

Levin, Stanford L.; Schmidt, Stephen

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Policies to Facilitate FTTP Deployment

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Policies to Facilitate FTTP Deployment

Stanford L. Levin
Southern Illinois University Edwardsville
USA

Stephen Schmidt
TELUS Communications Company
Canada

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Policies to Facilitate FTTP Deployment

INTRODUCTION

First generation fixed broadband access is a mature technology in the majority of OECD countries. Governments, regulators and providers have now turned their focus to the deployment and adoption ultra-fast next generation broadband networks, particularly fiber networks in various forms, whether fiber-to-the-premises (FTTP), fiber-to-the-node (FTTN), cable systems with hybrid fiber-coax networks (HFC), wireless (particularly LTE and LTE-A), and other network technologies (OECD, 2014, pages 7, 18). The deployment of ultra-fast broadband networks, particularly fiber networks, has risen to the top of so many government and regulatory agendas because of the material social and economic benefits that have been demonstrated to flow from the deployment and adoption of broadband services (Cambini and Jiang, 2009, pages 559-560).

The major technology development today for the delivery of wireline voice, data, and video over next generation broadband networks is fiber-to-the-premises (FTTP), and telephone and cable television companies, and other potential service providers, as well as governments and industry regulators, are all concerned with the speed and extent of deployment of FTTP. This paper looks at the accumulating evidence from various sources, including both fixed broadband networks and wireless networks to understand the connection between policy and FTTP deployment.

FTTP is a technology to deliver voice, data, and video service. FTTP is not a final product or service itself but is a delivery platform that competes with other delivery platforms including

copper wires, copper networks with a fiber backbone, fiber-to-the-node (FTTN), cable systems with hybrid fiber-coax networks, wireless (particularly LTE and LTE-A), and other network technologies. This is the case whether FTTP is used by the carrier deploying FTTP or whether the FTTP or space on the FTTP is sold by that carrier in a wholesale transaction to another service provider that uses the FTTP to deploy voice, data, and video services

At this time, the products and services delivered over FTTP are not materially different from the products and services delivered, or that can be delivered, using other technologies. Even broadband speeds of 100 MBS can typically be provided over copper networks properly configured and by cable companies using their current technology. While FTTP may be required to provide very high speed broadband, such as 1 GB service, these services do not yet have significant demand in the market. This demand is likely to develop first for businesses and for business and residential users in countries that are more Internet ready. Nonetheless, in the future there will most likely be services that can only be provided over FTTP, so the deployment of FTTP is an important policy issue.

Cambini and Jiang (2009, pages 560-562) identify three broad policy approaches to broadband deployment. The first, exemplified by the U. S., features platform competition and a deregulatory approach to FTTP networks, which are not subject to mandatory unbundling requirements.¹ A second approach, exemplified by East Asian nations such as South Korea and Japan, features strong policy intervention and direction from the state to promote FTTP

¹ Canada occupies a middle-zone between the deregulatory policies of the U. S. and the unbundling policies of the EU. Like the U. S., Canada features successful and pervasive platform competition, particularly between cable and telephone companies. However, unlike the U. S., and more like the EU, Canada has imposed mandatory unbundling requirements on broadband providers, notwithstanding the high level of platform competition in Canada.

deployment and adoption. A third approach is found in the EU where unbundling of fixed networks figures very prominently. At a broad level, these approaches reflect differing patterns of political and economic institutions among the U. S., the EU, and East Asia.

In practice, broadband policies might be further differentiated and described by whether they treat FTTP as a monopoly, on the one hand, or whether the approach is to encourage or permit multiple FTTP networks. Where the approach is to treat FTTP as a monopoly, or to create an FTTP monopoly, one company is selected to construct the FTTP network and other service providers are given mandated access to this network. Australia's National Broadband Network ("NBN") is an example of this approach. The other approach is to encourage or permit multiple FTTP networks, or networks that can provide equivalent service, and to not mandate access to any of the networks by other service providers. The United States and Canada offer examples of the latter approach where fiber networks are being constructed by telephone companies, cable companies (hybrid fiber coaxial networks or "HFC" networks), and other private and public network operators. Of course, combinations of these policies are also possible. For example, the FTTP network might be treated as a monopoly with mandated access, but other companies would not be prohibited from constructing their own networks. Alternatively, access to some FTTP networks might be mandated, but the terms of that access might be subject to commercial negotiation. Other policies are also possible.

While arguments for and against any of these policies can be made, and have been made, on a theoretical basis, there is now an increasing amount of actual evidence weighing upon which of these policies are most successful, and are likely to be most successful, in facilitating the

deployment of FTTP. It is this evidence that this paper brings together in order to make recommendations insofar as possible about the expected success or failure of alternative policies.

This evidence comes from two sources. One source is comparative international evidence from the wireline industry regarding investment levels and FTTP deployment. The other source is comparative international evidence from the wireless industry where there have also been varying degrees of mandatory access with consequences on the deployment of new technology. Evidence concerning the deployment of advanced wireless networks, capable of providing broadband services, may be instructive concerning the impact of policies on network deployment and investment more generally. Considering the evidence on the effect of alternative policies on the deployment of new technologies should contribute to moving the policy debate beyond the theoretical and hypothetical.

The analysis raises questions about infrastructure competition, or the lack of it, and how this relates to policy and FTTP deployment. In addition, the analysis suggests that certain policies are inconsistent with FTTP deployment and that some governments may want to re-align their policies given the emerging evidence.

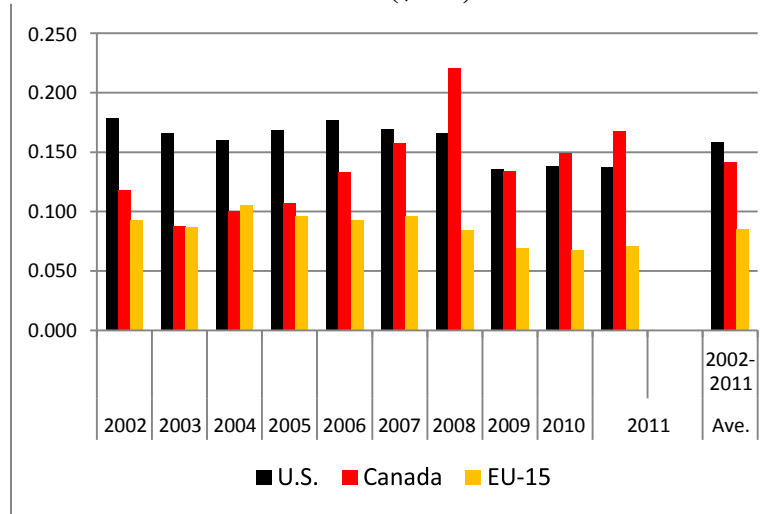
WIRELINE INDUSTRY EXPERIENCE

There is now sufficient experience around the world to begin to draw some conclusions about the effect of policy on investment in telecommunications infrastructure and FTTP deployment. It is important to remember that the data regarding FTTP generally only measure FTTP of the type deployed by telephone companies or specialized FTTP service providers. In countries with infrastructure competition, however, cable companies often deploy comparable facilities (HFC networks where fiber deployed with a coaxial connection to the home), but these are not counted in FTTP measures. As a result, FTTP-type deployment is understated in countries with infrastructure competition from cable companies.

Crandall (2014) examines capital spending on communications in the U. S., Canada, and the EU-15. As Figure 1 shows, capital spending has been consistently higher per communications path in the U. S. and Canada than it has been in the EU-15. He attributes this difference in investment to the fact that there is much less network unbundling and line sharing in the U. S. and Canada than in the EU-15 and to the fact that there is no unbundling or line sharing of FTTP in the U. S., while FTTP unbundling or line sharing continues to be either a fact or a possibility in the EU-15.

Figure 1

**Incumbent Telecom Companies' Capital Spending per Communications
Path United States, Canada, and EU-15
(\$000)**

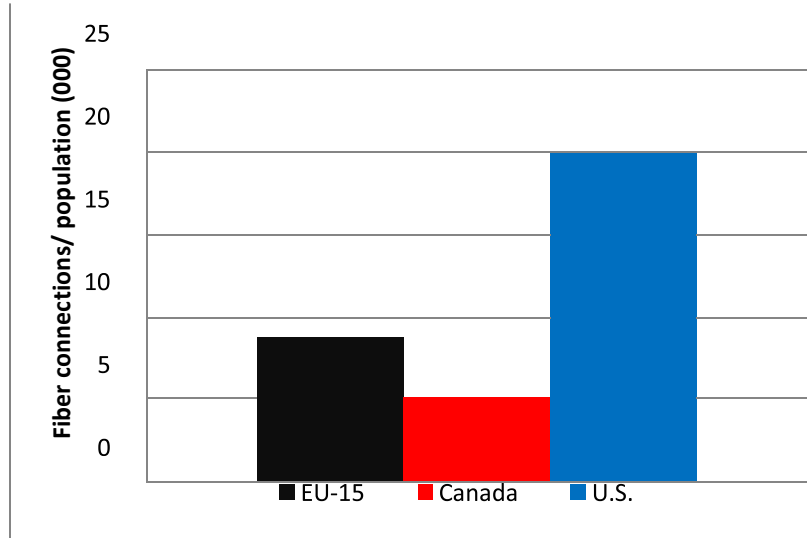


Source: OECD, *Communications Outlook, 2013*, in Crandall (2014, page 5).

In addition, Crandall shows the result of the U. S. not regulating FTTP. Figure 2 shows that fiber connections in the U. S. are significantly higher than in either Canada or the EU-15. This may understate the U. S. lead because these data do not count cable connections, which in the U. S. and Canada provide comparable service to FTTP through their own networks.

Figure 2

**Fiber Connections per Thousand
Persons, 2012 Europe vs. North
America**



Source: *Communications Outlook 2013* (fiber connections), OECD; World Bank and U. S. Census Bureau (population); in Crandall (2014, page 6).

Furthermore, mandatory unbundling does not increase broadband penetration and may even reduce penetration, perhaps because unbundling reduces investment and restricts competition (Crandall, *et al.*, 2013). This is consistent with the finding of other studies. For example, Grajek and Roller (2012, pages 189, 212), find access regulation to have a negative effect on both total industry and individual carrier investment. More particularly, access regulation discourages investments *both* by incumbents *and* individual entrants.

Yoo (2014) compares several broadband metrics between various European countries that rely on service-based competition (local loop unbundling or line sharing) and the U. S. with its facilities-based competition, using data for 2011 and 2012. For high-speed access (25 Mbps or

greater), more U. S. households than European households had access (82% versus 54%), and that lead was even larger in rural areas (48% versus 12%). Regarding new technology, FTTP availability was 23% versus 12% in Europe, and 4G LTE was available to 86% of U. S. households versus 27% in Europe.

Yoo also measures the deleterious effect on broadband investment in Europe with its reliance on service-based competition. He finds that broadband investment in 2012 was \$562 per household in the U. S. but only \$244 per household in Europe. At the same time, U. S. broadband speeds during peak times, defined as weekday evening, averaged 15 Mbps, below the European average of 19 Mbps, although in the U. S. download speeds were 96% of the advertised rate compared to 74% in Europe. Latency and packet loss were better in the U. S. At the time of his study, Yoo finds that U. S. broadband was less expensive than European broadband for speeds below 12 Mbps, although he points out that the higher cost in the U. S. for higher speeds needs to be seen in the context of U. S. households using 50% more bandwidth than European households. On balance, Yoo finds that the empirical evidence confirms that “the United States is faring better than Europe in the broadband race and provides a strong endorsement of the regulatory approach taken so far by the U. S.

Crandall and Yoo are not alone in reaching these conclusions. For example, Cambini and Jiang (2009) reviewed the literature available then and concluded that most of the empirical studies found that local loop unbundling reduced investment by both incumbents and entrants. Grajek and Roller (2012), as noted above, reached the same conclusion. Serentschy (2014) also

documented the low level of European investment and the relatively poor performance of the industry.

Lee, *et al.* (2011) find that local loop unbundling may initially increase the diffusion of fixed broadband service, but they recognize that the negative consequences on longer-term investment. Their analysis does not permit them to estimate the longer-term availability of fixed broadband which might result from the lower level of investment and the lack of facilities-based competition. The situation today, as presented in other studies, strongly suggests that the longer-term consequences of local loop unbundling have predominated, resulting in less investment and lower availability of higher-speed broadband.

Martin Cave put forth the theory of the ladder of investment, the idea that companies might begin providing service by using unbundled local loops or line sharing (bitstream access) and then climb the ladder of investment, ultimately reaching the top rung of facilities-based service. In a recent article (Cave 2014), however, Cave cannot really muster evidence to support this theory. Regarding what he describes as the end of the copper era, Cave concludes that “lines served by access-based entrants were by 2010 predominantly reliant on unbundled loops. There were no signs of entrants ‘jumping off the ladder’ to build their own local loops.” While Cave has methodological concerns with the analysis, he still concludes that “(t)here is persuasive evidence that end-to-end intermodal competition produces better results than access-based intra-modal competition.” This is certainly consistent with the evidence that others have evaluated.

Crandall (2014), for example, also states the finding that the ladder of investment has not been supported by the facts.

While Cave says that it is too early to evaluate the ladder of investment in the context of fiber, he does not provide any evidence to suggest that the outcome would be different than it has been for copper. Indeed, he states (2014, page 681),

It is clear that entrants faced with an alternative to investing in access infrastructures will normally adopt it. Where the alternative bitstream or virtual access product is denied or restricted, the evidence suggests that competitors will invest. Clearly, there are limits to such an approach in rural areas, but currently unbundled exchange areas can probably give a good indicator of those limits.

Cave (2014, page 682) concludes with the following.

There is good evidence that benefits accrue to broadband customers from full end-to-end competition between a telecommunications operator and a cable company. Access-based competition seems to confer fewer benefits. However, in areas without a cable network, the relevant alternative (the ‘counterfactual’) to unbundling would probably be not full network competition but monopoly regulation. It has been argued that unbundling is likely to have performed better against this option.

This casts the choice too narrowly, however. First, infrastructure competition can come from sources other than cable. For example, there can be independent fiber providers. More tellingly, Cave makes no mention of mobile 4G LTE service, which is rapidly becoming a viable broadband substitute for many users. Indeed, many broadband users, even if they subscribe to fixed broadband, may get a substantial amount of their data from a mobile device. Second, and more importantly for the long run, European regulators and analysts such as Cave ought to be asking why, in many but not all European countries, there is a lack of infrastructure competition from cable. Cable competition is widespread in the U. S. and Canada, and in some European

countries such as The Netherlands. This seems to be a very important, yet unasked, question. Contrary to what Cave suggests, in areas with no infrastructure competition, the only choices are not a regulated monopoly or unbundling. The better choice is a policy to develop infrastructure competition from cable or other service providers. For example, spectrum policy may offer governments an important lever for generating infrastructure-based competition for the provision of broadband services. For the many countries that have transitioned from an environment of monopoly wireline supply to an environment of competing, multiple platforms (wireline, wireless, broadcasting), the recognized policy choice is no longer between regulated monopoly or unbundling. Rather, the policy focus shifts to achieving investment and innovation (Bauer and Bohlin, 2007). Yesterday's policy choices (unbundling of monopoly networks) will not build tomorrow's networks. Different choices are necessary.

Kongaut and Bohlin (2014), similar to Cave, take the existing infrastructure as given. They argue that the choice between infrastructure competition and open access (local loop unbundling or the equivalent and other types of network sharing) is a choice depending on the existing extent of infrastructure competition in a country. This is, however, a static view and does not recognize the dynamic interaction between policy and competitive infrastructure. The more dynamic policy choices are better set out in Bauer and Bohlin (2007). Policies that enable infrastructure competition, and that do not take the current state of infrastructure as given, are likely to have better outcomes for consumers. Furthermore, once infrastructure sharing is implemented, it is much less likely that infrastructure competition will develop, given the documented tendency of such unbundling mandates to suppress investments by entrants.

Australia and New Zealand have embarked on the alternative of monopoly high-speed broadband networks. Beltran (2014) analyzes the early results of national FTTH initiatives in Australia and New Zealand. In Australia, a public company has struggled to meet its construction targets. Fiber uptake, however, has been around 16%, although this number has been boosted by incentives to the incumbent to shut down copper connections when fiber is available. New Zealand's public-private partnership, on the other hand, has exceeded its rollout targets but has an uptake of only around 3%.

Howell (October 9, 2014) points out some of the problems and the expense of Australia's policy of an NBN fiber monopoly. Because the government wants to maintain nationwide pricing, it must prevent infrastructure competition in urban areas where broadband is priced higher to subsidize rural areas. The government policy favors taxpayers as owners of the NBN in the short run over taxpayers as consumers benefiting from infrastructure competition in the long run.

Such government-owned or, in the case of New Zealand, public-private partnership national monopoly networks require substantial subsidies. Even with a recent revision of Australia's NBN to permit the NBN to include cable and other assets to be acquired for the NBN (at the cost of infrastructure competition), Howell (December 26, 2014) reports that the NBN will cost almost US \$5 billion more than relying in industry to provide the service. New Zealand recently announced that it would increase its ultra-fast broadband (UFB) network to reach 80% rather than 75% of households at an additional cost of US \$112-155 million on top of the initial cost of the network. At the end of 2014, however, the UFB network had only 69,301 subscribers.

Finally, Werbach (2013) correctly points out the need for a regulator to oversee the infrastructure monopolies in Australia and New Zealand. This is something that has generally been overlooked.

Yet in light of all of the evidence, many European regulators continue to pursue policies that will not deliver the hoped-for benefits. In the U. K., for example, Ofcom reports in November 2014 that 32% of broadband connections are at 30 Mbps or higher (*Telegeography*, 27 February 2015). At the same time, BT is “currently obligated to allow other operators to use its network to sell superfast broadband to consumers under a process known as ‘virtual unbundled local access (VULA)’” Regarding this, “British telecoms regulator Ofcom has unveiled new measures which it says are designed to promote competition and investment in the superfast broadband market . . . fixed line incumbent BT would be required to allow other providers to ‘maintain a sufficient margin between its wholesale and retail superfast broadband charges in order to allow other providers profitably to match its prices (*Telegeography*, 15 January 2015).’”

By contrast, in Canada (CRTC 2014), which is much less dense than the U. K., even in urban areas, 80% of broadband connections were at speeds of 30 Mbps or higher in 2013, compared to 32% of broadband connections in 2014 in the U. K.. Furthermore, Ofcom’s policies will prop up retail prices while inhibiting the development of infrastructure competition. After all, why would a company invest in infrastructure when they could purchase a wholesale service with a guaranteed retail margin.

WIRELESS INDUSTRY EXPERIENCE

There is some corroborating evidence from evaluating wireless service as well. For example, Mobile Virtual Network Operators (MVNOs) are the wireless equivalent, broadly, to unbundling and line sharing, and it is informative to consider the effect of MVNOs on the wireless industry.

Dippon (2014), for example, explains that MVNOs provide little if any competition to facilities-based network operators, a lesson that is also useful when considering wireline service providers using unbundled local loops or line sharing. Eisenach (2014) undertakes an analysis of the performance of the wireless markets in the U. S., Canada, and the EU, an analysis that is analogous to the research above regarding the wireline and broadband markets.

Eisenach (2014, page 4) describes the regulatory regimes in the three markets as follows.

The U. S. market is characterized by regulatory liberalization, including a relatively light-handed approach towards regulation of wholesale markets, while the EU market is characterized by a greater degree of government intervention. Canada lies somewhere between the two, but in recent years has moved towards a more interventionist regime.

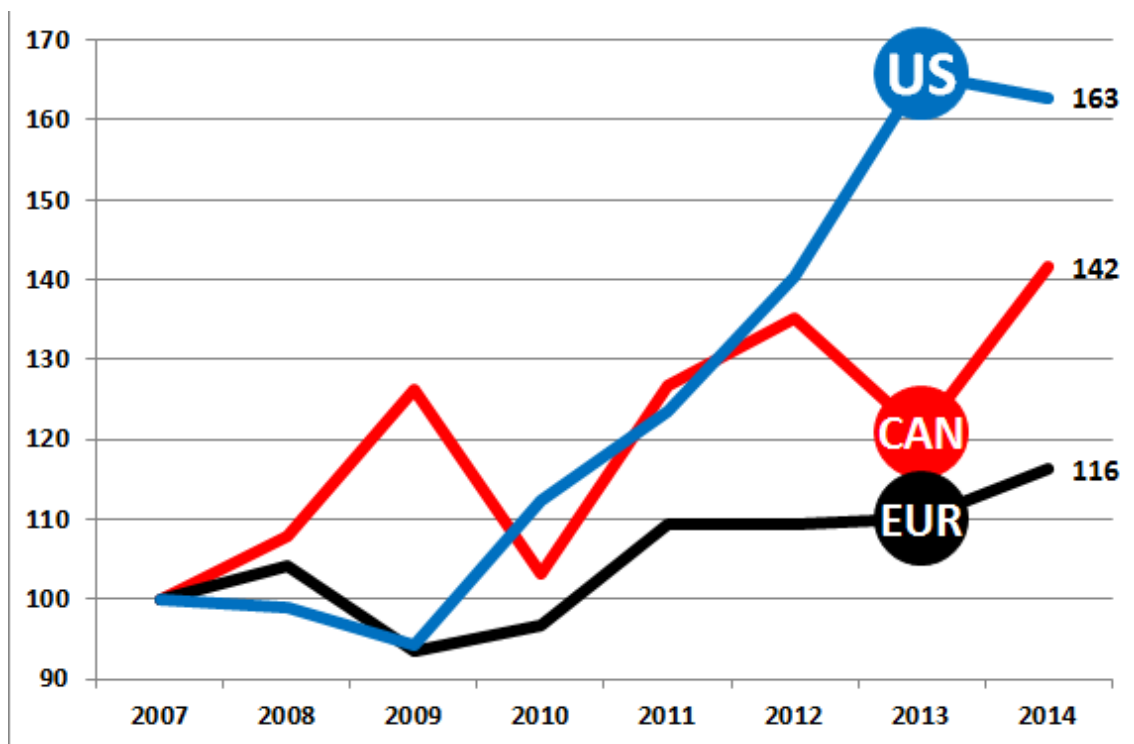
This distinction is comparable to the distinction between unbundled local loops and line sharing in the EU compared to much less intervention in the U. S. and Canada for wireline service.

Given the differences among regulatory regimes, and the parallels to wireline broadband service, it is informative to consider differences in performance that are attributable to the different regulatory policies.

The wireless investment data show the same relationship to the different policies as do the wireline investment data. Figure 3 shows the greatest increase in investment over the past eight years for the U. S. and the smallest increase in investment in the EU, with Canada in between. Figure 4 tells the same story for wireless capex per connections. These data are similar to the wireline investment data in Figure 1.

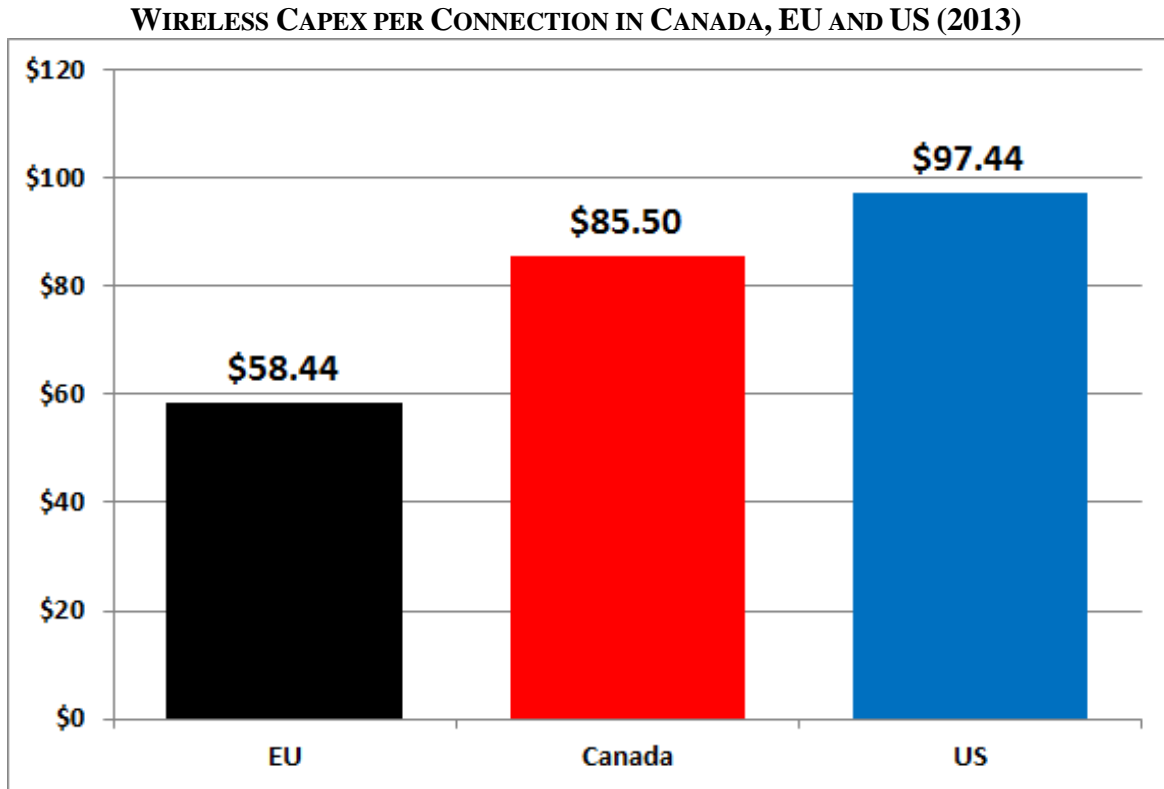
Figure 3

WIRELESS CAPEX IN EUROPE VS. THE US AND CANADA (2007-2014 EST.) (2007=100)



Source: Merrill Lynch in Eisenach (2014).

Figure 4



Source: GSMA Intelligence in Eisenach (2014)

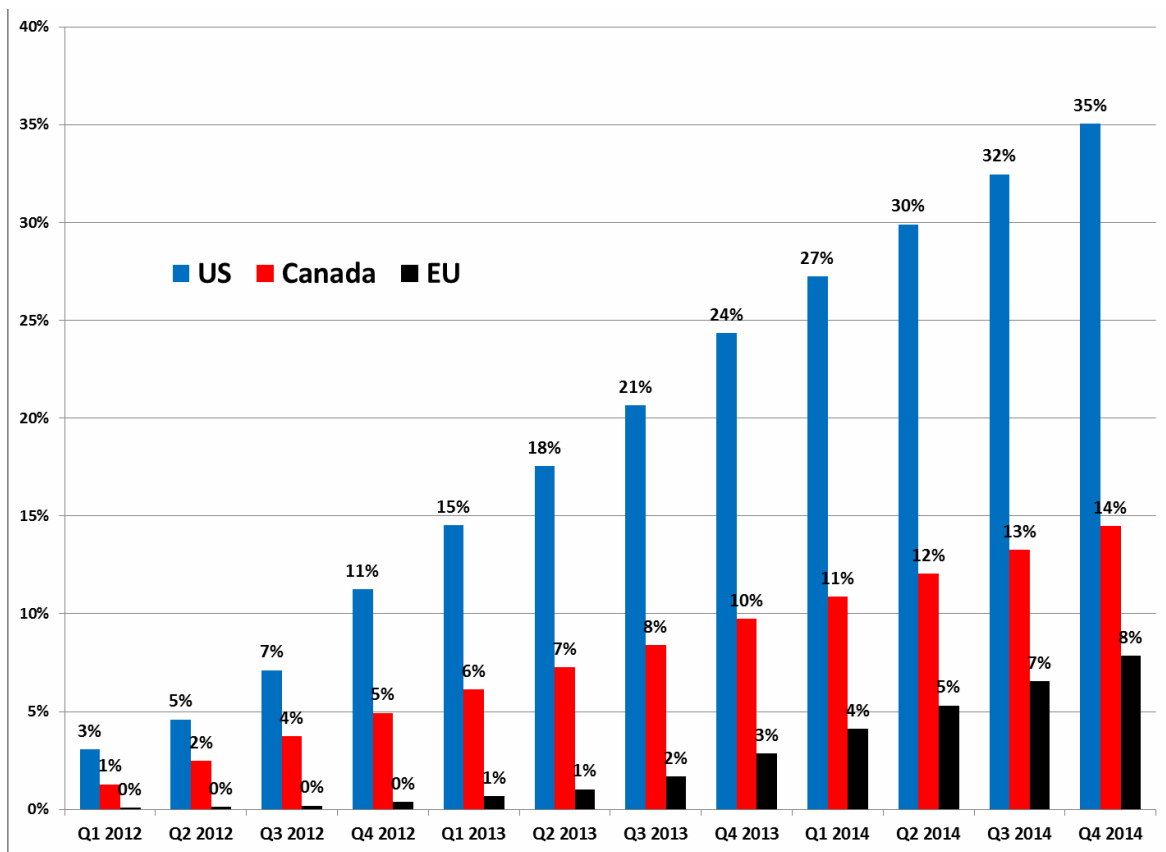
The greater levels of investment in the U. S. go along with higher usage and lower prices. Eisenach (2014) estimates that voice revenue per minute in 2013 was US \$.04 in the U. S. but \$.08 in Canada and \$.09 in the EU. At the same time, U. S. subscribers averaged 933 voice minutes per month, with the comparable figure for Canada at 394 and the EU only 182. U. S. subscribers averaged 884 Megabits of data per connection in 2013 and 1429 in 2014. In Canada the numbers were 869 and 1367, nearly as high as in the U. S. In the EU, in contrast, the 2013 use was only 376 Megabits and only 574 in the EU. So while the average revenue per user (ARPU) was higher in the U. S. and Canada, the actual price was lower. Because EU subscribers often use multiple SIM cards, the amount by which ARPU in the U. S. exceeds

ARPU in Europe is probably overstated, making U. S. and EU prices closer in spite of the substantial difference in usage.

Finally, considering the implementation of new technology, the more liberal regulation of wireless in the U. S. leads to a result that is analogous to the fiber availability shown in Figure 2. Figure 5 shows the much faster implementation of 4G LTE service in the U. S. compared to both Canada and the EU. At the end of 2014, the U. S. was estimated to have 35% LTE coverage, while it would only be 8% in the EU and 14% in Canada.

Figure 5

LTE CONNECTIONS AS PERCENTAGE OF CONNECTIONS (2012–2014)



Source: GSMA Intelligence (2014 estimated) in Eisenach (2014).

CONCLUSIONS

The emerging evidence shows that investment and FTTP deployment is greatest in countries that generally do not have mandatory unbundling. Mandatory unbundling of copper loops has slowed investment and infrastructure competition. It stands to reason that countries with mandatory unbundling of copper loops raise the threat of unbundling or line sharing of FTTP, even if such unbundling or line sharing has not yet been mandated, and the data support that premise. The only exception to this would be if a country makes a credible commitment not to unbundle or otherwise mandate sharing of FTTP. This conclusion is further substantiated by analogous results for policy and wireline service in the U. S. and the EU.

It is common for observers of EU telecommunications to take note of the fragmented nature of the EU market, with 28 national markets and regulators, and to assert that the consequent lack of scale cannot support infrastructure investment and the development of new products and services. Those observers should ask, however, if this is really the problem, or if it is just an excuse. Relatively small countries like The Netherlands and like Canada, which is much less densely populated, do well in terms of investment and technology diffusion as well as infrastructure competition compared to the EU in general. This supports a conclusion that the problem in the EU is policy and not fragmented markets or the lack of economies of scale. The EU should reconsider its policy of network sharing and should be supporting policies that would

foster the development of infrastructure competition, particularly from cable, but also from wireless players.

Furthermore, one of the justifications for unbundling, if not the primary justification, was the idea of the ladder of investment, that firms would begin by using unbundled local loops or line sharing for voice and data and would move on to build their own networks. This theory, however, has proved to be inconsistent with the facts. There is little to no evidence that mandatory unbundling or line sharing leads to infrastructure competition. Rather, it slows investment and inhibits infrastructure competition.

In addition, most clearly for wireless service, but also for wireline broadband and voice service, the EU policies of unbundling and line sharing (or MVNOs in the wireless case) have not resulted in lower prices. Because of the much higher usage of both wireline and wireless service in the U. S., prices per unit are lower in the U. S. than in the EU.

Monopoly FTTP networks, such as in Australia and New Zealand, have required substantial subsidies. As part of this strategy, infrastructure competition much be blocked, and this likely to be detrimental to consumers in the longer run.

Finally, the lack of infrastructure competition in Europe, in addition to the lack of investment and other outcomes already noted, may be part of a larger digital economy problem in Europe. There are no Amazons, Googles, and Apples that are European. Part of the reason for this may

be the lack of competing platforms, and this may limit Europe's ability to benefit fully from the digital economy.

REFERENCES

- Bauer, Johannes M. and Erik Bohlin, “Dynamic Regulation: Conceptual Foundations, Implementation, Effects,” TPRC 2007, August 15, 2007, available at SSRN: <http://ssrn.com/abstract=2103642>.
- Beltran, Fernando, “Fibre-to-the-home, high-speed and national broadband plans: Tales from Down Under,” *Telecommunications Policy*, 38 (2014) 715-729.
- Cambini, Carlo, and Yanyan Jiang, “Broadband Investment and Regulation: A Literature Review,” *Telecommunications Policy*, 33, 2009.
- Canadian Radio-television and Telecommunications Commission (CRTC), “Communications Monitoring Report, 2014.
- Cave, Martin, “The ladder of investment in Europe, in retrospect and prospect,” *Telecommunications Policy*, 38 (2014), 674-683.
- Crandall, Robert W., “The Effects of Mandated Network Unbundling on FTTP Deployment,” submitted to the Canadian Radio-Television and Telecommunications Commission, January 31, 2014.
- Crandall, Robert W., J. Eisenach, and A. Ingraham, “The long-run effects of copper-loop unbundling and the implications for fiber,” *Telecommunications Policy*, 37, 262-81, 2013.
- Dippon, Christian M., “Assessing the Competitive Effects of Mobile Virtual Network Operators,” Canadian Radio-television and Telecommunications Commission Notice of Consultation CRTC 2014-66, August 20, 2014.
- Eisenach, Jeffrey A., “Expert Report,” Canadian Radio-television and Telecommunications Commission Notice of Consultation CRTC 2014-76, May 15, 2014.
- Flacher, David, and Hugues Jennequin, “Access regulation and geographic deployment of new generation infrastructure,” *Telecommunications Policy*, 38 (2014), 741-759.
- Grajek, Michal, and Lars-Hendrik Roller, “Regulation and Investment in Network Industries: Evidence from European Telecoms,” *Journal of Law and Economics*, 55 (1), 2012, pp. 189-216.
- Howell, Bronwyn, “Pride, prejudice and precluding infrastructure competition for government-owned networks,” *TechPolicyDaily.com*, October 9, 2014.
- Howell, Bronwyn, “The NBN is dead . . . Long live the NBN (but not infrastructure competition,” *TechPolicyDaily.com*, December 26, 2014.

Kongaut, Chatchai, and Erik Bohlin, “Unbundling and infrastructure competition for broadband adoption: Implications for NGA regulation,” *Telecommunications Policy*, 38 (2014), 760-770.

Lee, Sangwon, Mircea Marcu, and Seonmi Lee, “An empirical analysis of fixed and mobile broadband diffusion,” unpublished manuscript, May 2011.

OECD (2014), “The Development of Fixed Broadband Networks”, *OECD Digital Economy Papers*, No. 239, OECD Publishing.

Serentschy, Georg, Statement in response to CRTC (Canadian Radio-television and Telecommunications Commission) Telecom Notice of Consultation CRTC 2014-76, August 2014.

TeleGeography, 15 January 2015.

TeleGeography, 27 February 2015.

TeleGeography, CommsUpdate, “New Zealand government confirms broadband expansion plans,” 17 March 2015.

Werback, Kevin, “The Development of Fixed Broadband Networks,” OECD Digital Economy Paper No. 239, OECD, December, 2013.

Yoo, Christopher S., “U. S. vs. European Broadband Deployment: What Do the Data Say?”, Center for Technology, Innovation and Competition, University of Pennsylvania Law School, June 2014.