Germany’s Digital Agenda 2014-2017. Retrieved from https://www.digitale-agenda.de/Content/DE/_Anlagen/2014/08/2014-08-20-digitale-agenda-engl.pdf?__blob=publicationFile&v=6

68 Study on National Broadband Plans in the EU-28. (2014). Retrieved from https://atenekom.eu/wp-content/uploads/2017/11/Study_on_National_Broadband_Plans_ateneKOMweb.pdf

69 Germany’s Digital Strategy 2025. Retrieved from https://www.de.digital/DIGITAL/Redaktion/EN/Publikation/digital-strategy-2025.pdf?__blob=publicationFile&v=8

70 Study on National Broadband Plans in the EU-28. (2014). Retrieved from https://atenekom.eu/wp-content/uploads/2017/11/Study_on_National_Broadband_Plans_ateneKOMweb.pdf

71 The Italian Strategy for NGA Network. Retrieved from https://www.agid.gov.it/sites/default/files/repository_files/documentazione/next_generation_access_network_-_english_version.pdf

72 Commission endorses Italy’s ultra-broadband plan for 2016-2022. (2015, June 30). Retrieved from <https://ec.europa.eu/digital-single-market/en/news/commission-endorses-italys-ultra-broadband-plan-2016-2022>

73 Toward Realization of the “New Broadband Super Highway (Hikari no Michi)” Plan Final Report. (2010, November 30). Retrieved from http://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/councilreport/pdf/101130_2.pdf

United Kingdom ⁷⁴	2010	<i>Britain's Superfast Broadband Future: Broadband Delivery UK</i>
		<ul style="list-style-type: none"> Plans to have coverage of at least 100 Mbps for nearly all UK premises (no specified date) and 95% coverage with 24 Mbps by December 2017. The British government committed over £530 million by 2014-2015, which is mostly reserved for underserved areas.
United States ^{75,76}	2010	<i>Connecting America: The National Broadband Plan</i>
		<ul style="list-style-type: none"> 100 million households to have access to download speeds of 100 Mbps and upload speeds of 50 Mbps by 2020. In 2011, the FCC approved a six-year transfer process to support the expansion of broadband services through the USD\$4.5 billion per year <i>Connect America Fund</i>.

A.1 AUSTRALIA

- 131 In Australia, access-based competition has been the main source of competition in telecommunications due to the relative attractiveness of wholesale products such as local loop unbundling (“LLU”), line sharing services (“LSS”) and bitstream access. The Australian Consumer and Competition Commission (“ACCC”) implemented a high degree of wholesale regulation, giving access seekers regulated access to eleven different access products and three other telecommunications products. It was more favourable for some firms to use wholesale access in preference to their own facilities in some cases. Australia is classified as having high levels of wholesale broadband regulation by Gilbert + Tobin. In 2007, only 37 percent of households in Australia could choose between their cable provider and telecom provider for Internet service. The remainder of households in Australia only had access to the incumbent telecom provider’s (i.e., Telstra) infrastructure for Internet service. Where Internet-enabled cable was not available, any other Internet service provider (“ISP”) would have had wholesale access to Telstra’s network.

⁷⁴ Study on National Broadband Plans in the EU-28. (2014). Retrieved from https://atenekom.eu/wp-content/uploads/2017/11/Study_on_National_Broadband_Plans_ateneKOMweb.pdf

⁷⁵ The FCC’s National Broadband Plan homepage can be found at <https://www.fcc.gov/general/national-broadband-plan>

⁷⁶ Wallsten, Scott and Lucia Gamboa. (2017, June). Public Investment in Broadband Infrastructure: Lessons from the U.S. and Abroad. Retrieved from <https://techpolicyinstitute.org/wp-content/uploads/2017/06/Public-Investment-in-Broadband-Infrastructure.pdf>

- 132 Today Australia remains heavily oriented towards access-based competition through wholesale regulation rather than relying on competition between independent facilities to the home. Wholesale services have historically been provided by Telstra, the incumbent telecommunications provider, although that is now changing with the Australian government in the process of rolling out a new, Australia-wide open-access network (the National Broadband Network or “NBN”). Although Telstra still provides access to its existing copper and cable networks, Telstra’s assets are progressively being handed back to the government with the roll out of the NBN. The government anticipates that by 2022, the NBN will be used to service approximately three quarters of Australian premises.
- 133 The lack of facilities-based competition has led to relatively poor market outcomes in Australia notwithstanding the concerted government intervention to overcome this. The government’s decision to build the NBN reflected concern over the lack of private investment in new network infrastructure, particularly in regional and rural areas where low population density and high build costs left many homes without access to broadband. Early plans for the NBN involved a large-scale roll-out of fibre to the premises (“FTTP”), however these plans were never executed given the unacceptably high build cost. Following a change in government in 2013, the design of the NBN was radically altered to involve a mix of technologies, including the continued use of Australia’s legacy Hybrid fibre-coax (“HFC”) networks. As of June 2018, approximately 60 percent of the NBN had been constructed, although customer migration from legacy asymmetric digital subscriber line (“ADSL”) and cable services has been slow with lower than expected uptake of higher speed plans.
- 134 Australia has the third lowest fixed broadband penetration rate of our eight study countries at 31.8 percent. This figure is skewed heavily towards low-speed services with the penetration rate being almost five times higher than for high-speed services. Next generation access (“NGA”) coverage in Australia is the lowest in this study at only 22 percent of households.

A.1.1 Headline Data

Market Outcome		
Indicator	Measurement/Index	Result
NGA Coverage	# homes passed / total # homes	25%
Wholesale Regulation	Classification based on wholesale regulation observed in broadband markets	High
Broadband Penetration	# of broadband subscribers per 100 Inhabitants	31.8
Price	Price per Mbps	\$2.08
Speed (Mbps)	• Maximum Speed Available	100
	• Average Download Speed	24.32
	• Average Upload Speed	8.57
Innovation	IPTV uptake	7%

A.1.2 Network Competitors

- 135 In 2009 the Australian Government established NBN Co to design, build and operate a new fixed-line network to replace large parts of Australia's existing copper network and the HFC networks owned by Telstra and Optus.⁷⁷ A key objective of the government in establishing NBN Co was to ensure all Australians have access to high-speed broadband as soon as possible, at affordable prices, while constructed at low cost.⁷⁸ The government structured the NBN to be a wholesale-only, open-access network with NBN Co providing wholesale broadband to all Retail Service Providers ("RSPs") on a non-discriminatory basis.
- 136 In order to facilitate this structural change to the Australian telecommunications market the government reached agreements with Telstra, Optus and other smaller network owners such as TransACT for the progressive handover of their respective networks as the NBN is rolled out across the country.⁷⁹ As of June 30, 2018 more than 60 percent of the NBN network was ready for connection, with the rollout expected to be completed by 2020.⁸⁰
- 137 The NBN currently comprises a mix of Fibre-to-the-Node/Basement/Curb/Premises ("FTTN/B/C/P"), HFC, fixed wireless and satellite technologies, although other technologies may be employed over time.⁸¹ Under the current plan the government intends that Telstra's copper network primarily be replaced with FTTN/B, with some augmentation and expansion of the HFC networks previously owned and operated by Telstra and Optus. As indicated in the table below, the government expects the HFC network to be accessible by 2.5 million premises by 2020.⁸²

77 Prior to the roll-out of the NBN Telstra, Australia's incumbent telephone operator, owned a virtually ubiquitous copper network as well as a large-scale HFC network. SingTel Optus also owned a HFC network.

78 NBN Co has committed to deliver access to peak wholesale download data rates of at least 25 megabits per second (Mbps) to all premises, and at least 50Mbps peak wholesale download data rates to 90 percent of its fixed-line network. Statement of Expectations ("SoE") provided to the Company on August 24, 2016 at <https://www.NBNco.com.au/content/dam/NBNco2/2018/documents/Policies/soe-shareholder-minister-letter.pdf>

79 NBN Co reached a long-term agreement with Telstra to allow the company to use its existing infrastructure including ducts, pits and exchanges for the purpose of rolling out the fixed line network. See NBN Co, nbn—the challenges of transforming an industry at <https://www.nbnco.com.au/content/dam/nbnco2/documents/nbn%E2%80%93the%20challenges%20of%20transforming%20an%20industry.pdf>

See also <https://www.communications.gov.au/departmental-news/revised-NBN-agreement-NBN-co-telstra-optus> and <https://www.NBNco.com.au/corporate-information/media-centre/media-statements/NBN-co-deal-with-transact.html>

80 NBN Co Corporate Plan 2019 (2019 – 2022), p. 37 at <https://www.NBNco.com.au/content/dam/NBNco2/2018/documents/media-centre/corporate-plan-report-2019-2022.pdf>

81 For example, in August 2018 NBN Co began deployment of new cable technology, DOCSIS 3.1. NBN Co is also evaluating the next generation of G.fast, G.mgfast, a potential upgrade technology that could help NBN Co provide access to ultra-fast broadband on FTTB and FTTC networks. See NBN Co Corporate Plan 2019 (2019 – 2022), p. 13.

82 NBN Co Corporate Plan 2019 (2019 – 2022), p. 58.

- 138 The government has faced a number of issues with the implementation of the NBN,⁸³ particularly in relation to the upgrade of the legacy HFC networks built by Telstra and Optus in the 1990s. In September 2016, NBN Co abandoned its proposed upgrade to Optus's HFC network, preferring instead to deploy FTTC in areas where continued use of the Optus HFC network had been planned.⁸⁴ Then, in November 2017, NBN Co temporarily paused all activations on Telstra's HFC network in order to conduct remediation work and improve network quality, with wholesale HFC services re-released to RSPs on April, 28 2017.⁸⁵
- 139 The transition to the NBN requires large-scale migration of end customers to new retail products. Once an area is declared ready for service there is an 18-month migration window for most end users to migrate to the NBN before legacy phone and Internet services are disconnected (with fixed-line voice services switching from the PSTN to VOIP services in most areas).⁸⁶ As of June 30, 2018 four million premises had migrated to the NBN, with a further four million homes and businesses expected to migrate by 2020.⁸⁷ NBN Co forecasts that by 2022, 73-75 percent of all Australian residents and business will take up an NBN service, with consumers at all remaining non-vacant premises taking out mobile only plans or a plan with an alternative fast broadband network provider.⁸⁸

83 In its recent report on competition in the communications sector, the ACCC noted "many consumers claimed to be worse off on the NBN compared to their legacy broadband service with slow speeds and congestion, particularly in peak evening periods. There has also been wide-spread media coverage of NBN speed issues, with NBN Co acknowledging the problems and estimating 15 percent of users are dissatisfied." See ACCC, Communications Sector Market Study: Final Report, April 2018, p. 91.

84 See <https://www2.NBNco.com.au/corporate-information/media-centre/media-statements/NBN-pushes-fibre-to-the-curb-for-up-to-700000-homes-and-businesses.html> and <https://www.smh.com.au/politics/federal/a-lemon-NBN-backflips-abandons-plan-to-use-optus-cables-it-purchased-for-800-million-20160928-grquam.html>

85 NBN Co Corporate Plan 2019 (2019 – 2022), p. 49 and <https://www2.NBNco.com.au/corporate-information/media-centre/media-statements/improved-customer-experience.html>.

86 NBN Co Corporate Plan 2019 (2019 – 2022), p. 45.

87 NBN Co Corporate Plan 2019 (2019 – 2022), p. 59.

88 NBN Co Corporate Plan 2019 (2019 – 2022), p. 60.

Non-NBN fibre broadband services are supplied to consumers (typically in apartment buildings or new housing estates or developments) by service providers using networks built and owned by network operators, such as OptiComm, OPENetworks, RedTrain or LBN Co. TPG also supplies wholesale and retail services using its own FTTB network to some apartment buildings. See ACCC, Communications Sector Market Study: Final Report, April 2018, p. 28 at https://www.accc.gov.au/system/files/Communications%20Sector%20Market%20Study%20Final%20Report%20April%202018_0.pdf

- 140 Although Australian telecommunications retail markets are relatively concentrated, the government's objective is to have consumer migration to the NBN enhance competition between RSPs.⁸⁹ The ACCC reports that by the end of 2016, Telstra, TPG Group, Optus and Vocus Group collectively accounted for approximately 94 percent of broadband customers on the NBN, down slightly from a 97 percent share of customers on the legacy ADSL and HFC networks.⁹⁰ Telstra holds a 51 percent share of subscribers using the legacy networks and the NBN.⁹¹ The rest of the market is comprised of a very large number of small firms, with over 100 RSPs in total providing services over the NBN. By the end of June 2018 at least six RSPs (including Telstra, Optus, TPG, Vocus and Aussie Broadband) had connected to all 121 points of interconnection ("POIs") on the NBN.⁹² A further two RSPs, MyRepublic and Vodafone, are each connected to over 90 POIs, with MyRepublic having announced plans to connect to all POIs in the near future.⁹³
- 141 In those areas where the NBN has not yet been rolled out, RSPs can still access Telstra's unconditioned local loop service ("ULLS"), LSS, wholesale line rental ("WLR"), local carriage service ("LCS") and fixed originating and terminating access services ("FOAS" and "FTAS"), all of which are "declared" services for which wholesale access is mandated and provided at regulated terms.⁹⁴ The ACCC is currently considering whether to extend the timeframe for declaration of these services beyond June 2019 given that, at that time, the rollout of the NBN should be near completion.⁹⁵

89 The ACCC has, however, observed some potential limitations with the supply of NBN wholesale aggregation services, which may impede the ability of smaller service providers from entering markets or offering differentiated products over the NBN. See ACCC, Communications Sector Market Study: Final Report, April 2018, p. 6.

90 ACCC, Communications Sector Market Study: Final Report, April 2018, p. 22.

91 ACCC, Communications Sector Market Study: Final Report, April 2018, p. 23.

92 ACCC Media Release, A third of NBN users now on higher speed plans, 13 August 2018 at <https://www.accc.gov.au/media-release/a-third-of-NBN-users-now-on-higher-speed-plans>.

93 MyRepublic are at 99 and Vodafone are at 91 of the NBN POIs.

94 Services are "declared" under section 152AL of the Competition and Consumer Act of 2010. Declaration allows access seekers to acquire the services on certain terms and conditions, including a maximum price.

95 See ACCC Media Release, Fixed-line telecommunications services review, 31 August 2018 at <https://www.accc.gov.au/media-release/fixed-line-telecommunications-services-review>.

A.1.3 Innovation

- 142 NBN has been designed so as to flexibly incorporate the use of new technologies where they are considered commercially viable. Although the bulk of the network comprises FTTN/B, NBN Co has opted to deploy other technologies where higher speeds can be achieved at lower cost. For example, as an alternative to the upgrade of Optus' legacy HFC network, NBN Co undertook a mass deployment of FTTC, which is capable of delivering peak download speeds of up to 100 Mbps and is expected to be available to approximately 1.4 million premises by 2020.⁹⁶ In August 2018 NBN Co also started deployment of DOCSIS 3.1 as an upgrade path across parts of Telstra's legacy HFC network.⁹⁷ NBN Co also provides eligible individual or groups of premises with the option to pay for a switch to FTTP.⁹⁸
- 143 Although the adoption of a Multi-Technology Mix ("MTM") was intended to minimize the cost of the NBN, a recent report published by the Organization for Economic Co-operation and Development ("OECD") suggests that the cost savings of this approach relative to a large-scale rollout of FTTP or FTTC are becoming less clear over time, with repair and renovation costs to pre-existing network facilities having been greater than originally anticipated.⁹⁹ The OECD also found that, despite the fact that the rollout of the NBN was intended to increase the availability of higher speed Internet services, in terms of speed and penetration Australia ranked fourth last of the 32 countries considered in its study.

⁹⁶ NBN Co Corporate Plan 2019 (2019 – 2022), p. 48.

⁹⁷ NBN Co note that lab testing has indicated that the DOCSIS 3.1 upgrade could enable HFC to provide access to the same wholesale speeds as FTTP technology. See NBN Co Corporate Plan 2019 (2019 – 2022), p. 48.

⁹⁸ NBN Co Corporate Plan 2019 (2019 – 2022), p. 48.

⁹⁹ See <https://www.afr.com/technology/web/nbn/oeed-report-highlights-nbn-failings-as-company-defends-fttn-rollout-20170307-guscjg> [Note - This article refers to an OECD Economic Survey for Australia dated March 2017. I haven't been able to find this full report online – just the exec summary.]

144 The lack of uptake of higher speed plans can, in part, be attributed to the wholesale pricing of NBN services. In the context of its Communications Market Study, the ACCC identified issues with both the structure and level of wholesale prices that provided RSPs with an incentive to maintain customers on lower speed plans and not aggressively compete on the basis of speed and service performance.¹⁰⁰ In order to address these issues the ACCC recommended that NBN Co engage constructively with RSPs to agree to a mutually beneficial negotiated pricing outcome.¹⁰¹ Following further consultation with the ACCC and RSPs, NBN Co announced various changes to its wholesale pricing structure in December 2017.¹⁰² Most RSPs now promote both 50 Mbps and 100 Mbps services, with uptake of fixed-line wholesale peak download speed plans of 50 Mbps and above having grown from 16 percent in June 2017 to 45 percent by June 2018.¹⁰³

A.1.4 Pricing and Competitive Dynamics

145 Most RSPs compete through the offer of differentiated bundles of telecommunications and other services. As a result, around two thirds of Australian households with fixed broadband acquire their home phone and broadband service from the same provider.¹⁰⁴

146 Although RSPs have traditionally bundled fixed voice, broadband and, for some, mobile phone services, many have now extended their bundled offerings to include other services such as entertainment, retail electricity services or insurance. For example, both Telstra and Optus offer their broadband and mobile customers access to exclusive content (e.g., AFL, NRL and English Premier League), access to their own entertainment channels and video streaming services as well as free access to music services for a limited period (Telstra offers Apple Music and Optus offers Spotify Premium). Other RSPs such as Amaysim and Dodo offer bundles that include energy services, with Dodo also offering bundles that include car, home and contents, and travel insurance products.¹⁰⁵

100 See ACCC, Communications Sector Market Study: Draft Report, October 2017.

101 The ACCC also recommended that the Government consider whether NBN Co should continue to be obliged to recover its full cost of investment through its prices or whether some form of Government intervention such as debt relief measures or an asset revaluation, would enable NBN Co to charge lower prices for its services. See ACCC, Communications Sector Market Study: Draft Report, October 2017, pp. 132 - 133.

102 The maximum price level and structure of NBN access service charges must be approved by the ACCC and is contained in NBN Co's Special Access Undertaking (SAU).

103 NBN Co Corporate Plan 2019 (2019 – 2022), p. 40 and ACCC Media Release, A third of NBN users now on higher speed plans, 13 August 2018.

104 ACCC, Communications Sector Market Study: Final Report, April 2018, p. 35.

105 ACCC, Communications Sector Market Study: Draft Report, October 2017, pp. 61 – 62.

147 The ACCC has noted that the bundling of telecommunications services with entertainment and content services may have implications for competition, with the potential for RSPs to lock-in customers where they are the only provider with products and/or services that the consumers value. However, it has noted that there are other means for consumers to access the exclusive content currently offered by Telstra and Optus, such that consumers are not compelled to purchase their bundled offers solely to access that content. It will, however, assess bundling conduct on a case-by-case basis where complaints arise.¹⁰⁶

A.2 CANADA

148 In 2007 there were relatively high levels of competition between copper and cable platforms. Internet-enabled cable passed around 85 percent of households in 2007, allowing for competition between network operators in most areas. Less than 10 percent of Internet subscribers received services from providers that relied on wholesale access to telco networks. Nevertheless, Canada had an extensive wholesale access regime in place, and as such it was classified previously as having high wholesale broadband regulation by Gilbert + Tobin, even though it also had the second highest level of EFC at 85 percent. Broadband penetration measured as number of broadband subscribers per 100 people was 22.4 percent in 2007, with subscriptions split fairly evenly between low and high speed service.

149 With such high levels of cable and telco competition in broadband historically, Canadian households continue to have access to multiple Internet infrastructure providers. In 2016, Internet-enabled cable passed at least 95 percent of households.¹⁰⁷ Since 2007, wholesale regulation of broadband has relaxed.

150 As of 2017, Canada's fixed broadband penetration rate was 37.85 percent, which ranks fourth in our sample of countries and just ahead of the United States. Broadband penetration is approximately split evenly between low-speed and high-speed connections. Only Canada, the United States, and Japan have high-speed penetration rates that are greater than or equal to their low-speed penetration rates, indicating a healthy uptake in high-speed service subscriptions. Canada is well ahead of many countries in terms of NGA coverage at 86 percent.¹⁰⁸ In 2016, 97 percent of households had access to wired/fixed wireless broadband service with speeds of at least 5 Mbps.¹⁰⁹

106 ACCC, Communications Sector Market Study: Draft Report, October 2017, pp. 61 – 62.

107 Singer, Hal (2015). The Economic Impact of the CRTC's Decision to Unbundle Fibre-to-the-Premises Networks.

108 CRTC Communications Monitoring Report, 2017.

109 CRTC Communications Monitoring Report, 2017.

151 The CRTC has established the following objectives for Canadian fixed broadband services: access to a download rate of at least 50 Mbps, access to an upload rate of at least 10 Mbps, and the option of unlimited monthly data.¹¹⁰ By December 2016, services meeting these criteria were available to 84 percent of Canadian households but only 11 percent of households were subscribing to them.¹¹¹ Canadians are demanding broadband data at an increasing rate. The average monthly amount of data downloaded by residential subscribers increased by 25.6 percent to 116.9 GB per month from 2015 to 2016.¹¹² As a result of increased demand for broadband data, the uptake of unlimited Internet packages has increased from 12 percent in 2012 to 23 percent in 2016.¹¹³

A.2.1 Headline Data

Market Outcome		
Indicator	Measurement/Index	Result
NGA Coverage	# homes passed / total # homes	86%
Wholesale Regulation	Classification based on wholesale regulation observed in broadband markets	High
Broadband Penetration	# of broadband subscribers per 100 inhabitants	37.85
Price	Price per Mbps	\$0.90
Speed (Mbps)	• Maximum Speed Available	1500
	• Average Download Speed	57.86
	• Average Upload Speed	18.19
Innovation	IPTV uptake	22%

A.2.2 Network Competitors

152 The top Internet providers by revenue share are Bell, Rogers, Shaw, TELUS, and Videotron.¹¹⁴ In 2017, cable-based carriers have 49 percent of the residential market for Internet service, and telecommunications service providers (“TSPs”) have 39 percent of the market by revenue.¹¹⁵

110 Telecom Regulatory Policy CRTC 2016-496.
 111 CRTC Communications Monitoring Report, 2017.
 112 CRTC Communications Monitoring Report, 2017.
 113 CRTC Communications Monitoring Report, 2017.
 114 CRTC Communications Monitoring Report, 2017.
 115 CRTC Communications Monitoring Report, 2017.

153 According to the Competition Bureau, there are more than 550 ISPs in Canada but 87 percent of consumers purchase Internet from traditional facilities-based providers, even though resellers' prices are up to 30 percent lower.¹¹⁶ Resellers are predominately located in Ontario and Quebec. Of all wholesale high-speed access subscriptions in Canada in 2016, 68 percent were in Ontario and 25 percent were in Quebec.¹¹⁷ Rural and Northern markets are served by fewer providers.

A.2.3 Innovation

154 The rollout of fibre technology has been underway in Canada for almost a decade. In 2016, the FTTP cables of incumbents, cable-based carriers, and other facilities-based service providers passed 12.59 million, 13.26 million, and 0.04 million homes, respectively.¹¹⁸ The percentage of homes using fibre-optic cable provided by large incumbent TSPs has increased from 23.6 percent in 2014 to 26.1 percent in 2016.¹¹⁹ DSL is available to 77 percent of households, cable modem to 85 percent and fibre to 28 percent.¹²⁰

155 In April 2018, Bell rolled out a next generation all-fibre network in Toronto. The FTTP connections can deliver symmetrical 1 Gbps download and upload speeds that are projected to increase to 5 Gbps in 2019 and eventually reaching speeds of 40 Gbps.¹²¹ Bell's fibre network, which offers speeds of up to 1.5 Gbps in Quebec and Ontario, covers more than 9.5 million homes and businesses with 4.4 million direct FTTP connections at the end of Q3 2018, up from 3.7 million at the end of 2017.¹²²

156 There are 569,000 or 4 percent of retail local telephone lines that are subscribed to VoIP services.¹²³ Canada has the second highest uptake in IPTV of the study countries with 22 percent.

116 Competition Bureau, Competition in Broadband Services. Retrieved from <http://www.competitionbureau.gc.ca/eic/site/cb-bc.nsf/eng/04360.html>

117 CRTC Communications Monitoring Report, 2017.

118 CRTC Communications Monitoring Report, 2017.

119 CRTC Communications Monitoring Report, 2017.

120 CRTC Communications Monitoring Report, 2017.

121 Cision (2018, April 5) It's On! Bell's all-fibre broadband network is now lighting up Toronto. Retrieved from <https://www.newswire.ca/news-releases/its-on-bells-all-fibre-broadband-network-is-now-lighting-up-toronto-678848503.html>

122 Bell Shareholder Report 2018 Third Quarter.

123 CRTC Communications Monitoring Report, 2017.

A.2.4 Pricing and Competitive Dynamics

157 In the table¹²⁴ below we provide prices, usage limits, and download speeds for various broadband plans from the top three carriers in Canada. The majority of plans provide unlimited monthly usage and both Rogers and Bell offer speeds in the 1 Gbps or higher range. These offerings are on par with global trends in broadband, particularly in Europe and Asia.

Carrier	Plan	Usage	Download Speed (Mbps)	Monthly Price (CAD)
Rogers	Ignite 30	250 GB	30	\$77.99
Rogers	Ignite 60	Unlimited	60	\$95.99
Rogers	Ignite 150	Unlimited	150	\$107.99
Rogers	Ignite 500	Unlimited	500	\$127.99
Rogers	Ignite Gigabit	Unlimited	1000	\$152.99
Bell	Fibe 25	250 GB	25	\$79.95
Bell	Fibe 50	Unlimited	50	\$94.95
Bell	Gigabit Fibe	Unlimited	1000	\$99.95
Bell	Gigabit Fibe 1.5	Unlimited	1500	\$109.95
TELUS	Internet 25	300 GB	25	\$76.00
TELUS	Internet 75	500 GB	75	\$80.00
TELUS	Internet 150/150	Unlimited	150	\$95.00
TELUS	Internet 300/300	Unlimited	300	\$110.00

A.3 FRANCE

158 In 2007, France was characterized as having high levels of wholesale regulation and very little EFC. Access-based competition was well established with the incumbent France Telecom – now known as Orange after France Telecom rebranded its global operations in 2006. With access-based competition the predominant form of competition in France in 2007, France Telecom had only 45 percent of retail broadband connections. There was significant deployment of LLU compared to other European countries. Gilbert + Tobin classified France as a country with very high wholesale broadband regulation. France also had very poor levels of EFC and was tied for the second last of the 13 sample countries with only 25 percent of households passed by Internet-ready cable coverage.

124 Prices were accessed from company websites in September 2018 and exclude promotional pricing.

- 159 In the latest OECD data on broadband subscriptions from December 2017, France has the third highest fixed broadband penetration rate in our sample with 42.84 subscriptions per 100 inhabitants. This is more than double the broadband penetration estimated by the OECD in 2006. It is important to note, however, that broadband penetration in France is heavily skewed towards lower speeds, with a low-speed penetration rate nearly five times higher than that of high-speed. NGA coverage was 47 percent in 2016.¹²⁵ This falls well below the EU average of 76 percent.^{126,127} Access to next generation technologies has been trending higher with 1.2 million more households eligible for NGA in 2016 compared to the year before.¹²⁸ Of all households eligible for NGA, 45.1 percent were eligible for FTTH.¹²⁹ Total fixed broadband coverage reached 99.95 percent in 2016 with an uptake of 72 percent, leaving a demand gap of 27.95 percent.¹³⁰ However, only 18 percent of French households that subscribe to fixed broadband chose the high-speed broadband option, which is well below the EU high-speed subscription rate of 37 percent.¹³¹
- 160 To improve high speed broadband coverage, the government adopted the *Plan France Très Haut Débit* in 2013 as well as the *Mission Très Haut Débit* to oversee its implementation. The plan aims for there to be high-speed broadband coverage at or above 30 Mbps throughout France by 2022 with a priority for FTTH. Financing for the plan is shared by local authorities, the federal government, and private companies.

125 WIK-Consult, 2015. Competition & investment: An analysis of the drivers of superfast broadband.

126 Europe's Digital Progress Report, 2017.

127 NGA coverage includes all technologies and speeds of 30 Mbps and above in the Europe Digital Progress Report.

128 Europe's Digital Progress Report, 2017.

129 Europe's Digital Progress Report, 2017.

130 Europe's Digital Progress Report, 2017.

131 Europe's Digital Progress Report, 2017.

A.3.1 Headline Data

Market Outcome		
Indicator	Measurement/Index	Result
NGA Coverage	# homes passed / total # homes	47%
Wholesale Regulation	Classification based on wholesale regulation observed in broadband markets	Very High
Broadband Penetration	# of broadband subscribers per 100 inhabitants	42.84
Price	Price per Mbps	\$0.53
Speed (Mbps)	• Maximum Speed Available	1000
	• Average Download Speed	54.31
	• Average Upload Speed	23.08
Innovation	IPTV uptake	40%

A.3.2 Network Competitors

161 Four firms dominate the fixed broadband market in France by number of customers: Orange (formerly France Telecom) with 40 percent, Free with 23 percent, SFR also with 23 percent, and Bouygues with 10 percent.¹³² These rankings change when focusing on superfast broadband with speeds of more than 30 Mbps. In the high-speed segment of the market, SFR is the leader with 51 percent of subscribers, followed by Orange with 30 percent, Bouygues with 13 percent and Free with 6 percent.¹³³ The most recent change in the competitive landscape in the French broadband market was the 2014 merger of SFR and Numericable. Orange maintained its leadership status in the market and is significantly increasing its superfast access market share in the residential retail market.¹³⁴

132 WIK-Consult, 2016. Copper ULL pricing in front of decreasing demand and migration to NGA.

133 WIK-Consult, 2016. Copper ULL pricing in front of decreasing demand and migration to NGA.

134 Prysman Group, 2016. Arcep reports on status of broadband in France. Retrieved from <https://www.prysmiangroup.com/staticres/NExsT-2016-4/article-6.html>

162 In the wholesale market, Orange is the leader for superfast local loops with the reach of marketing products to over 90 percent of households that are eligible for FTTH access.¹³⁵ Orange has been classified as a carrier with significant market power by the *Autorité de Régulation des Communications Électroniques et des Postes* (“ARCEP”), which is the national regulatory agency in France. Orange is required to provide full open wholesale access at tariffs established by ARCEP.¹³⁶ Of all new entrants into the fixed broadband market, 85.1 percent enter through full LLU access, with 4.3 percent under shared access and 10.6 percent under bitstream.¹³⁷ ARCEP projects that in three years, 7 to 8 million additional premises will have access to FTTH, supplied by at least two operators,¹³⁸ which will give consumers more choices for superfast broadband and stimulate competition.

A.3.3 Innovation

163 In December 2015, 30.2 million access lines of the copper network were viable for xDSL technologies.¹³⁹ At the same time as the prioritized FTTH rollout, VDSL2 is growing as a key player in NGA technology.¹⁴⁰ In 2016, several companies tested DOCSIS 3.1 technology and achieved maximum speeds of 3 Gbps, however most companies are currently using the technology to offer download speeds of 1 Gbps to consumers.¹⁴¹

164 The fixed broadband market shares by technology are as follows: DSL (84.9 percent), cable (7.4 percent) and FTTH (6.4 percent).¹⁴²

A.3.4 Pricing and Competitive Dynamics

165 According to ARCEP, 99 percent of all subscriptions to fixed, high-speed or very high-speed broadband are bundled with at least one telephony service and 69 percent of these subscriptions are also bundled with a TV service.

135 Prysman Group, 2016. Arcep reports on status of broadband in France. Retrieved from <https://www.prysmiangroup.com/staticres/NEsT-2016-4/article-6.html>

136 European Commission, November 2016. State aid: Commission endorses French broadband scheme “Plan Très Haut Débit”. Retrieved from http://europa.eu/rapid/press-release_IP-16-3610_en.htm

137 Europe’s Digital Progress Report, 2017.

138 Prysman Group, 2016. Arcep reports on status of broadband in France. Retrieved from <https://www.prysmiangroup.com/staticres/NEsT-2016-4/article-6.html>

139 WIK-Consult, 2016. Copper ULL pricing in front of decreasing demand and migration to NGA.

140 WIK-Consult, 2016. Copper ULL pricing in front of decreasing demand and migration to NGA.

141 Altice, SFR achieve 3 Gbps speed in DOCSIS 3.1 field trial. (2016, June 8). Retrieved from <https://www.telegeography.com/products/commsupdate/articles/2016/06/08/altice-sfr-achieve-3gbps-speeds-in-docsis-3-1-field-trial/>

142 Europe’s Digital Progress Report, 2017.

166 All of the plans in the table below are bundled with some combination of television, fixed phone and mobile phone.

Carrier	Plan	Down-load Speed (Mbps)	Monthly Price (USD)
SFR	Box Starter Fibre	50	\$51.45
SFR	Box Power Fibre	100	\$57.73
SFR	Box Premium Fibre	200	\$70.28
Orange	Zen Fibre	100	\$52.70
Orange	Play Fibre	200	\$60.23
Orange	Jet Fibre	500	\$70.27
Free	Freebox Mini 4K	1000	\$43.91
Free	Freebox Révolution	1000	\$56.46
Bouygues	Bbox Must	500	\$41.40
Bouygues	Bbox Ultym	1000	\$50.19

A.3.5 Other Observations

167 Co-investment agreements are common in the building of fibre networks in France. The agreements are typically between two to four of the main carriers that are listed in the table in Section A.3.4. These agreements play out in the same way every time. One operator becomes the operator of a building through a contract with the building's owners. This operator is responsible for the construction of the network within that building and offers passive access to other members of the co-investment agreement in the form of a 30- or 24-year indefensible rights of use ("IRU"), which is renewable two times.¹⁴³

A.4 GERMANY

168 Germany had the lowest level of EFC in 2007 with only 10 percent of households being passed by Internet-enabled cable, notwithstanding there relatively high levels of cable throughout the country. The low levels of facilities competition led to Germany having one of the lowest broadband penetration rates of the 13 countries studied. Gilbert + Tobin previously classified Germany as having very high wholesale regulation. Wholesale regulation in Germany remains high at present.

143 BEREC, April 2012. BEREC report on Co-investment and SMP in NGA networks.

169 The fixed broadband penetration rate in Germany as of December 2017 is 40.19 percent, which is more than double the 18.19 percent penetration rate from 2007. Most subscribers use low-speed service. The low-speed broadband penetration rate of 27.8 percent is more than two-and-a-half times the high-speed penetration rate. NGA coverage increased drastically from only 10 percent in 2007 to 69 percent in mid-2014.¹⁴⁴ In 2016, less than two years later, NGA coverage had again increased by a significant margin to 82 percent.¹⁴⁵

170 Overall, Germany has total fixed broadband coverage of 99 percent and an uptake rate of 86 percent, leaving a demand gap of 13 percent.¹⁴⁶ Among fixed broadband subscriptions, 31 percent are for high-speed broadband, which is 6 percentage points lower than the EU average. Connections of 50 Mbps or more were available to 75.5 percent of households and 7.1 percent of households were covered with fibre optic infrastructure as of mid-2016.¹⁴⁷

171 The German government rolled out a Digital Agenda for 2014-2017 with the aim of expanding the reach of high-speed broadband.¹⁴⁸ Deployment of high-performance broadband is primarily driven by private companies. Companies belonging to the Network Alliance for a Digital Germany invested €8 billion in each of 2015 and 2016. DT also invested €8.2 billion from 2015 to 2016. The German federal government is responsible for helping to close the gap in NGA roll-out to rural and structurally weak regions. Programs to address these gaps are outlined in Section A.4.5. The Federal Ministry of Transport and Digital Infrastructure (“BMVI”) is confident that broadband with download speeds of at least 50 Mbps will be available to all German households by the end of 2018.

144 WIK-Consult, 2015. Competition & investment: An analysis of the drivers of superfast broadband.

145 Europe’s Digital Progress Report, 2017.

146 Europe’s Digital Progress Report, 2017.

147 Europe’s Digital Progress Report, 2017.

148 Germany’s Digital Agenda 2014-2014. Retrieved from https://www.digitale-agenda.de/Content/DE/_Anlagen/2014/08/2014-08-20-digitale-agenda-engl.pdf?__blob=publicationFile&v=6

A.4.1 Headline Data

Market Outcome		
Indicator	Measurement/Index	Result
NGA Coverage	# homes passed / total # homes	82%
Wholesale Regulation	Classification based on wholesale regulation observed in broadband markets	High
Broadband Penetration	# of broadband subscribers per 100 inhabitants	40.19
Price	Price per Mbps	\$0.81
Speed	• Maximum Speed Available	500
	• Average Download Speed	47.62
	• Average Upload Speed	10.25
Innovation	IPTV uptake	6%

A.4.2 Network Competitors

172 The incumbent broadband carrier is DT, which has a 40.4 percent market share.¹⁴⁹ The main competitors are Vodafone (19.5 percent), 1&1 (13.7 percent), Unitymedia (10.4 percent), o2 (6.5 percent) and Tele Columbus (1.7 percent).¹⁵⁰ Market consolidation has occurred through several mergers in the space. Tele Columbus acquired both PrimaCom and PepCom in 2015, NeckarCom was acquired by NetCom BW in 2016, and Level 3 was taken over by CenturyLink, also in 2016.¹⁵¹

A.4.3 Innovation

173 There have been significant upgrades to cable infrastructure, providing the largest high-performance infrastructure based on DOCSIS 3.0 technology, allowing for download speeds of up to 400 Mbps in networks made of fibre optic and coaxial cables.¹⁵² Beginning in 2017, DOCSIS 3.1 technology was rolled out, enabling speeds in excess of 1 Gbps.¹⁵³

149 Europe's Digital Progress Report, 2017.

150 Statista. Retrieved from <https://www.statista.com/statistics/778910/market-share-german-broadband-providers/>

151 Europe's Digital Progress Report, 2017.

152 Europe's Digital Progress Report, 2017.

153 Europe's Digital Progress Report, 2017.

- 174 HFC networks have been growing steadily by 700,000-800,000 connections per year and are creating competitive pressures on the market.¹⁵⁴ Very-high-bit-rate digital subscriber line (“VDSL”) connections increased from 13.9 percent in 2014 to 28.3 percent in mid-2016.¹⁵⁵ Vectoring technology, with theoretical speeds of up to 100 Mbps, is expected to provide connection speeds above 50 Mbps to 1.4 million households. There are lower investment costs associated with VDSL vectoring relative to FTTB that could translate into retail pricing strategies that would undermine the short-term returns of FTTB networks.
- 175 DT intends to deploy nearshore vectoring, use G.fast technology, and invest in FTTH. In 2016, the BMVI began preparing a comprehensive 5G strategy for Germany. By the end of 2020, the preconditions for a nationwide 5G roll-out will be created and gigabit-capable converged infrastructure is anticipated to be available by 2025.¹⁵⁶
- 176 The distribution of fixed broadband usage by technology are as follows: DSL (76.1 percent), cable (22 percent) and FTTH (1.6 percent).¹⁵⁷

A.4.4 Pricing and Competitive Dynamics

- 177 At the end of 2015, around 95 percent of the 30.7 million fixed broadband connections (with download rates of greater than 144 Kbps) were contracted as bundled offers.¹⁵⁸ It is very difficult for new customers to obtain services as a single offer.

Carrier	Plan	Usage	Download Speed	Monthly Price (USD)
Vodafone	100 Kabel	Unlimited	100	\$44.90
Vodafone	200 Kabel	Unlimited	200	\$51.32
Vodafone	400 Kabel	Unlimited	400	\$57.73
Vodafone	500 Kabel	Unlimited	500	\$64.15
DT	L	Unlimited	100	\$57.68
DT	XL	Unlimited	250	\$70.51

154 Europe’s Digital Progress Report, 2017.

155 Europe’s Digital Progress Report, 2017.

156 Europe’s Digital Progress Report, 2017.

157 Europe’s Digital Progress Report, 2017.

158 Europe’s Digital Progress Report, 2017.

A.4.5 Other Observations

- 178 In an effort to close the gap in fast broadband in rural and structurally weak areas, the German federal government has implemented two funding programs to incentivize the roll-out: (1) the profitability gap model where the profitability gap is covered by the state and (2) the operator model where municipalities are subsidized to roll out passive infrastructure that will be leased to network operators. Approximately 75% of funds go to the profitability gap model.¹⁵⁹

A.5 ITALY

- 179 In 2007, Italy had Internet-enabled cable coverage of 0 percent,¹⁶⁰ with ADSL being the most common technology used for accessing the Internet.¹⁶¹ Almost all access services are regulated on a cost-based basis and services such as fibre unbundling and fibre bit-stream are regulated only in Italy among the main EU countries.¹⁶² As a result, Italy is classified by Gilbert + Tobin as having high wholesale regulation. There is increased infrastructure competition particularly in the deployment of FTTP services. Amid the increased competition, Telecom Italia (“TIM”) has planned to legally separate its fixed network assets to more clearly define its retail and wholesale arms in order to improve cooperation with operators that seek access to its fixed network.¹⁶³
- 180 Italy has the second lowest fixed broadband penetration rate in our sample at 27.4 percent. The low-speed penetration rate of 17.2 percent is more than double the high-speed penetration rate.

159 Europe’s Digital Progress Report, 2017.

160 OECD Communications Outlook 2005.

161 Mastrodonardo, Raffaele (2013, September 23). Broadband that’s not so broad: Italians paying for download speeds they don’t get. Retrieved from <https://www.zdnet.com/article/broadband-thats-not-so-broad-italians-paying-for-download-speeds-they-dont-get/>

162 Burkitt-Gray, Alan (2018, June 11). TIM warns falling wholesale prices may hit network separation plan. Retrieved from <https://www.capacitymedia.com/articles/3812910/Webinars>

163 Joiner, James (n.d.). Telecom Italia plans voluntary separation of fixed access network. Retrieved from <https://technology.ihc.com/600644/telecom-italia-plans-voluntary-separation-of-fixed-access-network>

181 Italy is almost fully covered by fixed broadband at 99 percent in 2016, 1 percent above the EU average.¹⁶⁴ The uptake of fixed broadband, however, sits at only 55 percent,¹⁶⁵ leaving a demand gap of 44 percent. Italy's slower uptake has been attributed to a lack of drive from the demand side, where people with low technical skills result in lower Internet performance indicators.¹⁶⁶ The percentage of subscriptions to high-speed broadband has increased from 5 percent in 2015 to 12 percent in 2016. As of mid-2014, only 32 percent of households were passed by NGA capabilities,¹⁶⁷ which was the second lowest coverage in our sample at that time. However, as of 2016, NGA coverage increased significantly to 72 of households,¹⁶⁸ just below the EU average of 76 percent.

A.5.1 Headline Data

Market Outcome		
Indicator	Measurement/Index	Result
NGA Coverage	# homes passed / total # homes	72%
Wholesale Regulation	Classification based on wholesale regulation observed in broadband markets	High
Broadband Penetration	# of broadband subscribers per 100 inhabitants	27.41
Price	Price per Mbps	\$1.26
Speed (Mbps)	• Maximum Speed Available	1000
	• Average Download Speed	25.46
	• Average Upload Speed	8.21
Innovation	IPTV uptake	2%

A.5.2 Network Competitors

182 TIM is the incumbent internet provider with 46.6 percent¹⁶⁹ of the broadband market share and over 18.5 million¹⁷⁰ fixed access lines. TIM's market share is more than the average incumbent's market share in the EU of 40.7 percent.¹⁷¹ Other key players in the market are Wind Tre, Fastweb, and Vodafone each with shares in the 14-15 percent

164 Europe's Digital Progress Report, 2017.

165 Europe's Digital Progress Report, 2017.

166 Europe's Digital Progress Report, 2017.

167 WIK-Consult, 2015. Competition & investment: An analysis of the drivers of superfast broadband.

168 Europe's Digital Progress Report, 2017.

169 Europe's Digital Progress Report, 2017.

170 Telecom Italia, September 2018.

171 Europe's Digital Progress Report, 2017.

range.¹⁷² These firms, as well as Wind-Infostrada and Tiscali, all have business models focused on different segments of the market.¹⁷³

183 A strategic partnership between Fastweb and TIM began in July 2016 with their joint venture, Flash Fiber. The goal of their venture is to increase FTTH access with speeds at 1 Gbps from 2 to 5 million premises in 29 cities by 2020 through an investment of €1.2 billion.¹⁷⁴ The venture was originally challenged by the Italian competition authority *Autorità per le Garanzie nelle Comunicazioni* (“AGCom”),¹⁷⁵ but was later accepted.¹⁷⁶

184 The expansion of FTTH networks is top priority in Italy’s national broadband strategy. Infratel, the contracting authority for the Italian Ministry of Economic Development, has launched two out of three calls for tenders for fibre network expansion in 2016 worth €1.4 billion and €1.2 billion, respectively.¹⁷⁷ In both auctions, Open Fiber (an Enel company) won all lots offered, covering 6700 municipalities and 9.3 million real estate units. TIM appealed the results citing that Infratel was favouring rival bidders but was unsuccessful.¹⁷⁸ Open Fiber’s development plan has increased competition by introducing new networks that overlap with existing infrastructure in the following ways: areas with two FTTH networks overlapping with FTTC networks; areas with one FTTH network overlapping with FTTC networks; areas with FTTH networks overlapping with ADSL networks; and areas with FTTC networks overlapping with ADSL networks.¹⁷⁹ New access seekers enter the broadband market in the following ways: 72.1 percent full LLU, 0.7 percent shared access, and 27.2 percent bitstream.¹⁸⁰

172 Pekic, Branislav (2018, January 16). Italy: 16.4m fixed broadband lines. Retrieved from <https://advanced-television.com/2018/01/16/italy-16-4m-fixed-broadband-lines/>.

173 Telecom Italia Annual Report, 2017. Retrieved from <http://www.telecomitalia.com/tit/en/investors/business-areas-competitors/domestic-market.html>.

174 Fastweb, July 2016. Retrieved from <https://www.fastweb.it/corporate/media/comunicati-stampa/fastweb-e-tim-danno-il-via-una-partnership-strategica-per-realizzare-una-rete-ftth-nazionale/?lng=EN>.

175 Competition authority investigates TIM/Fastweb JV. (2017, February 10). Retrieved from <https://www.telegeography.com/products/commsupdate/articles/2017/02/10/competition-authority-investigates-timfastweb-jv/>.

176 Antitrust accepts TIM, Fastweb Flash Fiber vows. (2018, April 9). Retrieved from http://www.ansa.it/english/news/2018/04/09/antitrust-accepts-tim-fastweb-flash-fiber-vows-3_cfec7557-e849-4c2e-aa40-35aa83ec500c.html.

177 A third call was launched in April 2018.

178 TIM loses appeal on broadband tenders. (2017, March 21). Retrieved from <https://www.telegeography.com/products/commsupdate/articles/2017/03/21/tim-loses-appeal-on-broadband-tenders/>.

179 Telecom Italia Annual Report, 2017. Retrieved from <http://www.telecomitalia.com/tit/en/investors/business-areas-competitors/domestic-market.html>.

180 Europe’s Digital Progress Report, 2017.

A.5.3 Innovation

- 185 AGCom is in the process of updating the Electronic Communications Code in order to foster innovation. The aim is to promote the use of emerging ultra-broadband technologies like CDSL2, VDSL and G.fast as well as the coordinated use of vectoring by means of multioperator vectoring (“MOV”).¹⁸¹
- 186 Copper based x-DSL technology continues to dominate with 92.6 percent of the technology share,¹⁸² however increasing FTTH access through massive government investment should result in more uptake. Currently FTTH only makes up 2.7 percent of the technology share of fixed broadband.¹⁸³

A.5.4 Pricing and Competitive Dynamics

- 187 According to the OECD’s June 2017 pricing data, performance-adjusted prices were relatively high in Italy at \$0.10USD per 100 Kbps.¹⁸⁴ However, in the short time that has passed, performance-adjusted prices have dropped dramatically. Fastweb now offers a €29.95 plan with download speeds of 1 Gbps, which translates to less than \$0.01USD per 100 Kbps. Italy appears to be offering some of the most competitively priced broadband packages currently further to a broadband war that is taking place.¹⁸⁵ It has been reported that TIM and Enel are in a race to build out their fibre networks — often working side by side, digging cable trenches along the same roads, sometimes inches apart.¹⁸⁶
- 188 Service providers have concentrated on expanding broadband penetration and defending voice revenues by bundling voice, broadband and service deals in a highly competitive environment with pricing pressures.¹⁸⁷ Deals and offers are also becoming more competitive due to the consolidation, among competitors, of an approach based on control over infrastructure.¹⁸⁸

181 AGCom Annual Report, 2017.

182 Europe’s Digital Progress Report, 2017.

183 Europe’s Digital Progress Report, 2017.

184 Based on Fastweb’s Joy Fiber Plan: 30720 Kbps download speed; 10240 Kbps upload speed.

185 ‘It makes little sense’: view from frontline of Italy’s broadband war. (2017, June 28). Retrieved from <https://www.reuters.com/article/italy-broadband-race/it-makes-little-sense-view-from-frontline-of-italys-broadband-war-idUSL8N1JJ4DY>

186 ‘It makes little sense’: view from frontline of Italy’s broadband war. (2017, June 28). Retrieved from <https://www.reuters.com/article/italy-broadband-race/it-makes-little-sense-view-from-frontline-of-italys-broadband-war-idUSL8N1JJ4DY>

187 Telecom Italia Annual Report, 2017. Retrieved from <http://www.telecomitalia.com/tit/en/investors/business-areas-competitors/domestic-market.html>

188 Telecom Italia Annual Report, 2017. Retrieved from <http://www.telecomitalia.com/tit/en/investors/business-areas-competitors/domestic-market.html>

189 The two main carriers' plan prices for 1 Gbps download speeds are provided in the table below:

Carrier	Plan	Usage	Download Speed (Mbps)	Monthly Price (Local)	Monthly Price (USD)
Fastweb		Unlimited	1000	\$29.95	\$41.64
TIM	Connect FIBRA	Unlimited	1000	\$24.90	\$34.62

A.5.5 Other Observations

208 The government's ultra-broadband initiative breaks the country into intervention areas for the tendering of fibre networks. In each intervention area one or more concessionaires will be selected through public tenders covering: (a) the construction of a passive network, and/or (b) the maintenance, management and commercial exploitation of the network. The infrastructure deployed will remain in public ownership and be made available at wholesale level to all service providers on non-discriminatory terms and under the technical and economic conditions laid down by the Italian national regulatory authority.

209 The *ex ante* replicability test of TIM's retail offers has been confirmed by the AGCom as an essential tool to ensure, before the launch of the retail offer, the absence of a margin squeeze and the compliance with non-discrimination in the technical and economic conditions of supply of essential services at wholesale level.¹⁸⁹

A.6 JAPAN

210 In 2007, Japan had Internet-enabled cable coverage of 28 percent.¹⁹⁰ Despite having low cable coverage, Japan's Internet access is predominantly fibre, which results in high performance outcomes. Facilities-based competition is considerable in major urban areas with the incumbent, NTT, competing with electric utilities, USEN Corporation, and KDDI that have deployed fibre networks and account for 25 percent of fibre subscriptions.¹⁹¹ Wholesale access regulation is classified as low and the share of

189 Europe's Digital Progress Report, 2017.

190 OECD Communications Outlook 2005.

191 Crandall, Robert (2014, January 31). The effects of mandated network unbundling on FTTP deployment. Retrieved from [https://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/DGTP-002-2015-TELUS-AppendixC.pdf/\\$FILE/DGTP-002-2015-TELUS-AppendixC.pdf](https://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/DGTP-002-2015-TELUS-AppendixC.pdf/$FILE/DGTP-002-2015-TELUS-AppendixC.pdf).

broadband connections over unbundled loops has fallen from 37 percent in 2006 to 10 percent in 2011.¹⁹²

- 211 Japan's fixed broadband penetration is 30.96 percent, which ranks 20th in the OECD. However, it is the only country in our sample that has a greater high-speed penetration rate than low-speed at 20.96 percent compared to 10.0 percent. In mid-2014, NGA coverage reached 91 percent—the highest in our sample.¹⁹³ As of 2017, 99 percent of households are covered by superfast broadband and 68 percent have access to advertised speeds of 1 Gbps or higher.¹⁹⁴ 95 percent of fixed broadband connections are superfast.¹⁹⁵ Japan has the highest full-fibre uptake with 75 percent of connections provided using fibre technologies.¹⁹⁶
- 212 Japan was an early global leader in broadband innovation and in November 2010 the government released a new strategic plan for broadband development called the *New Broadband Super Highway (Hikari no Michi)*.¹⁹⁷ The main goal of the plan was to make broadband available to all households by 2015. The initiative moved the broadband space from a monopoly to a competitive market.¹⁹⁸

192 Crandall, Robert (2014, January 31). The effects of mandated network unbundling on FTTP deployment. Retrieved from [https://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/DGTP-002-2015-TELUS-AppendixC.pdf/\\$FILE/DGTP-002-2015-TELUS-AppendixC.pdf](https://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/DGTP-002-2015-TELUS-AppendixC.pdf/$FILE/DGTP-002-2015-TELUS-AppendixC.pdf).

193 WIK-Consult, 2015. Competition & investment: An analysis of the drivers of superfast broadband.

194 Ofcom, 2017. The International Communications Market. Retrieved from https://www.ofcom.org.uk/__data/assets/pdf_file/0026/108908/icmr-2017-telecoms-networks.pdf.

195 Ofcom, 2017. The International Communications Market. Retrieved from https://www.ofcom.org.uk/__data/assets/pdf_file/0026/108908/icmr-2017-telecoms-networks.pdf.

196 Ofcom, 2017. The International Communications Market. Retrieved from https://www.ofcom.org.uk/__data/assets/pdf_file/0026/108908/icmr-2017-telecoms-networks.pdf.

197 Toward Realization of the "New Broadband Super Highway (Hikari no Michi)" Plan Final Report. (2010, November 30). Retrieved from http://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/councilreport/pdf/101130_2.pdf.

198 Bell, Pete (2018, August 14). Is Recent Growth in Asia's Fixed Broadband Sector Set to Slow? Retrieved from <https://blog.telegeography.com/recent-growth-in-asias-fixed-broadband-sector-set-to-slow>

A.6.1 Headline Data

Market Outcome		
Indicator	Measurement/Index	Result
NGA Coverage	# homes passed / total # homes	99%
Wholesale Regulation	Classification based on wholesale regulation observed in broadband markets	Low
Broadband Penetration	# of broadband subscribers per 100 Inhabitants	30.96
Price	Price per Mbps	\$0.78
Speed (Mbps)	• Maximum Speed Available	2000
	• Average Download Speed	66.32
	• Average Upload Speed	62.91
Innovation	IPTV uptake	8%

A.6.2 Network Competitors

- 213 NTT (formerly state-owned, then privatized in 1985) is the incumbent and has 54 percent of fixed broadband lines.¹⁹⁹ KDDI is another key player in the broadband market. NTT has several subsidiaries that also provide fixed broadband services. FTTH subscriber shares are as follows: NTT East with 38.1 percent, NTT West with 30.3 percent and KDDI with 12.9 percent.²⁰⁰
- 214 The WiMAX wireless broadband network operated by UQ Communications has been a large driver behind broadband growth.²⁰¹ UQ Communications is a joint venture of KDDI with East Japan Railway Company, Kyocera, Daiwa Securities Group, and the Bank of Tokyo-Mitsubishi.

199 Ofcom, 2017. The International Communications Market. Retrieved from https://www.ofcom.org.uk/__data/assets/pdf_file/0026/108908/icmr-2017-telecoms-networks.pdf.

200 KDDI Annual Report 2017. Retrieved from <http://www.kddi.com/english/corporate/ir/ir-library/annual-report/2017-selected/kddi/>.

201 Bell, Pete (2016, August 31). Big in Japan: UQ Continues to Spur WiMAX Growth. Retrieved from <https://blog.telegeography.com/wimax-growth-in-japan>.

A.6.3 Innovation

215 Continuing to lead innovation, NTT successfully demonstrated 100 Gbps transmission using Orbital Angular Momentum (“OAM”) multiplexing in May 2018, which is five times faster than the 5G that is scheduled for launch.²⁰²

A.6.4 Pricing

Carrier	Plan	Usage	Download Speed (Mbps)	Price (Local)	Monthly Price (USD)
NTT East	E	Unlimited	200	¥ 5,200.00	\$52.21
NTT East	C	Unlimited	1000	¥ 5,400.00	\$54.22

A.6.5 Other Observations

216 There is voluntary self-regulation in Japan since there is no independent regulatory commission for broadband; however, it is overseen by the Ministry of Internal Affairs and Communications.

A.7 UNITED KINGDOM

217 In 2007 the UK was noted as having significant access-based competition with bitstream services of non-incumbent carriers accounting for over half of the DSL connections. There was relatively low facilities-based competition with only 45 percent of households being passed by Internet-ready cable. Gilbert + Tobin previously classified the UK as having very high wholesale regulation. The current state of wholesale regulation in the UK is at a high level. In the March 2018 Wholesale Local Access Market Review Statement, Ofcom put measures in place to make it easier and cheaper for competitors to use British Telecom’s (“BT”) underground ducts and over-ground telegraph poles in an attempt to incentivize investment in fibre networks by both BT and its competitors.²⁰³

202 NTT demos 100 Gbps wireless transmission using OAM multiplexing. (2018, May 16). Retrieved from <https://www.telegeography.com/products/commsupdate/articles/2018/05/16/ntt-demos-100gbps-wireless-transmission-using-oam-multiplexing/>.

203 Ofcom (2018, July 31). Wholesale Broadband Access Market Review 2018. Retrieved from https://www.ofcom.org.uk/__data/assets/pdf_file/0030/116994/statement-wba-review.pdf.

- 218 The fixed broadband penetration rate in the UK is 39.38 percent, up from 21.45 percent since the last report. The proportion of low- and high-speed subscriptions is 22.4 and 16.1 per 100 inhabitants respectively. The proportion of households being covered by NGA was 75 percent by mid-2014.²⁰⁴ More recently, total fixed broadband coverage is at 100 percent, fixed broadband uptake is at 87 percent (creating a demand gap of 13 percent), and total NGA coverage had increased to 92 percent²⁰⁵ in 2016, which is well above the EU average of 76 percent. Some 43 percent of subscriptions are for high-speed broadband.
- 219 The UK has implemented a strategy to increase access to high-speed broadband through the *Superfast Broadband Programme*. Government and local authorities have invested £1.7 billion in public funding to help bring superfast broadband to over 95 percent of the UK by the end of 2017.²⁰⁶ Broadband Delivery UK (“BDUK”) is responsible for implementing the rollout of the national plan.

A.7.1 Headline Data

Market Outcome		
Indicator	Measurement/Index	Result
NGA Coverage	# homes passed / total # homes	92%
Wholesale Regulation	Classification based on wholesale regulation observed in broadband markets	High
Broadband Penetration	# of broadband subscribers per 100 inhabitants	39.38
Price	Price per Mbps	\$1.19
Speed (Mbps)	<ul style="list-style-type: none"> • Maximum Speed Available • Average Download Speed • Average Upload Speed 	49.27 9.43
Innovation	IPTV uptake	7%

A.7.2 Network Competitors

- 220 The incumbent is BT and it has 36.6 percent of the market share, which is below the EU average of 40.7 percent. BT’s main competitors are Virgin Media, Sky, and TalkTalk. The latter two purchase their wholesale inputs from BT. As of July 2016, there were 25 million fixed broadband connections in the UK.²⁰⁷ Of these connections, 19.2 percent were

204 WIK-Consult, 2015. Competition & investment: An analysis of the drivers of superfast broadband.

205 Europe’s Digital Progress Report, 2017.

206 Details about the Superfast campaign can be found here: <https://gosuperfast.campaign.gov.uk/>.

207 Europe’s Digital Progress Report, 2017.

Virgin Media cable connections and about 30 percent were ADSL and VDSL connections provided over BT's network.²⁰⁸

- 221 New entrants' DSL subscriptions are typically full LLU (79.9 percent), shared access (11.6 percent) or resale (7.5 percent) and only 1 percent of new entrant access is through their own network.²⁰⁹

A.7.3 Innovation

- 222 The UK government rolled out a £10 million Innovation Fund to test innovative solutions to deliver superfast broadband services to the most difficult to reach areas in 2014.²¹⁰ In 2016, the European Investment Bank ("EIB") agreed to provide £21 million for investment by Hyperoptic to provide 1 Gbps fibre broadband to more than half a million homes in UK cities. Furthermore, Openreach announced a partnership with EIT Digital to roll out an ultrafast broadband service powered by G.fast technology over its current copper network with the goal of reaching 10 million homes and businesses by the end of 2020 at speeds 10 times faster than those in 2016.²¹¹ A nationally-coordinated program of 5G testbed facilities and application trials to support fibre and 5G deployment was announced in November 2016. The government will invest £1 billion by 2020-2021.

- 223 The fixed broadband market shares by technology are as follows: DSL (80.1 percent), cable (19.3 percent) and FTTH (0.5 percent).²¹²

A.7.4 Pricing and Competitive Dynamics

- 224 The gap has narrowed between the prices of superfast and standard broadband and many people can upgrade their broadband at no extra cost.²¹³ Virtually all new contracts for bundles that include a fixed broadband service feature a promotional discount of 20 percent on average.²¹⁴ The prices for standard broadband have increased — particularly for BT customers. 80 percent of UK households purchased bundled services in 2018, partly because most fixed broadband service require a landline voice service to be purchased from the same provider. Between 2012 and 2017, the average non-

208 Europe's Digital Progress Report, 2017.

209 Europe's Digital Progress Report, 2017.

210 UK Government Unveils Bidders for £10m Broadband Innovation Fund. (2014, June 19). Retrieved from <https://www.ispreview.co.uk/index.php/2014/06/uk-government-unveils-bidders-10m-broadband-innovation-fund.html>.

211 Openreach to supercharge broadband speeds thanks to innovation with EIT Digital. (2016, October 13). Retrieved from <https://www.eitdigital.eu/newsroom/news/article/openreach-to-supercharge-broadband-speeds-thanks-to-innovation-with-eit-digital/>.

212 Europe's Digital Progress Report, 2017.

213 Ofcom, 2018. Pricing trends for communications services in the UK. Retrieved from https://www.ofcom.org.uk/__data/assets/pdf_file/0030/113898/pricing-report-2018.pdf.

214 Ofcom, 2018. Pricing trends for communications services in the UK. Retrieved from https://www.ofcom.org.uk/__data/assets/pdf_file/0030/113898/pricing-report-2018.pdf.

discounted price of superfast bundles increased by about 7 percent whereas the price of bundles with standard speeds increased by 23 percent over the same period.²¹⁵

Carrier	Plan	Usage	Download Speed (Mbps)	Monthly Price (USD)
Virgin	VIVID 50	Unlimited	50	\$49.07
Virgin	VIVID 100	Unlimited	100	\$56.08
Virgin	VIVID 200	Unlimited	200	\$63.09
Virgin	VIVID 350	Unlimited	350	\$70.10
BT	Superfast Fibre	Unlimited	50	\$73.59
BT	Superfast Fibre 2	Unlimited	67	\$82.70

A.8 UNITED STATES

- 225 The Federal Communications Commission (“FCC”) had rolled back a number of avenues previously available to access-based entrants around the time of the last report. This contributed to its previous regulatory classification of medium by Gilbert + Tobin. Facilities-based competition was high, being tied for third out of 13 countries at 80 percent. Wholesale access regulation is now classified as low after being classified as medium in the 2007 report.
- 226 The fixed broadband penetration rate in the United States is 33.72 percent, which is less than Canada, the UK, Germany and France. There is equal penetration of high- and low-speed broadband services. The US remains one of the leading countries in terms of EFC. The US was tied with Canada having 89 percent NGA coverage in mid-2014²¹⁶ but has since increased this coverage to 92.3 percent by 2016.²¹⁷
- 227 The National Broadband Plan was released by the FCC in March 2010. The benchmark download speed set by the FCC has increased from 4 Mbps in 2010 to 25 Mbps as of 2017.²¹⁸ The high-speed target for the plan is for 100 million homes to have access to actual speeds of 100 Mbps by 2020. Despite having high levels of NGA coverage and strategic initiatives surrounding broadband roll-out, 10 percent of Americans still cannot

215 Ofcom, 2018. Pricing trends for communications services in the UK. Retrieved from https://www.ofcom.org.uk/__data/assets/pdf_file/0030/113898/pricing-report-2018.pdf.

216 WIK-Consult, 2015. Competition & investment: An analysis of the drivers of superfast broadband.

217 FCC, 2018. Broadband Deployment Report.

218 The National Broadband Research Agenda. (2017, January). Retrieved from <https://www.ntia.doc.gov/files/ntia/publications/nationalbroadbandresearchagenda-jan2017.pdf>.

access services that meet the current speed standards and 27 percent of households had not adopted residential broadband Internet service as of July 2015.²¹⁹

A.8.1 Headline Data

Market Outcome		
Indicator	Measurement/Index	Result
NGA Coverage	# homes passed / total # homes	92.3%
Wholesale Regulation	Classification based on wholesale regulation observed in broadband markets	Low
Broadband Penetration	# of broadband subscribers per 100 inhabitants	33.72
Price	Price per Mbps	\$1.04
Speed (Mbps)	• Maximum Speed Available	2000
	• Average Download Speed	70.75
	• Average Upload Speed	27.64
Innovation	IPTV uptake	9%

A.8.2 Network Competitors

228 The top five broadband carriers by subscription are Comcast, Charter, AT&T, Verizon, and Century Link.²²⁰ At the end of 2016, 90 percent of households could choose from two or more fixed providers.²²¹ However, fewer than 40 percent of American have more than one ISP choice in the high-speed category.²²² The chart below summarizes the number of ISPs that census blocks had access to at the end of 2016.^{223,224} Almost half of all

219 The National Broadband Research Agenda. (2017, January). Retrieved from <https://www.ntia.doc.gov/files/ntia/publications/nationalbroadbandresearchagenda-jan2017.pdf>.

220 Kafka, Peter and Rani Molla. (2017, April 27). Comcast, the largest broadband company in the U.S., is getting even bigger. Retrieved from <https://www.recode.net/2017/4/27/15413870/comcast-broadband-internet-pay-tv-subscribers-q1-2017>.

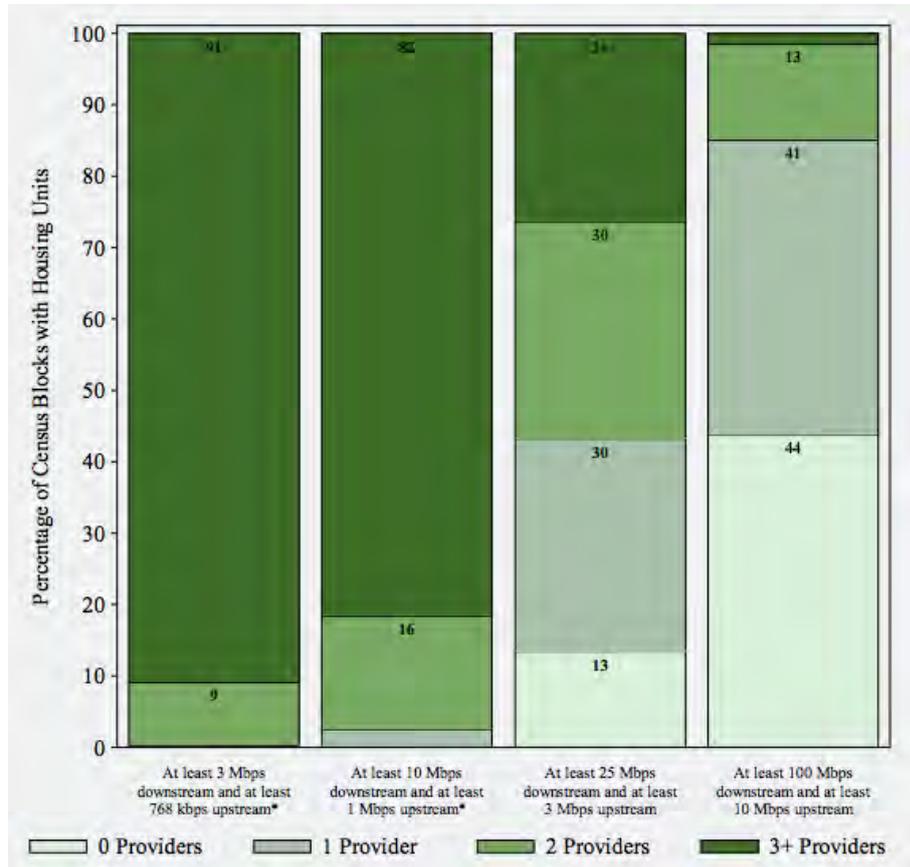
221 Brogan, Patrick. (2018, March 20). New Analysis: USTelecom Data Highlights U.S. Broadband Expansion, Competition and Usage. Retrieved from <https://www.ustelecom.org/blog/new-analysis-ustelecom-data-highlights-us-broadband-expansion-competition-and-usage>.

222 The National Broadband Research Agenda. (2017, January). Retrieved from <https://www.ntia.doc.gov/files/ntia/publications/nationalbroadbandresearchagenda-jan2017.pdf>.

223 Brodtkin, Jon. (2018, December 2). FCC report finds almost no broadband competition at 100 Mbps speeds. Retrieved from <https://arstechnica.com/information-technology/2018/02/fcc-report-finds-almost-no-broadband-competition-at-100mbps-speeds/>.

224 FCC, February 2018. Internet Access Services: Status as of December 31, 2016. Retrieved from https://transition.fcc.gov/Daily_Releases/Daily_Business/2018/db0207/DOC-349074A1.pdf.

census blocks had no providers offering download speeds in the 100 Mbps and above market.



Source: FCC, December 2016.

A.8.3 Innovation

229 Many public-private partnership models have emerged, resulting in over 50 communities having publicly owned networks offering at least 1 Gbps services.²²⁵ Moreover, the latest deployments by Verizon FiOS and Google Fiber are capable of reaching speeds of 500 Mbps and 1 Gbps respectively.²²⁶

230 At the end of 2016, 71.8 percent of fixed connections providing a download speed of at least 10 Mbps were by way of cable modem, followed by FTTP with 13.1 percent and aDSL with 12.8 percent.²²⁷

225 The National Broadband Research Agenda. (2017, January). Retrieved from <https://www.ntia.doc.gov/files/ntia/publications/nationalbroadbandresearchagenda-jan2017.pdf>.

226 Fiber-optic internet in the United States. (2018, September 24). Retrieved from www.broadbandnow.com/Fiber.

227 FCC, February 2018. Internet Access Services: Status as of December 31, 2016. Retrieved from https://transition.fcc.gov/Daily_Releases/Daily_Business/2018/db0207/DOC-349074A1.pdf.

A.8.4 Pricing and Competitive Dynamics

231 Broadband prices in the United States are high relative to other countries.²²⁸ Prices for four Xfinity/Comcast plans are listed below. The Gigabit Pro plan provides some of the highest download speeds available around the world. However, all plans are subject to a 1000 GB usage limit where most carriers worldwide have adopted unlimited usage plans.

Carrier	Plan	Usage	Download Speed (Mbps)	Monthly Price (USD)
Xfinity/Comcast	Performance	1000 GB	60	\$74.95
Xfinity/Comcast	Extreme Pro	1000 GB	400	\$99.95
Xfinity/Comcast	Gigabit	1000 GB	1000	\$109.99
Xfinity/Comcast	Gigabit Pro	1000 GB	2000	\$299.95

A.8.5 Other Observations

232 Since 2015, the federal government has given large telcos (AT&T, CenturyLink, Frontier, and Verizon) \$1.5 billion in subsidies through the Connect America Fund to bring high-speed (only needs to be 10 Mbps to receive the subsidy) internet service to rural areas.²²⁹

228 Reese, Nick. (2018, February 5). FCC Report Concludes US Internet Speeds Are 'Among Worst in the Developed World'. Retrieved from <https://broadbandnow.com/report/2018-fcc-international-data-insights/#note-1477-1>.

229 Trostle, H. and Christopher Mitchell. (2018, July). Profiles of Monopoly: Big Cable and Telecom. Retrieved from <https://ilsr.org/wp-content/uploads/2018/07/profiles-of-monopoly-2018.pdf>.

APPENDIX B: SUMMARY DATA AND SOURCES USED IN COUNTRY STUDIES

B.1 SUMMARY DATA

233 This following table summarizes the key data for each country:

Country	NGA Coverage	Internet-Ready Cable Coverage	Wholesale Regulation	Broadband Penetration	Performance -Adjusted Price (CAD)
Japan	99	40	Low	30.96	\$0.78
US	92.3	90	Low	33.72	\$1.04
UK	92	47	High	39.38	\$1.19
Canada	86	95	Medium	37.85	\$0.90
Germany	82	63	High	40.19	\$0.81
Italy	72	0	High	27.41	\$1.26
France	47	30	Medium	42.84	\$0.53
Australia	25	27	High	31.8	\$2.08

B.2 DATA SOURCES

Cable Coverage

234 Internet-ready cable coverage from the 2007 report was found in the 2005 OECD Communications Outlook for all study countries.

235 Ofcom's *Communications Market Report* from December 2016 was used to obtain figures the percentage of households in areas served by cable broadband for all study countries except for Canada.²³⁰ The Canadian figure was taken from *The Economic Impact of the CRTC's Decision to Unbundle Fibre-to-the-Premises Networks* by Hal Singer.

Next Generation Access Coverage

236 NGA coverage data from 2016 for France, Germany, Italy and the United Kingdom have been obtained from country reports in *Europe's Digital Progress Report 2017*²³¹ by the European Commission.

230 Ofcom. (2016, December 16). The Communications Market Report. Retrieved from https://www.vau.net/system/files/documents/ICMR_2016-Full.pdf.

231 Europe's Digital Progress Report, 2017. Retrieved from <https://ec.europa.eu/digital-single-market/en/news/europes-digital-progress-report-2017>.

237 Data for the remaining countries are from: Ofcom's 2017 report *The International Communications Market: Telecoms and Networks* for Japan; the FCC's 2018 *Broadband Deployment Report* for the US; the 2017 CRTC *Communications Monitoring Report* for Canada; and the 2017 National Broadband Network Corporate Plan for Australia.

Broadband Wholesale Regulation Index

238 The broadband Wholesale Regulation classification for all countries was based on the broadband Regulatory Index Number. The index reflects the degree of price, non-price and services regulation in broadband markets and is based on research by Gilbert + Tobin. The methodology behind the calculation of this index is more fully explained in the companion can be found in Section B.3 of this appendix.

Broadband Penetration

239 Fixed broadband penetration data comes from the OECD Broadband Statistics (December 2017) for all countries.²³² Broadband penetration from the last report is the June 2006 observation from the same source.

Broadband Performance-Adjusted Price

240 The performance-adjusted broadband prices for all countries are calculated based on international plan prices from the 2017 Nordicity report. We take the average plan prices across the five service levels and divide that by the average download speeds from Speedtest.

Broadband Speed

241 Average fixed broadband speeds were obtained from Speedtest for all countries.²³³ Speedtest data is measured by Ookla and is based on results of consumers' individual tests for download and upload speeds.²³⁴

Innovation (IPTV Uptake)

242 IPTV uptake was used as a measure of innovation. Data for Australia, France, Germany, Italy, Japan, the United Kingdom, and the United States came from a 2017 Ofcom report *The International Communications Market: TV and Audio-Visual*.²³⁵ The Canadian data came from a 2016 CRTC report *Broadcasting Distribution: Cable, IPTV, and DTH*.²³⁶

232 OECD Broadband Statistics can be found at <http://www.oecd.org/sti/broadband/broadband-statistics/>.

233 The Global Index can be found at <http://www.speedtest.net/global-index>.

234 Speedtest methodology can be found at <https://www.speedtest.net/awards/methodology/>.

235 Ofcom International Communications Market Report 2017. Retrieved from <https://www.ofcom.org.uk/research-and-data/multi-sector-research/cmr/cmr-2017/international>.

236 <https://crtc.gc.ca/eng/publications/reports/branalysis/dist2016/bdu2016.htm>.

B.3 WHOLESALE REGULATION INDEX METHODOLOGY

- 243 The law firm of Gilbert + Tobin was commissioned by Bell to further study the regulatory environments in each of the study countries and prepare a wholesale regulation index (“WRI”) based on several features of the broadband market in each country. The methodology that was used to create the index is presented in this subsection.
- 244 Gilbert + Tobin have assessed the level of wholesale regulation of broadband markets across the study economies based on the following parameters:
- the scope of regulated services;
 - the regulated pricing principle used to set wholesale prices (if any); and
 - the required non-price terms and conditions.
- 245 Each study economy receives a score out of 100 representing regulatory scope and intensity in each parameter. The scope of regulation is measured by ascribing a value to an identified wholesale broadband market or non-price term. The intensity of regulation is measured by ascribing a higher or lower value to a regulated market or non-price term, according to the stringency of regulation in that market or term. The total score out of 300 represents regulation in wholesale broadband markets across the three parameters.

The Number of Regulated Services

- 246 Study economies receive one of three possible values for each broadband market:
- Regulated;
 - Partial regulation; and
 - Not regulated.
- 247 Nine wholesale broadband markets²³⁷ are included in the number of regulated services WRI, with each market receiving equal weighting in the total score out of 100. Unbundled fibre and VULA markets have been added since the 2007 report reflecting their importance.

²³⁷ These markets are: LSS, LLU, unbundled fibre, VULA, resale, bistream, Ethernet, leased lines (wholesale terminating segment) and leased lines (wholesale trunk segment).

248 Where a market is regulated, it is ascribed a score of 100/9 (11.11111). Partial regulation receives a score of $100/9 * 0.5$ (5.55556) to reflect the relatively lesser intensity of regulation in that market. No regulation receives a score of zero.

Regulation Status (Possible Value)	Score Ascribed to Value
Regulated	100/9 (11.11111)
Partial regulation	$100/9 * 0.5$ (5.55556)
Not regulated	0

Wholesale Pricing Principles

249 Study economies receive one of five possible values for each broadband market:

- Long run incremental cost methodology (“LRIC”);
- Cost-oriented standard (including LRIC with mark up, or a hybrid model where anchor or standard product is LRIC but other tiers are controlled more loosely);
- Retail minus or price cap;
- Regulated but no pricing principle; and
- Not regulated.

250 As in the Number of Regulated Services index, nine wholesale broadband markets are included in the index, with each market receiving equal weighting in the total score out of 100. Reflecting the stringency of each pricing principle, the following scores are ascribed:

Pricing Principle Applied (Possible Values)	Score Ascribed to Value
LRIC	100/9 (11.11111)
Cost-oriented standard	$100/9 * 0.75$ (8.33333)
Retail minus or price cap	$100/9 * 0.5$ (5.55556)
Regulated but no wholesale pricing principle	$100/9 * 0.25$ (2.77778)
Not regulated	0

Non-Price Conditions

251 Study economies receive one of 4 possible values for non-price terms and conditions:

- High regulation;
- Moderate regulation;
- Low regulation; and
- No regulation.

Five non-price terms and conditions²³⁸ are included in the index. Organizational separation is given a 60 percent weighting, reflecting its significance as a regulatory measure. The remaining four non-price terms are equally weighted, each receiving a 10 percent weighting. High regulation of organizational separation receives a score of 60; moderate regulation of organisational separation receives a score of 60×0.6 ; low regulation a score of 60×0.3 . No regulation receives a score of zero.

Organizational Separation (Possible Values)	Score Ascribed to Value
High regulation	100×0.6
Moderate regulation	$100 \times 0.6 \times 0.6$
Low regulation	$100 \times 0.6 \times 0.3$
Not regulated	0

252 High regulation of each of the other non-price terms receives a score of 10; moderate regulation receives a score of 10×0.5 ; low regulation a score of 10×0.25 . No regulation receives a score of zero.

Other Non-Price Term or Condition	Score Ascribed to Value
High regulation	100×0.1
Moderate regulation	$100 \times 0.1 \times 0.5$
Low regulation	$100 \times 0.1 \times 0.25$
Not regulated	0

238 The five conditions are: service levels/KPIs/SLGs, regulatory oversight of non-price terms, accounting separation, equivalence requirements, and organizational separation.

