Chapter 2

The Global Broadband Bonus: Broadband Internet's Impact on Seven Countries

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2.1 Introduction

2.2 The diffusion of the Internet

To familiarize readers with this technology and market, we provide a picture of deployment, adoption, and revenue generation for broadband.[3] This experience provides a benchmark for further analysis.

The data tell a story of technology diffusion and upgrade. The diffusion of dial-up coincided with the initial use of the Internet in most households. The diffusion of broadband came a few years later and, for households in several dozen developed economies, involved an upgrade in bandwidth.

During the 2003 to 2009 period, broadband service was delivered to households primarily in two forms of wireline service: cable or telephone lines. Countries differed significantly in the extent to which these different delivery channels played a role. At the end of the period, there was growing use of third and fourth delivery channels–fiber optics to the home and access through mobile modes. Some cable firms built out their facilities to deliver these services in the late 1990s, and many, especially telephone companies, waited until the early to mid-2000s.

Cable modem service involved a gradual upgrade to cable plants in many locales, depending on the generation of the cable system. Broadband delivery through telephone lines involved upgrades to telephone switches and lines to make it feasible to deliver a service called digital subscriber line (DSL). Both choices typically support higher bandwidth *to* the household than *from* it–called asymmetric digital subscriber line (ADSL).

Broadband has several appealing features that users experience in heterogeneous ways. In comparison to dial-up service, broadband provides households with faster Internet access and access to better online applications. Broadband may also allow users to avoid a separate phone line for supporting dial-up. Additionally, broadband services are "always on", which users perceive as a more convenient service. It is also generally faster in use. Maximum rates of 14.4K (kilobytes per second) and 28.8K were predominant in the mid 1990s for dial-up modems. The typical bandwidth in the late 1990s was 43K to 51K, with a maximum of 56K. DSL and cable achieved much higher maximum bandwidths, typically up to 750K to 3M (megabytes per second), depending on user choices and vendor configuration. Even higher bandwidth became available to some households late in this period.

Many factors shape the quality of a user's experience, such as the capacity/bandwidth of lines, the number of users in the neighborhood in a cable system, the geographic location of a system in the national grid, the frequency of use of sites with geographically dispersed servers, and the time of day at which the household performs most activities. Generalizations are hard to make beyond the obvious: broadband gives the user a better experience than dial-up access.

Non-wireline services were also available during that period, primarily via satellite. These services tended to be expensive and limited, so they were not popular with most households; however, they were popular with households lacking wireline broadband. Another channel for delivering data in mobile format involved limited use of cell phone infrastructure combined with a card for laptop computers or a specialized personal digital assistant (PDA) device, such as BlackBerry®. These were used primarily to support email and texting and other low-bandwidth applications.

Near the very end of our sampling period, a new set of mobile broadband services began to gain market traction with households, primarily in the form of smartphones. Though smartphones had been available in a variety of

3 For the U.S. experience, see Greenstein and McDevitt, 2009. Much of the experience for the developed and developing world economies is tracked in OECD Broadband Portal (ww.oecd.org/sti/ict/broadband).

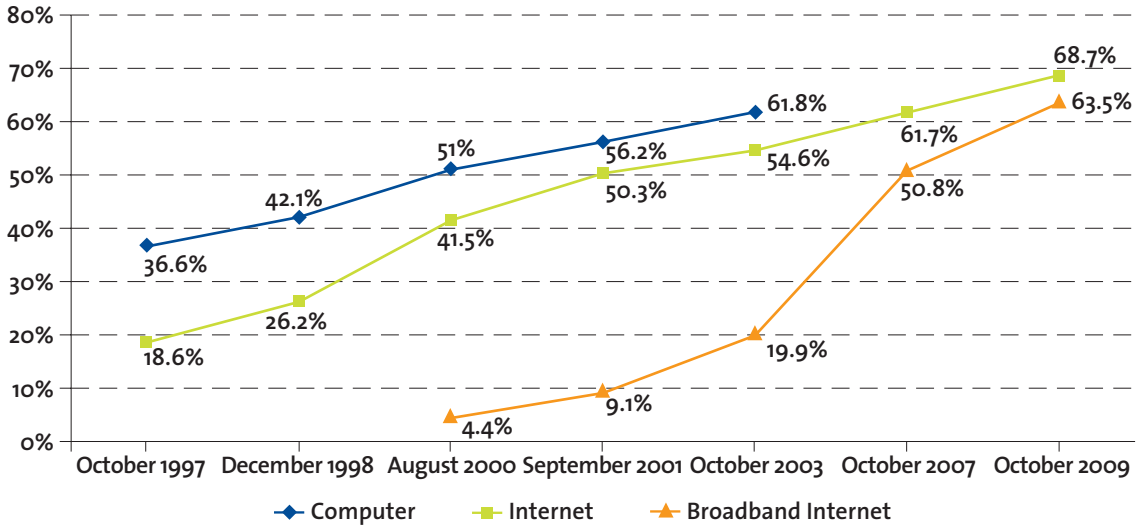
models for many years, it is commonly acknowledged that the category began to take off after the introduction of the Apple iPhone® in 2007. Recent reports suggest the Apple iPhone and new designs from BlackBerry dominate this product category for the time being.

In the United States, broadband was available in only a few locations during the 1990s and early 2000s, but it became more widely accessible over time. User demands for high-bandwidth Internet applications (such as music downloading) increased as households became familiar with them. Firms also rolled out new services as more users acquired broadband (e.g., Web 2.0 applications), which then generated even more adoption.

This is consistent with **Figure 2.1**, which provides a summary of the U.S. government's efforts to collect data about the adoption of the Internet. The first survey questions about broadband use appear in 2000 and show a growth in adoption, peaking at close to 20% of households in 2003, when these surveys were discontinued for some time. Recent data about household use, collected by the Pew Internet and American Life Project, show that the diffusion continued in the anticipated direction. Adoption reached over 47% of households by 2006. The survey resumed in 2007 and the anticipated trajectory continued, with 50.8% of households having broadband in October 2007 and 63.5% in October 2009.

Prior to 2002, the diffusion of broadband Internet access was very much supply-driven in the sense that supply-side issues were the main determinants of Internet availability and, hence, adoption. Most households simply switched from dial-up to broadband if they could, and they found the higher bandwidth worth the extra expense. Cable and telecom operators needed to retrofit existing plants, which constrained availability in many places. During those years, the spread of broadband service was much slower and less evenly distributed than dial-up service. Highly populated areas were more profitable due to economies of scale and lower last-mile expenses. As supply-side building has removed these constraints, demand-related factors—such as price, bandwidth, and reliability—have played a more significant role in determining the margins between adopters and non-adopters. By 2006, supply-side issues began to fade, with only the most low-density parts of the country lacking suppliers.

Figure 2.1. PERCENT OF HOUSEHOLDS WITH COMPUTERS AND INTERNET CONNECTIONS, SELECTED YEARS, 1997–2009*



Note: 2001, 2003, 2007, and 2009 Census-based weights and earlier years use 1990 Census-based weights.
Source: National Telecommunications Information Administration, 2010.

Figure 2.2. OECD BROADBAND SUBSCRIBERS PER 100 INHABITANTS, BY TECHNOLOGY, JUNE 2009

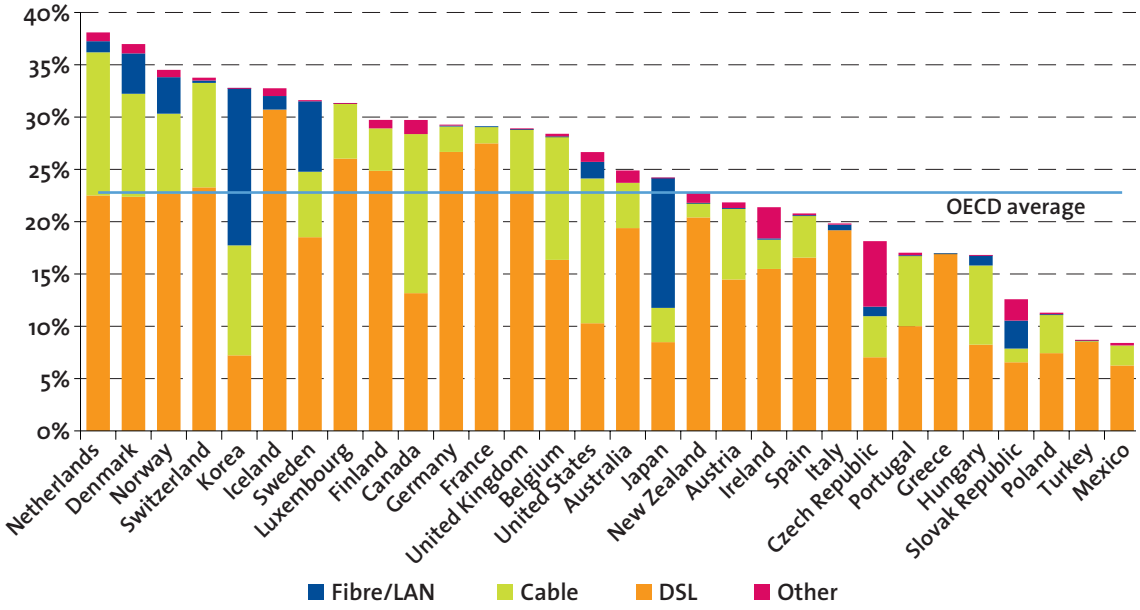
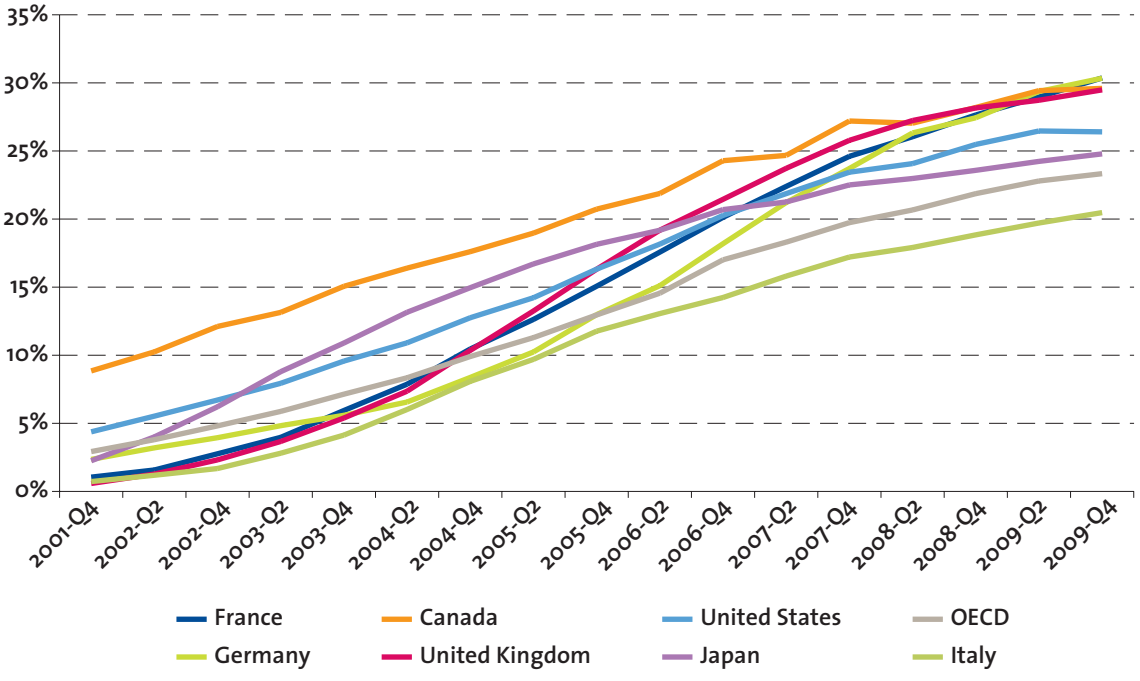


Figure 2.3. BROADBAND PENETRATION, G7 COUNTRIES



Source: OECD.

A similar wave of investment occurred in many developed countries during the first decade of the new millennium. **Figure 2.2** shows the subscribers per 100 inhabitants in many countries in June 2009. There is a range of adoption levels across different economies. While these numbers must be interpreted with caution, a few facts stand out. A couple dozen countries in the Organisation for Economic Co-operation and Development (OECD) have substantial adoption of broadband, and many do not. This is not surprising since countries vary in economic wealth, and GDP per capita and broadband per capita have a simple correlation of 0.67.

Figure 2.3 shows the growth of subscribers per 100 inhabitants in the G7–Canada, the United States, the United Kingdom, Germany, France, Italy, and Japan–as well as the entire OECD. Though countries differ in the level of broadband use (partly due to household size and other factors), the similarities between them are more apparent. Adoption of broadband grew in all countries.

To gain further insight into these general trends in this study we examine several countries in detail. **Tables 2.1** and **2.2** present broadband and dial-up adoption for the seven countries covered in this study–the United States, Canada, the United Kingdom, Spain, China, Mexico, and Brazil. The broadband data in **Table 2.1** come from Point Topic Ltd, a private consultancy. (For a more detailed discussion of our choice in data source, see Section 4 "Data and challenges".) **Table 2.2** provides OECD's estimates of household dial-up adoption by year.

One fact immediately emerges from the descriptive statistics in the tables, which shapes all the results below. The scale of adoption in both the United States and China far outweighs the scale of adoption in any other

Tabla 2.1. OVERALL BROADBAND ADOPTION (IN THOUSANDS)

Nation	2003	2004	2005	2006	2007	2008	2009	CAGR
Brazil	634	1,442	2,671	4,278	5,691	7,509	9,480	47.2%
Canada	3,706	4,829	5,809	6,982	8,001	8,860	9,528	14.4%
China	–	11,385	20,367	30,033	41,778	54,322	68,964	35.0%
Mexico	234	429	1,060	1,945	3,106	4,774	7,836	65.1%
Spain	1,401	2,524	3,444	5,469	7,322	8,296	9,023	30.5%
United Kingdom	960	3,734	7,203	10,983	13,968	16,282	17,641	51.6%
United States	16,042	28,770	37,676	47,489	58,791	67,536	77,334	25.2%

Source: Poin Topic.

Tabla 2.2. OVERALL DIALUP ADOPTION (IN THOUSANDS)

Nation	2003	2004	2005	2006	2007	2008	2009	CAGR
Canada	2,846	2,381	1,876	1,437	1,088	824	624	–19.5%
Mexico	2,016	2,134	1,960	1,719	1,288	965	723	–13.6%
Spain	2,559	1,852	1,199	841	536	342	218	–29.7%
United Kingdom	10,607	9,374	6,417	4,318	2,671	1,652	1,022	–28.4%
United States	67,880	55,000	44,493	35,994	29,118	23,556	19,056	–16.6%

Source: Poin Topic.

country. That occurs for two rather obvious reasons: the United States and China have much larger populations, and the general level of economic development is a major determinant of adoption.

2.3 Motivation and method

The economic determinants behind the growth of broadband are straightforward: Dial-up became available first and diffused to households as a means to deliver the Internet. Broadband emerged later as a higher-quality, more expensive alternative, albeit limited in its availability. Then, over time, broadband became more reliable and more widely available, which led many households to upgrade their Internet service.

There are two common approaches to measuring gains from the new good. First, what is the increase in revenue (GDP) above and beyond what would have been generated had dial-up continued? Second, what is the increase in consumer surplus beyond what would have occurred had dial-up continued? When addressing these questions, traditional approaches are not concerned about *which* vendor or user gains or loses. Our approach will be the same, and we will only compute an aggregate measure.

We focus on revenue instead of producer surplus because we are hampered by the lack of precise information about the unit cost of provision, which is necessary for an estimate of producer surplus at each point in time. Instead, we examine the difference in vendor revenue between actual history and a hypothetical scenario without broadband, absent multiplier and general equilibrium effects–that is, we estimate how much GDP increased in the Internet access market as a result of the deployment of broadband.

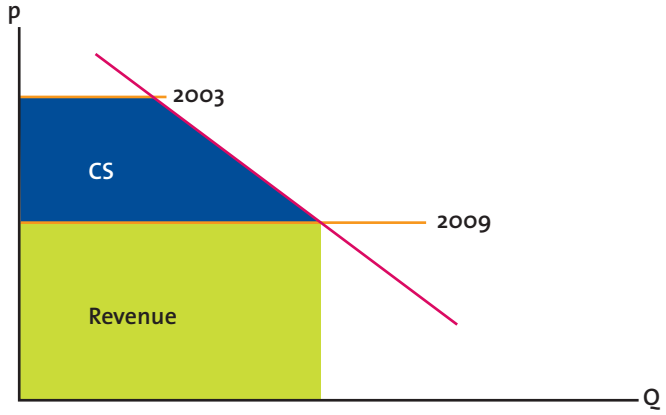
To measure consumer surplus ideally, we should measure the difference in "areas under the demand curves" between the actual demand for broadband and what consumer surplus would have demanded had dial-up continued and not been replaced by broadband. This is challenging to do for many reasons, but one is primary: we cannot observe what the dial-up market would have looked like had broadband not diffused. Instead of measuring two demand curves, we get close to our ideal measure by looking at estimates of user willingness to pay for the upgrade to broadband.

For estimates of consumer surplus in the U.S. market, our earlier research employed a set of estimates developed from Savage and Waldman (2004), who conducted an extensive survey of dial-up and broadband users in 2002. This study had advantages because it surveyed both users and nonusers. The authors also used this survey to directly estimate "willingness to pay" measures for attributes of dial-up and broadband service, which facilitates some simple accounting of the value of broadband in comparison to dial-up for existing dial-up users.

While sufficient for U.S. data, this approach has three drawbacks for a cross-country comparison. First, it is very data-intensive, requiring yearly data on both broadband and dial-up use. Second, it does not fully account for heterogeneity in household willingness to pay; it averages out such differences. Finally, to our knowledge, there are a limited number of similar estimates for demand in the United States or, for that matter, other countries. While the limited evidence suggests many similarities across countries in demand, the evidence is not large and does not come from the countries of interest.

Our strategy is illustrated in **Figure 2.4**. Our data provide information about the deployment and use of broadband in the same country over multiple years. That facilitates a comparison over time. In most countries, nominal broadband prices remain virtually unchanged one year to the next, in spite of inflation. Hence, as household incomes keep pace with inflation, the real price of broadband and the fraction of a household budget devoted to it falls.

Figure 2.4. GAINS IN CONSUMER SURPLUS BETWEEN 2003 AND 2009 FROM DECLINE IN PRICE



This forms the basis for a feasible measurement strategy *within a country*. In **Figure 2.4**, we illustrate the difference between 2003 and 2009. As the real price falls, the demand for broadband rises. Over time, the fall in price "traces" out the demand curve. With this approach, it also is possible to trace the change in consumer surplus in a country.

This approach is quite simple, an advantage for cross-country comparisons. It can also apply to any country in which the underlying premises of the model remain valid.

More concretely, this model assumes that a stable set of factors determine demand, and that these same factors do not shift the demand over time, which is reasonable over short periods of time. We also do not expect large year-to-year increases and decreases in broadband demand. Fortunately, our preliminary examination of data for the United States, Canada, the United Kingdom, China, Brazil, Spain, and Mexico did not find large year-to-year increases or decreases in adoption, which suggests that the data are consistent with these assumptions. Nonetheless, we are wary that the countries with fast growth in incomes, such as Brazil and China, might depart from these assumptions if we tried to extend the study a few more years, so we remain alert for other issues.

This method has another characteristic, and we consider it to be another advantage: it will result in a conservative estimate. It ignores the gains to adoption for all early adopters, for example, because it does not measure the "upper part of the triangle"–namely, it does not measure the surplus generated from households that adopted prior to 2003.

This approach has two drawbacks, however. First, it requires the same data each year. As we will demonstrate below, not all countries have data about broadband that satisfy such a requirement, particularly earlier in the decade. Most of the available data also do not adjust for the quality of broadband, which most observers presume has improved over time.

Second, and somewhat technically, this method measures surplus arising only from movement along a demand curve and not any shifts in demand. It acts as if all increases in volume come from price declines and nothing else. That means the method underestimates surplus that arises from a demand shift linked to, for example, an increase in GDP per capita or a fall in the price of complementary goods, such as personal computers. This feature is related to our previous remark about the framework working best in countries where incomes are not growing rapidly.

Why use this framework in spite of its drawbacks? The drawbacks raise valid concerns since both factors–data constraints and rapid income growth–shape demand in rapidly growing countries, such as China and Brazil. Our answer is a practical one: income effects can be hard to measure. In addition, none of the leading research to date gives sufficient clues about a pragmatic approach to apply to a variety of countries. In addition, we are comfortable with a conservative approach (in an accounting sense) because it lets us make comparisons. There is more consumer surplus being generated than we measure, but at least we can make the comparison.

This approach is also conservative in a different sense. It does not stress "indirect" benefits from broadband, a topic commonly discussed in policy debates. More concretely, though the diffusion of broadband clearly helps firms in the same country whose revenue depends on electronic commerce and advertising-supported online media, it is unclear how large such "spillovers" are. Also, increased broadband use may generate educational or civic benefits that defy economic measurement. While the size of indirect benefits could differ substantially across countries, there is no practical way to measure their size in a way that allows for meaningful comparison.

That circumscribes our interpretation. We measure the economic factors considered by parties involved in a transaction–anything that shapes the perceived or anticipated costs of using dial-up, the willingness to pay for

information about the seven countries of interest and many more. In general, the company's data about adoption and revenue in the United States do not substantially differ from our prior estimates for the same country.

Table 2.1 shows the estimates from Point Topic for household broadband adoption for the seven countries of interest–United States, Canada, the United Kingdom, Spain, Mexico, China, and Brazil. We use Point Topic's data for the first quarter of each year to provide a conservative analysis of the annual rate of adoption. It is conservative because adoption is growing in many countries, so a number from later quarters will be higher. Our definition of broadband Internet is also technologically conservative, as it includes DSL and cable but excludes other formats, such as mobile, primarily due to lack of consistent data for all countries.

Note the key strength and limitation of Point Topic's data. These data are a consistent source for most countries in most years. Definitions remain consistent, and so do reporting standards, which permit meaningful comparisons over time. However, Point Topic does not have complete observations for every country for every year. It only has data for the United States and Canada back to 1999, and for every country except China back to 2002. China's data begin in 2004. To achieve consistency across countries, we begin our analysis in 2003 with the exception of China, for which we begin in 2004.

Finally, we present estimates for revenue for each country for each year. **Table 2.3** shows total revenue for each of the countries in terms of its local currency. It uses Point Topic's estimate of broadband users and a price index from the major provider(s) in each country, expressed in 2009 real terms and in the local currency of the country of origin (e.g., Canadian dollars for Canada, Mexican pesos for Mexico, etc).[4]

Figure 2.5 shows year over year (YoY) growth rates in revenue for each country. These growth rates follow a standard pattern for a diffusing technology. During the earliest moments of diffusion, the growth rates for revenue are very high, reflecting the low base from which they start. Over time, however, growth rates approach zero, a symptom of market maturity and potential saturation. Four countries–the United States, Canada, Spain, and perhaps the United Kingdom by the end of the sample–show signs of reaching maturity in this sense. Three countries–Brazil, China, and Mexico–show the fewest symptoms of maturity.

These revenue levels are important to stress because access fees generated most of the revenue during the first decade of the commercial Internet. The typical household spent more than three-quarters of its time online at

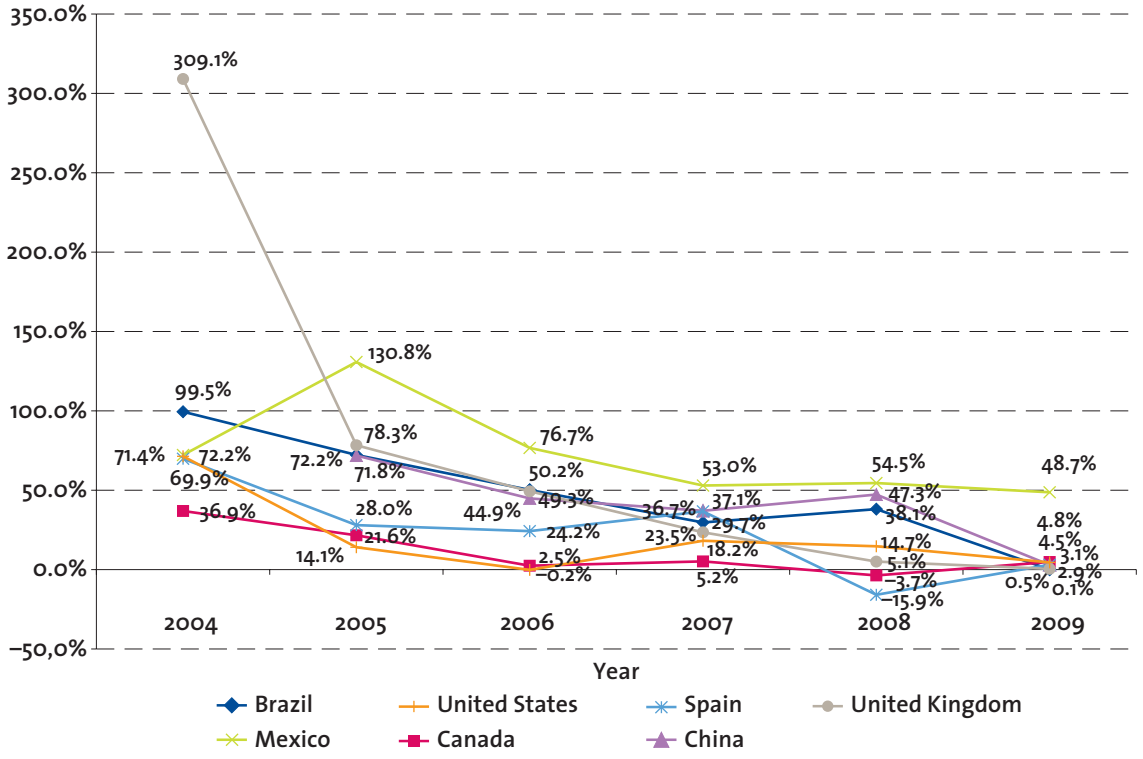
Tabla 2.3. BROADBAND REVENUE ESTIMATE (IN THOUSANDS OF 2009 LOCAL CURRENCY, REAL TERMS)

Nation	2003	2004	2005	2006	2007	2008	2009	CAGR
Brazil	1,294,154	2,581,327	4,446,171	6,677,188	8,660,612	11,959,924	11,969,980	37.4%
Canada	1,717,952	2,352,523	2,860,999	2,931,341	3,082,933	2,970,079	3,112,854	8.9%
China	–	20,472,775	35,181,958	50,961,697	69,843,624	102,868,641	105,899,025	31.5%
Mexico	1,193,741	2,055,538	4,744,069	8,380,884	12,820,374	19,811,401	29,461,214	58.1%
Spain	775,689	1,317,567	1,686,770	2,095,704	2,864,485	2,410,174	2,484,086	18.1%
United Kingdom	237,527	971,708	1,733,031	2,588,178	3,196,210	3,357,633	3,373,604	46.1%
United States	10,287,743	17,630,773	20,114,146	20,081,002	23,728,754	27,214,363	28,446,051	15.6%

Source: Point Topic.

4 Price indices for each country come from the CIA World Factbook.

Figure 2.5. REVENUE GROWTH RATE YoY



free or advertising-supported sites, devoting most of its Internet budget to access fees, not separate subscription fees for each service online.[5] Although subscription-based services and advertising services started growing rapidly after 2003, the amount spent on access fees each year far exceeds advertising revenue. Advertising revenue is now growing at a more rapid pace than access fees, and it may exceed access revenue soon, but not as of this writing.

2.5 The broadband bonus in seven countries

Our primary goal is to compute something equivalent to the estimate of the broadband bonus found in our earlier work–that is, we estimate consumer surplus and net gain in producer revenue (broadband revenue minus lost dial-up revenue), expressed in a single currency for comparability. These estimates are in **Tables 2.7A** and **B**, and we will discuss them at the end of this section. However, to be able to appreciate the construction and robustness of these results, we present the several intermediate steps that were taken in order to reach those final tables.

Table 2.4 presents the first step to the main results. This table computes an estimate for consumer surplus in the local currency indexed to 2009 prices. It is constructed with Point Topic's price estimates and accounts for users' willingness to pay by assumption. As stated earlier, a decline in *real* prices generates consumer surplus.

5 See, for example, Goldfarb, 2004.

Tabla 2.4. BROADBAND CONSUMER SURPLUS ESTIMATE (IN THOUSANDS OF 2009 LOCAL CURRENCY, REAL TERMS)

Nation	2003	2004	2005	2006	2007	2008	2009	CAGR
Brazil	76,476	242,336	424,660	711,644	906,125	732,581	3,365,402	71.7%
Canada	112,211	97,764	201,681	625,539	865,814	1,260,235	1,329,846	42.4%
China	–	–	806,324	1,428,402	2,181,531	–	19,363,619	88.8%
Mexico	36,419	87,825	193,137	375,601	651,181	770,741	2,602,165	84.0%
Spain	16,203	50,210	138,113	525,808	563,560	1,392,932	1,509,804	91.1%
United Kingdom	53,702	56,982	130,308	165,953	241,067	555,307	798,209	47.0%
United States	342,406	336,281	2,314,854	6,258,536	7,212,023	7,357,369	10,106,207	62.2%

Source: Point Topic.

Such declines are common in all these economies from the combination of general price inflation with flat or no growth in nominal prices for broadband. Surplus grows over time in all the estimates, but the data source shapes the level reached at any point in time. For example, **Table 2.4**, using Point Topic data, puts the estimates for surplus without correcting for dial-up revenue at $6.2 billion and $10.1 billion for the United States in 2006 and 2009, respectively.

It is informative to compare across countries using the same methodology and data source, recognizing that each estimate is denominated in local currency, which prevents comparisons among countries. All countries are growing. This is not a surprise. When revenue and adoption grow, so does consumer surplus. The scale of growth is also not surprising, since it largely depends on the change in price levels and change in revenue.

One additional comparison provides confidence in this step. Despite differences in approach and method to accommodate differences in the sources of data, the estimates for the United States in **Table 2.4** are qualitatively similar to the estimates in our earlier work for the overlapping years, with some (unsurprising) differences in the timing of growth. **Table 2.4** puts the total consumer surplus in 2006 at $6.2 billion, while we had estimated it to be between $8.3 billion and $10.5 billion. The estimates for **Table 2.4** are generally lower than our prior estimates, which is largely due to the different methods for estimating changes in prices.

Figure 2.6 converts these estimates into growth rates for each country. The figure illustrates one feature of this approach. It results in comparatively "unsmooth" changes in the size of consumer surplus from one year to the next, which the figure portrays as a substantial growth rate followed by non-growth. Such "lack of smoothness" is plausible in adjacent years in a country, but this periodicity appears to be more than we would expect. This feature suggests not placing too much emphasis on any particular estimate in any specific year. Accordingly, we focus on general trends.

The next step adjusts the estimates for the replacement of dial-up by broadband, presuming that dial-up would have been available had broadband never diffused. **Table 2.5** provides estimates of cannibalized dial-up revenue, using OECD's figures for dial-up use and an estimate of the price of dial-up service, also from OECD. When available, the price survey from 2000 is used and remaining years are estimated to be the proportional rate for DSL price changes. This method is used because price estimates for dial-up in more recent years are not available from OECD. Since OECD does not provide dial-up use in China and Brazil, **Tables 2.6A** and **B** and **Tables 2.7A** and **B** present adjusted estimates for the five countries for which dial-up information is available, as well as unadjusted estimates that include China and Brazil. In this way, the reader can see what matters and what does not.

Figure 2.6. CONSUMER SURPLUS CHANGE YoY

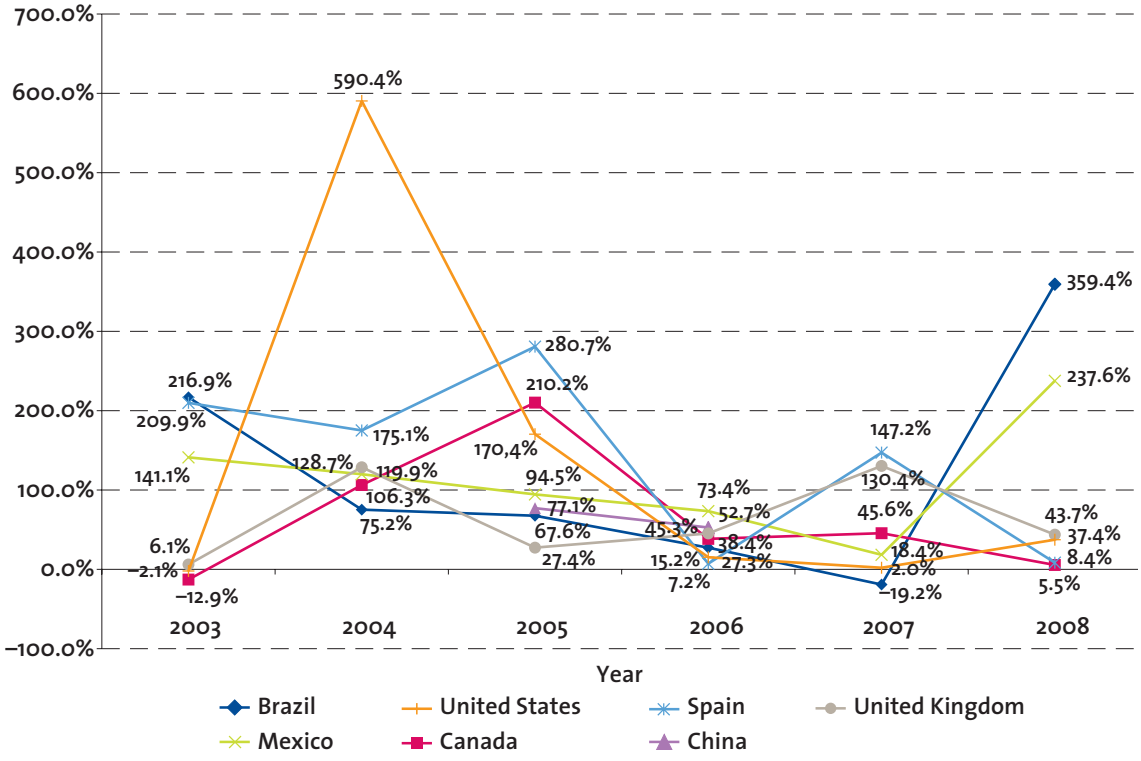


Tabla 2.5. CANNIBALIZED DIALUP REVENUE ESTIMATE (IN THOUSANDS OF 2009 LOCAL CURRENCY, REAL TERMS)

Nation	2003	2004	2005	2006	2007	2008	2009	CAGR
Canada	153,245	451,899	790,475	780,721	928,274	903,895	958,658	29.9%
Mexico	–	–	612,341	1,401,123	2,761,753	3,668,897	4,209,230	47.0%
Spain	264,253	644,978	972,280	926,805	947,695	636,503	631,292	13.2%
United Kingdom	64,901	226,617	586,675	842,786	1,022,474	1,024,043	1,007,115	48.0%
United States	2,328,896	5,936,192	8,240,000	6,138,964	6,814,296	8,137,521	9,485,053	22.2%

Source: Point Topic.

The estimates for cannibalized revenue in **Table 2.5** vary in size across countries. It is not surprising that the United States has the largest amount of cannibalization because its dial-up industry was quite large before broadband began to deploy. Once again, these are denominated in local revenue, so it is not possible to directly compare the size of the estimates across countries.

Table 2.6A derives a broadband bonus. It adds gross broadband revenue to consumer surplus and subtracts cannibalized dial-up revenue. The table uses Point Topic data and estimates, including local currencies indexed to 2009, and supplements them with OECD data for five countries. The size of the net gains follows directly from the prior tables, reflecting the scale of the components that went into them.

Tabla 2.6A. BROADBAND BONUS ESTIMATE WITH CANNIBALIZED DIALUP (IN THOUSANDS OF 2009 LOCAL CURRENCY, REAL TERMS)

Nation	2003	2004	2005	2006	2007	2008	2009	CAGR
Canada	1,676,918	2,018,388	2,272,205	2,776,159	3,020,473	3,326,419	3,484,041	11.0%
Mexico	1,230,160	2,143,362	4,324,865	7,355,362	10,709,802	16,913,244	27,854,148	56.2%
Spain	527,639	722,799	852,602	1,694,708	2,480,349	3,166,603	3,362,599	30.3%
United Kingdom	226,328	802,072	1,276,664	1,911,345	2,414,804	2,888,897	3,164,698	45.8%
United States	8,301,253	12,029,862	14,188,959	20,200,574	24,126,482	26,434,212	29,067,205	19.6%

Source: Point Topic.

Tabla 2.6B. BROADBAND BONUS ESTIMATE WITHOUT CANNIBALIZED DIALUP (IN THOUSANDS OF 2009 LOCAL CURRENCY, REAL TERMS)

Nation	2003	2004	2005	2006	2007	2008	2009	CAGR
Brazil	1,370,630	2,823,663	4,870,831	7,388,832	9,566,737	12,629,505	15,335,382	41.2%
Canada	1,830,163	2,450,287	3,062,680	3,556,880	3,948,747	4,230,314	4,442,700	13.5%
China	–	20,472,775	35,988,282	52,390,099	72,025,155	102,868,641	125,262,644	35.2%
Mexico	1,230,160	2,143,362	4,937,206	7,756,485	13,471,555	20,582,142	32,063,378	59.3%
Spain	791,892	1,367,777	1,824,882	2,621,513	3,428,045	3,803,106	3,993,890	26.0%
United Kingdom	291,229	1,028,690	1,863,339	2,754,131	3,437,278	3,912,940	4,171,813	46.3%
United States	10,630,149	17,966,054	22,429,000	26,339,538	30,940,777	34,571,732	38,552,257	20.2%

Source: Point Topic.

As a step toward comparing the importance of cannibalization across countries, **Table 2.6B** goes as far as possible without using the OECD data on dial-up. That permits us to compare all seven countries. The table adds net revenue to consumer surplus and does not subtract dial-up revenue. These are overestimates of the true broadband bonus because they do not account for what dial-up would have provided. Why make such an overestimate? It puts all countries on a similar footing, though not a similar currency. That is an intermediate step toward comparing the size of the Brazilian and Chinese experience to the other five, once we put all seven in the same real currency.

Tables 2.7A and **B** correspond to **Tables 2.6A** and **B** but express figures in U.S. dollars, indexed to 2009. This allows for comparability across countries. **Table 2.7A** shows that the U.S. bonus exceeds that of Canada, Mexico, Spain, and the United Kingdom. The differences are parallel to differences in the scale of the broadband economies in each country.

Table 2.7B includes China and Brazil, as well as the other countries, but does not subtract cannibalization of dial-up, which follows directly from **Table 2.6B**. All these comparisons must be interpreted cautiously because they do not reflect the subtraction of lost dial-up revenue, but they are suggestive nonetheless.

In both estimates, the size of the broadband bonus in China is large, just under half the size for the United States (before correcting for cannibalized dial-up). The size for Brazil is also quite large, though the tables do not pro-

Tabla 2.7A. BROADBAND BONUS ESTIMATE WITH CANNIBALIZED DIALUP IN U.S.D. (IN THOUSANDS OF 2009 USD, REAL TERMS)

Nation	2003	2004	2005	2006	2007	2008	2009	CAGR
Canada	1,087,919	1,557,639	1,855,164	2,399,031	2,567,774	3,293,810	2,844,580	14.7%
Mexico	115,812	196,279	383,989	697,720	977,528	1,550,820	2,006,205	50.3%
Spain	561,318	914,936	1,121,845	2,066,717	3,221,233	4,656,769	4,424,472	34.3%
United Kingdom	365,045	1,458,313	2,408,800	3,353,237	4,734,910	5,664,504	4,586,519	43.6%
United States	8,301,253	12,029,862	14,188,959	20,200,574	24,126,482	26,434,212	29,067,205	19.6%

Source: Point Topic.

Tabla 2.7B. BROADBAND BONUS ESTIMATE WITHOUT CANNIBALIZED DIALUP IN U.S.D. (IN THOUSANDS OF 2009 USD, REAL TERMS)

Nation	2003	2004	2005	2006	2007	2008	2009	CAGR
Brazil	390,160	965,685	1,865,147	3,344,271	4,697,636	7,598,028	7,029,742	51.1%
Canada	1,187,338	1,890,946	2,500,556	3,073,695	3,356,922	4,188,844	3,627,286	17.3%
China	–	2,472,557	4,346,411	6,491,958	9,245,848	14,208,376	18,313,252	39.6%
Mexico	115,812	196,279	438,356	830,628	1,229,605	1,887,231	2,309,376	53.3%
Spain	842,438	1,731,363	2,401,161	3,196,967	4,452,006	5,592,804	5,255,119	29.9%
United Kingdom	469,724	1,870,345	3,515,734	4,831,808	6,739,761	7,672,431	6,046,106	44.1%
United States	10,630,149	17,966,054	22,429,000	26,339,538	30,940,777	34,571,732	38,552,257	20.2%

Source: Point Topic.

vide a robust sense of this scale. According to the Point Topic data, the size exceeds the magnitudes for the United Kingdom and Spain.

The size and scale of adoption is the biggest determinant of the size of the estimates for the broadband bonus. For example, consider all seven countries, even those for which there is no data on dial-up cannibalization. The correlation in 2009 between the number of adopters and the size of the bonus *without cannibalization* is 0.91. This suggests that many countries have gone through similar changes, similar to the changes found in the United States in this time period, and these changes are proportionate to the size and extent of diffusion within their countries.

Table 2.8 presents another approach to understanding the scale of the estimates, once again continuing with estimates that do not subtract dial-up revenue. It computes the fraction of the broadband bonus stemming from consumer surplus. The calculations for 2009 are the most informative because they show the results after diffusion has progressed furthest–and, correspondingly, the distortion from lack of dial-up data is at its lowest. In most of the countries, a large part of the bonus from diffusion goes to consumers, appearing nowhere in standard GDP statistics. In Brazil, Canada, Spain, and the United States, these percentages exceed 20%, and in both China and the United Kingdom, they exceed 15%. Only Mexico shows a smaller percentage, which may be due to the early point of broadband diffusion in that country.

Tabla 2.8. THE PROPORTION OF BROADBAND BONUS STEMMING FROM CONSUMER SURPLUS (IN 2009 USD REAL TERMS)

Nation	2003	2004	2005	2006	2007	2008	2009
Brazil	5,58%	8,58%	8,72%	9,63%	9,47%	5,77%	21.95%
Canada	6,13%	3,99%	6,59%	17,59%	21,93%	29,79%	29.93%
China		0,00%	2,24%	2,73%	3,03%	0,00%	15.46%
Mexico	2,96%	4,10%	3.91%	4,29%	4,83%	3,74%	8.12%
Spain	2,05%	3,67%	7,57%	20,06%	16,44%	36,63%	37.80%
United Kingdom	18,44%	5,54%	6,99%	6,03%	7,01%	14,19%	19.13%
United States	3,22%	1,87%	10,32%	23,76%	23,31%	21,28%	26.21%

Source: Point Topic.

Table 2.8 reinforces a key point: countries with greater adoption of broadband provide their consumers with a greater benefit. Ignoring consumer surplus leads to missing a large part of the benefit of broadband to consumers.

2.6 Conclusions and future developments

This research was motivated by a seemingly simple questions addressed in our earlier research.[6] What consumer surplus and revenue growth was affiliated with broadband's diffusion in seven countries, the United States, Canada, the United Kingdom, Spain, Mexico, Brazil, and China? We chose these seven countries because they vary in their circumstances, and their economies represent typical experiences in high-income and middle-income countries around the world. These two questions drew our interest because this type of economic gain from new technology is not otherwise readily visible.

In general, the findings support the view that motivated our investigation at the outset. The scale of the broadband bonus for countries is comparable to the size of the broadband economies in those countries. Countries with large Internet economies, such as the United States and China, are receiving large economic bonuses from investment in broadband. Countries with smaller Internet economies, such as Canada, the United Kingdom, and Spain, receive bonuses that are small but that are proportionate to their scale of Internet use.

The results for Brazil and Mexico are intriguing. In comparison with other countries, both had a later start and more recent acceleration in broadband investment. Greater potential exists in Mexico, but, as yet, that potential has not been realized. Brazil's Internet economy appears to be growing rapidly now, which suggests a considerable broadband bonus will be generated in the near future.

More broadly, we have focused attention on the gains from the diffusion of a single technology across several countries. This is clearly part of a broader worldwide trend. We conjecture that a detailed analysis of other developing countries would yield similar findings.

There is nothing about our approach that is unique to broadband. A similar approach could be used for any widely diffused access technology. Thus, we look forward to parallel research, reborn with another technology and product.

6 Greenstein and McDevitt, 2009.

In a few years time, we may be able to trace the gains from the deployment of mobile broadband access. We say "a few years time" because this topic comprises two markets, mobile broadband on a small screen and on a large screen. Until the latter part of the decade, demand for smartphones was primarily about demand for a phone on a PDA (e.g., Palm, BlackBerry), namely, a small screen. To some extent it was also about enabling laptop mobility, especially in business applications, i.e., a big screen. It is widely recognized that supply and household demand changed after the introduction of the iPhone in mid-2007. We will need another few years or so to see how this technology creates value in a wide set of countries and collect data about the experience.

It will be tempting to perform measurements similar to those found in this paper. It might even be possible. It is very clear that 3G use has begun to grow around the world. Counting devices with 3G capability as of the 4th quarter of 2009, Canada has 2.7 million, China has 9.4 million, Brazil 8.9 million, Mexico 3.9 million, Spain 21.9 million, the United Kingdom 30.7 million, and the United States 122.6 million.[7] Most of this growth occurred in the last two years. Big-screen use is considerably lower, and, as noted, much of it is for business use, which takes it outside the consumer surplus framework of this paper.

At this time, however, several issues make it difficult to infer much from a few years' experience. First, the product category has taken considerable time to reach a stable market structure, and no observer today would call it stable enough to define a clear price for a standardized service (which can be compared over time). While Apple and BlackBerry clearly lead as of this writing, Palm, Microsoft, Nokia, and Google have come up with competitive responses, and those firms and others will continue their attempts. Such experimentation will continue as long as the executives in those firms believe demand growth will continue, which makes it difficult to be able to define the key features needed for measurement–price and quantity.

Second, it is quite difficult to characterize the earliest experiences in this market as the movement down a demand curve, as our present framework interprets all such movements. Such a framework applies most readily to a setting that has clearly moved beyond its early adopters, the set of intrepid users with an enthusiasm for technology. Though the market for smartphones has reached that point in the United States and the United Kingdom, and probably in Spain and Canada, it is not clear the market has reached that point in every country. Once again, it appears it will soon, at which point measurement will be more clearly defined.

Third, as of this writing, it is not clear whether the majority of users treat their smartphones as substitutes to their home broadband use. Smartphones provide additional mobility, and that might be a valuable trait in and of itself, independently of the value of broadband. If smartphones are simply additional services due to their mobility, then the exercise in this paper could be applied, and the results could be interpreted as the "value of mobile broadband". If the additional services are, however, partial substitutes, then estimation would need to incorporate how much wireline broadband smartphones have replaced, looking for the net gain in using smartphones above and beyond using broadband lines. Without such an adjustment, any estimate would overestimate the gains to smartphones.

One last issue is particularly vexing for measuring smartphone use, namely, the vague boundaries between home and business use. Notions of consumer surplus will not apply well if a sizeable set of buyers are business users. With wireline broadband, this is less of an issue because the destination of the location for Internet access largely identifies its buyer (home or business). Smartphones, however, sell both to the home and business markets, and any estimate of consumer surplus would need to have clear information about the bright line between these customers.

These issues should not deter further measurement. Rather, it suggests the discussion remains far from closed. Because mobile broadband is leapfrogging fixed broadband in certain emerging economies, mobile broadband

7 Wireless Intelligence, as of February 2010.

may be the first broadband experience for many people. It is not clear whether mobile broadband substitutes or complements fixed broadband, and the extent of substitutability could vary substantially by country, according to each country's stage of infrastructure development.

We foresee numerous challenges extending these results to the next generation of mobile broadband. That should motivate further interest in the topics covered in this article, and in approaches related to them. We look forward to such efforts.

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