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Measuring the Broadband Bonus in Thirty OECD Countries

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MEASURING THE BROADBAND BONUS IN THIRTY OECD COUNTRIES

Shane Greenstein and Ryan McDevitt[1]

ABSTRACT

This paper provides estimates of the economic value created by broadband Internet using measures of new gross domestic product and consumer surplus. The study finds that the economic value created in 30 OECD countries correlates roughly with the overall size of their broadband economies. In addition, price and quality data from the United States suggest that widespread adoption of broadband Internet has occurred without a dramatic decline in prices, which reflects an unobserved increase in broadband quality that conventional government statistics do not capture.

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MEASURING THE BROADBAND BONUS IN THIRTY OECD COUNTRIES

The majority of households with residential Internet service among OECD countries now have broadband connections. How much new economic value has resulted from the global transition to broadband Internet? In this paper, we derive estimates to answer this question by considering both new gross domestic product (GDP) and new consumer surplus for 30 OECD countries between 2005 and 2011.

We have considered similar questions before. In Greenstein and McDevitt (2011a), we estimated the economic value created by the diffusion of broadband from 1999 to 2006 in the United States. We observed USD 39 billion of total revenue in Internet access in 2006, with broadband accounting for USD 28 billion of this total. Depending on the specification, households generated USD 20 to USD 22 billion of the broadband revenue, but only USD 8.3 to USD 10.6 billion was additional revenue created. The switch from dial-up to broadband access was associated with USD 4.8 to USD 6.7 billion in consumer surplus, which is not measured via GDP. An Internet-access Consumer Price Index (CPI) would have had to decline by 1.6% to 2.2% per year for it to reflect this creation of value.

This research motivated questions about whether similar gains have occurred outside the United States. In Greenstein and McDevitt (2011b), we analysed six additional countries: Canada, the United Kingdom, Spain, Mexico, Brazil and China. Each was chosen as a representative of a different geographic situation and stage of economic development. In general, we found that the scale of the broadband bonus in other countries is comparable to the size of their broadband economies. Countries with large Internet economies, such as the United States and China, are receiving large economic bonuses from their investments in broadband. Countries with smaller Internet economies, such as Canada, the United Kingdom and Spain, receive smaller bonuses, but bonuses in proportion to their scale of Internet use.

Relatedly, in Greenstein and McDevitt (2011c) we sought to understand whether declining prices drove the adoption of broadband Internet over the past decade, or whether hard-to-measure improvements in quality did. We found that, while real quality-adjusted broadband prices fell approximately 5% per year between 2004 and 2009 in the United States, this decline was relatively modest compared to other technology sectors that have experienced similarly high adoption rates. As a result, unmeasured consumer surplus appears to have spurred the transition to broadband, which conventional government statistics do not incorporate. This is consistent with recent research by Rosston, Savage and Waldman (2010), which found increased willingness to pay for broadband among US households.

In this present report, we synthesize our previous three papers to examine the broadband bonus in 30 OECD countries. We will use similar techniques – especially those in Greenstein and McDevitt (2011b) – to derive estimates for both GDP and new consumer surplus accruing in these countries between 2005 and 2011.

As in our prior work, we consider the revenue growth and new consumer surplus related to household broadband diffusion. In this report, we explain how the method and data were modified to accommodate all 30 OECD countries. Specifically, we will construct a "broadband bonus" for each nation using estimates of *i*) broadband revenue, *ii*) cannibalized dial-up revenue, and *iii*) broadband consumer surplus.

The diffusion of the Internet

Most households first accessed the Internet via dial-up connections. The diffusion of broadband came several years later and, for households in several developed economies, involved an upgrade of bandwidth.

During the main time period of our study, broadband service was delivered to households primarily in two forms of wire-line service—over cable or telephone lines. Countries differed significantly in the extent to which each delivery channel played a role. Cable broadband access involved a gradual upgrade to cable infrastructure in many cases. Broadband over telephone lines involved upgrades to telephone switches and lines to deliver Digital Subscriber Line (DSL) service. More recently, fiber to the home and mobile broadband have become more prevalent.

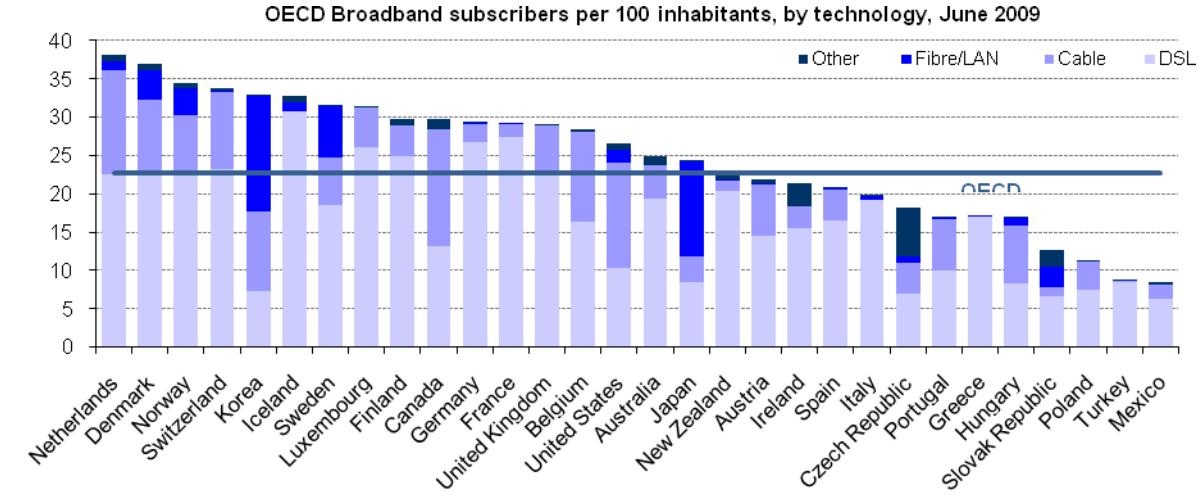
Broadband has many advantages over dial-up access. Broadband provides faster Internet service and, thus, access to better online applications. Broadband also may allow users to avoid paying for an additional phone line for supporting dial-up. In addition, broadband services are "always on."

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

In the earliest years of broadband diffusion, households simply switched from dial-up to broadband if they found the higher bandwidth worth the extra expense and the service was available to them. Cable and telecom operators needed to retrofit existing plants, which constrained availability in many places. In those years, the spread of broadband service was much slower and less evenly distributed than that of dial-up service. Highly populated areas were more profitable due to economies of scale and lower last-mile expenses. As wider deployment has removed these constraints, demand-side factors such as price, bandwidth, and reliability have played a more significant role in determining the margins between who adopts and who does not.

To provide a sense of where broadband has diffused, Figure 1 shows the subscribers per 100 inhabitants in many countries in 2009. A main pattern emerges: many OECD countries have substantial adoption of broadband, while others 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. In the remainder of this paper, we will estimate the extent to which these countries have benefitted economically from this diffusion.

Figure 1



Source: OECD

Motivation and challenges

The economic determinants behind the growth of broadband are straightforward to state: dial-up became available first and diffused to households as a means to deliver the Internet. Broadband emerged later as a higher quality and more expensive alternative, albeit one available in only a few places and from a limited set of providers, if any. Over time, broadband became more reliable and more widely available, and as that happened, many households paid to upgrade their Internet service. The adoption of broadband motivated application developers to find ways to take advantage of faster throughput, and their success raised the value of the service to broadband users. A virtuous cycle resulted, with such improvements motivating even further adoption of broadband.

There are two common approaches to measuring gains from a new good. First, what is the *increase* in revenue (GDP) above and beyond what would have been generated had dial-up continued to be the only means to access the Internet? Second, what is the *increase* in consumer surplus beyond what would have occurred had dial-up continued to be the only means to access the Internet? When addressing these questions, traditional approaches do not worry about which vendor or user gains or losses. We will do the same, and 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 what actually occurred and a hypothetical scenario without broadband, absent multiplier and general equilibrium effects.

To measure new consumer surplus, ideally we should measure the difference in "areas under the demand curves" between the actual demand for broadband and what consumers would have demanded had dial-up not been replaced by broadband. This is challenging to do for many reasons, but one is primary here: 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 users' willingness to pay for the upgrade to broadband.

For estimates of new consumer surplus in the United States market, Greenstein and McDevitt (2011a) employed one set of estimates from Savage and Waldman (2004). It is representative of the type of findings seen in other studies. These authors conducted an extensive survey of dial-up and broadband users in 2002. This study had advantages over other sources because it is a survey of both users and non-users. 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 this is sufficient for United States data, it comes with three drawbacks for a cross-country comparison. First, it is very data-intensive. It requires 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. Third, to our knowledge there are only a limited number of similar estimates for demand in the United States, or, for that matter, other countries.

As such, we will implement an alternative method for estimating consumer surplus, as we did in Greenstein and McDevitt (2011b). Applying the methods used in Greenstein and McDevitt (2011a) to a non-United States country would require data on the total number of households, number of Internet users, number of broadband users, and information relevant to the cost of adoption, such as the price of access or cost of second lines. In general, however, older data are difficult to obtain, particularly about the cost of dial-up and the cost of a second line to support it. Hence, our strategy will favour recent data over older data, and broadband data over all other data, consistent with the focus of this study.

Our strategy is the following. We derive a lower bound for a consumer's willingness to pay by assuming that anyone who adopts broadband in year t and pays the prevailing price, p_t, would be willing to pay at least that much for broadband in later years. As prices decline—in both a real and nominal sense—this consumer is better off in later years. That is, he would be willing to pay pt for broadband in year t+1, but only has to pay $p_{t+1} < p_t$. The difference, $p_t - p_{t+1} > 0$, is his new consumer surplus.

This forms the basis of a feasible measurement strategy within a country. As the real price falls, the demand for broadband rises. Over time, the declining price "traces" out the demand curve. With this approach, it is also possible to trace the change in consumer surplus in a country.

This approach has two advantages. First, it is quite simple, and that has advantages for cross-country comparisons. Second, it can 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 determines demand, and these same factors are not shifting the demand over time, which is reasonable over short periods. We also do not expect large year-to-year increases and decreases in broadband demand. Nonetheless, we are wary that the countries with rapidly growing incomes 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 assumes that adopters have no consumer surplus at the time of adoption—they are just indifferent between subscribing to broadband or not.

One crucial drawback, however, is that this method gives us no scope for incorporating improvements to broadband. For instance, someone who was willing to pay pt in year t for broadband speeds of 5MB/s would likely be willing to pay even more than p_t in year t+1 for broadband speeds of, say, 10MB/s. One straightforward way to incorporate this detail is to apply a similar logic as above but to per-MB prices.

That is, if a subscriber was willing to pay USD 0.01/KB in 2005 but only has to pay USD 0.005/KB in 2010, the difference can be thought of as a quality-adjusted consumer surplus.

In practice, we are likely understating new consumer surplus. This approach is conservative in that 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, more broadband may generate educational or civic benefits that lie beyond direct 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 across countries.

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 an upgrade to broadband, and/or the decision not to return to dial-up.

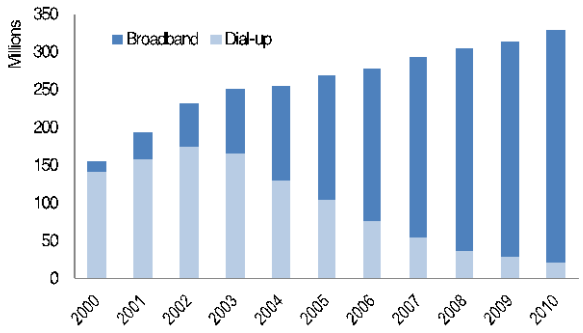
For suppliers, these factors include: sale of second lines, revenue for dial-up access, and revenue for broadband access. For households, the following factors shape the anticipated value of broadband service and, hence, the willingness to pay for an upgrade: savings on a second line, savings on commute time, anticipated health and entertainment benefits, and anticipated savings on phone bill (*e.g.*, if user moves to VoIP, or Voice-Over Internet Protocol).

Our understanding of these factors shapes our interpretation of the estimates, which do not include externalities, namely, benefits or costs not considered by the parties involved in the transaction. For example, our interpretation does not include externalities to suppliers, such as the benefits to Cisco from selling more Wi-Fi equipment to users, to Amazon from additional sales because broadband users experience more satisfying service, or to Google from more advertisement sales because users stay on-line longer.

Similarly, our interpretation does not include externalities to users. Those would be unanticipated or unperceived costs or gains—such as the unanticipated slowness that one neighbour's use imposes on another's in a cable architecture, or the benefits that one person's participation in a p2p (peer-to-peer) network confers on another (as long as there is no membership fee). That also does not include such externalities as changes to privacy (for good or ill) or crime (online identity theft, etc).

Finally, we must account for the revenue lost from cancelled dial-up subscriptions. Because the transition from dial-up to broadband access is nearly complete during this time period, we will say comparatively little about whether the revenue from broadband contracts has cannibalized dial-up revenue. At this point, that matter is relatively settled for OECD countries, as shown in Figure 2.

Figure 2: Number of OECD fixed Internet subscriptions



Instead, we will assume that all dial-up subscribers in 2001 represent cannibalized revenue in 2005-2011 and that the net price of dial-up would be approximately 50% of the DSL price. This is a rough approximation, but captures the crux of the issue—while we are overstating cannibalized dial-up revenue in the sense that some households still access the Internet in this manner though we have assumed all users from 2001 have switched modes, we are understating it in the sense that many new Internet users would likely use dial-up service in a counterfactual world in which broadband had not diffused. On net, we feel our treatment is conservative on this point. Please see Greenstein and McDevitt (2011a) for a more thorough and precise treatment.

The broadband bonus in 30 OECD countries

Our primary goal is to compute something equivalent to the estimate of the broadband bonus found in Greenstein and McDevitt (2011a). That is, we estimate consumer surplus and the net gain in producer revenue (broadband revenue minus lost dial-up revenue), expressed in a single currency for comparability. These estimates are in Tables 6 and 7, and we will discuss them at the end of this section. However, to give readers an appreciation for the construction and robustness of these results, we present the several intermediate steps towards those final tables.

Table 1 presents the first step to the main results. It shows the number of broadband subscribers in each of the 30 OECD countries between 2005 and 2010. Not surprisingly, large, developed countries such as the United States and Japan have the most broadband subscribers by 2010. Perhaps more surprising, countries such as Greece, Mexico, and the Slovak Republic experienced the most substantial growth in subscribers over this period.

Table 1: Broadband subscribers

	2005	2006	2007	2008	2009	2010	CAGR
Australia	2,785,000	3,816,172	4,830,200	5,336,000	5,236,000	5,020,000	12.5%
Austria	1,181,692	1,383,798	1,597,991	1,768,941	1,877,815	1,965,075	10.7%
Belgium	1,902,739	2,355,603	2,715,793	2,962,450	3,133,881	3,340,223	11.9%
Canada	6,695,546	7,929,081	8,975,902	9,405,318	10,290,000	9,987,482	8.3%
Czech Republic	661,000	1,136,758	1,501,420	1,769,684	2,034,986	858,814	5.4%
Denmark	1,350,415	1,728,337	1,945,842	2,021,404	2,067,000	2,052,458	8.7%
Finland	1,174,200	1,429,200	1,617,100	1,616,900	1,459,000	1,591,000	6.3%
France	9,465,600	12,718,313	15,550,000	17,725,000	19,582,000	20,930,000	17.2%
Germany	10,706,600	14,982,600	19,531,000	22,532,000	24,977,400	26,221,320	19.6%
Greece	156,560	509,081	1,084,115	1,506,614	1,918,630	2,287,074	71.0%
Hungary	639,505	965,384	1,395,612	1,696,714	1,880,226	1,860,072	23.8%
Iceland	78,017	87,738	97,937	103,697	107,072	105,444	6.2%
Ireland	274,100	519,029	767,736	896,346	961,748	853,970	25.5%
Italy	6,896,696	8,393,000	10,131,542	11,283,000	12,281,429	13,416,719	14.2%
Japan	27,972,788	26,438,351	28,749,525	30,107,327	31,630,781	35,011,355	4.6%
Korea	13,810,713	14,012,921	14,709,998	15,474,931	16,347,716	17,230,624	4.5%
Luxembourg	67,357	99,280	129,260	143,766	158,548	168,530	20.1%
Mexico	2,301,054	2,978,359	4,457,247	7,528,969	9,488,780	11,863,822	38.8%
Netherlands	4,114,573	5,065,000	5,617,902	5,855,000	6,130,000	6,378,000	9.2%
New Zealand	374,000	490,067	757,132	914,961	988,993	1,108,043	24.3%
Norway	1,045,589	1,250,899	1,436,255	1,607,750	1,633,592	1,676,872	9.9%
Poland	920,752	2,736,923	3,297,700	3,995,458	4,682,835	4,365,591	36.5%
Portugal	1,165,440	1,423,687	1,513,314	1,692,306	1,902,273	2,124,787	12.8%
Slovak Republic	133,900	274,108	413,244	618,871	627,722	674,814	38.2%
Spain	4,994,274	6,658,907	7,898,436	9,156,969	9,786,578	10,737,288	16.5%
Sweden	2,182,000	2,398,000	2,780,000	2,905,000	2,941,648	2,978,352	6.4%
Switzerland	1,788,829	2,064,118	2,438,128	2,523,649	2,793,723	2,984,517	10.8%
Turkey	1,530,000	2,773,685	4,395,800	5,736,619	6,446,374	7,114,584	36.0%
United Kingdom	9,826,300	12,995,140	15,606,100	17,275,660	18,213,290	19,428,446	14.6%
United States	48,474,844	60,642,869	70,056,146	77,600,095	79,331,337	80,776,663	10.8%

Table 2 presents a broadband revenue estimate calculated in 2010 USD. These calculations take the price quotes from Tables 7.17 and 7.18 in the OECD Communications Outlook 2011 multiplied by the estimated subscribers by access type in Table 4.16.

Table 2: Broadband revenue estimate in 2010 USD

	2005	2006	2007	2008	2009	2010	CAGR
Australia	3,544,709,488	3,826,018,072	3,950,957,035	4,148,509,218	3,937,119,753	2,460,998,530	-7.0%
Austria	1,319,500,171	1,494,154,602	1,698,713,171	1,109,021,890	1,148,987,839	723,479,614	-11.3%
Belgium	1,793,797,424	2,174,657,705	2,774,187,867	3,111,133,287	2,413,393,628	1,983,859,310	2.0%
Canada	4,378,320,766	4,202,084,562	5,234,056,990	5,263,007,981	5,673,160,692	6,576,327,700	8.5%
Czech Republic	1,177,940,966	424,574,051	359,827,366	481,481,511	360,837,098	642,744,957	-11.4%
Denmark	1,496,984,686	1,762,615,829	1,458,338,590	986,290,538	1,024,297,246	979,229,726	-8.1%
Finland	1,271,374,303	1,310,773,819	1,306,575,098	769,887,823	1,158,992,257	826,464,763	-8.3%
France	6,066,540,723	7,054,737,964	9,135,570,954	10,892,772,331	9,769,550,756	10,108,162,238	10.8%
Germany	6,042,580,359	8,280,542,851	9,386,707,718	15,525,971,528	15,960,040,527	15,737,936,419	21.1%
Greece	90,556,595	235,526,545	422,928,939	464,924,622	552,490,039	618,206,698	46.8%
Hungary	1,247,238,113	1,373,969,008	654,384,202	693,914,404	609,322,250	576,706,297	-14.3%
Iceland	128,318,479	123,015,965	143,064,758	101,100,930	47,156,047	32,259,756	-24.1%
Ireland	235,017,626	202,975,876	398,418,212	385,474,145	437,452,134	456,736,833	14.2%
Italy	4,764,706,719	5,003,936,471	6,442,803,577	5,050,265,953	5,171,326,786	5,329,930,956	2.3%
Japan	13,032,981,114	10,584,945,077	9,633,587,936	12,308,831,076	15,404,002,698	17,270,072,210	5.8%
Korea	6,148,697,082	7,094,801,951	6,992,972,944	5,676,740,778	5,049,282,680	5,506,905,317	-2.2%
Luxembourg	99,618,775	121,221,315	168,149,082	191,977,206	195,675,928	198,547,391	14.8%
Mexico	2,405,757,884	1,488,123,658	2,058,002,946	4,550,955,916	3,210,633,155	4,338,225,643	12.5%
Netherlands	5,124,227,123	4,365,822,491	5,196,589,562	5,690,749,710	4,181,414,394	4,053,948,279	-4.6%
New Zealand	268,935,815	181,411,602	513,942,777	630,066,787	549,226,690	670,299,835	20.0%
Norway	1,339,181,201	1,394,786,177	1,676,270,730	1,893,474,523	1,632,882,877	1,633,124,713	4.0%
Poland	1,153,231,646	2,362,003,625	2,845,762,511	2,534,461,556	1,934,326,231	1,874,101,806	10.2%
Portugal	1,149,686,990	1,113,288,400	904,079,640	1,044,381,800	938,590,046	1,135,747,264	-0.2%
Slovak Republic	3,366,994	3,482,921	2,486,993	4,372,252	3,575,382	3,593,253	1.3%
Spain	3,340,343,448	4,118,675,318	5,236,162,518	5,187,180,207	5,596,873,426	5,399,440,124	10.1%
Sweden	1,562,564,608	1,561,226,479	1,874,592,966	1,839,755,785	1,597,106,310	1,636,819,901	0.9%
Switzerland	1,647,031,643	1,088,160,845	1,185,754,328	1,333,022,988	1,501,988,993	1,674,878,542	0.3%
Turkey	4,948,089,434	5,369,129,127	3,614,201,123	4,200,802,273	3,423,084,455	3,641,335,891	-5.9%
United Kingdom	7,579,396,623	8,562,656,587	10,211,719,111	10,017,031,578	8,295,857,036	8,624,336,265	2.6%
United States	34,984,151,357	32,835,644,922	37,505,675,270	33,860,117,038	40,880,090,062	44,264,378,671	4.8%

An immediate question stands out: How could revenue decline in a nation like Australia that experienced 12.5% compound annual growth in subscribers? Declining prices provide the answer. The nominal price of a DSL subscription fell from USD 129 to USD 40 over this period, while the cable price fell from USD 75 to USD 60. Incorporating inflation only furthers the decline. While perhaps an incredible figure, based on OECD data, this is the result. Fortunately, it also highlights an advantageous feature of our approach: any mismeasurement of revenue will be offset, at least partially, by a corresponding change in new consumer surplus in the other direction. If the OECD-listed prices are lower than what consumers actually pay and we undercount revenue as a result, then consumer surplus will be higher in our calculations and the net effect for the broadband bonus will be essentially unchanged.

Table 3 accounts for cannibalized dial-up revenue. As discussed above, many broadband subscribers would have subscribed to dial-up had broadband not diffused. As such, the broadband revenue figures in Table 2 substantially overstate broadband's contribution to GDP. For instance, cannibalized dial-up revenue represents 30.7% of broadband revenue in the United States in 2010. Other countries that did not have sizable populations of dial-up subscribers, such as Turkey and the Slovak Republic, have comparatively less cannibalized revenue.

Table 3: Cannibalized dial-up revenue estimate in 2010 USD

	2005	2006	2007	2008	2009	2010	CAGR
Australia	2,617,163,705	2,115,483,715	1,457,671,197	1,408,608,821	1,470,024,505	838,589,301	-20.4%
Austria	622,902,993	614,051,157	718,635,891	497,877,048	467,848,452	218,545,280	-18.9%
Belgium	444,991,423	437,162,107	488,484,813	501,872,887	262,267,672	252,108,678	-10.7%
Canada	850,017,560	837,898,905	921,716,161	86[illegible]604,048	876,301,814	952,730,815	2.3%
Czech Republic	457,637,248	94,541,855	68,125,820	76[illegible]149,312	71,054,040	104,935,769	-25.5%
Denmark	989,805,833	930,529,651	673,410,304	422,475,175	498,967,414	474,579,494	-13.7%
Finland	499,678,210	421,281,124	374,036,634	192,925,409	364,414,662	279,654,488	-11.0%
France	2,060,101,594	1,772,106,089	1,913,558,897	1,998,038,648	1,615,264,640	1,517,093,692	-5.9%
Germany	3,685,995,320	3,632,101,497	3,180,135,908	4,651,280,472	4,376,454,036	4,127,056,823	2.3%
Greece	101,222,561	84,969,614	68,270,031	54,003,088	50,393,123	47,449,035	-14.1%
Hungary	254,503,230	163,323,762	76,665,064	44,604,516	56,116,280	58,460,576	-25.5%
Iceland	38,651,631	33,635,165	35,076,599	23,436,005	10,577,141	7,036,032	-28.9%
Ireland	262,894,514	139,304,322	194,027,827	150,122,681	149,026,129	142,895,451	-11.5%
Italy	2,611,826,554	2,256,098,012	2,428,009,957	1,703,017,611	1,596,039,912	1,499,098,262	-10.5%
Japan	4,457,369,554	3,745,957,774	2,998,995,599	3,744,702,632	4,531,755,972	4,309,261,071	-0.7%
Korea	152,523,485	160,076,953	160,394,341	122,744,841	103,023,188	104,798,205	-7.2%
Luxembourg	59,610,115	50,683,771	54,287,998	56,363,262	53,035,834	49,450,222	-3.7%
Mexico	794,559,230	513,735,378	489,892,232	687,026,585	349,074,936	358,442,122	-14.7%
Netherlands	3,209,316,862	2,114,145,040	2,282,349,242	2,390,722,528	2,231,353,621	2,100,996,541	-8.1%
New Zealand	209,382,531	106,674,822	206,593,147	217,538,118	165,417,193	186,448,944	-2.3%
Norway	670,452,520	598,290,308	649,707,487	650,549,929	513,741,793	522,080,865	-4.9%
Poland	732,284,052	404,199,933	441,589,607	340,456,608	288,231,423	234,292,103	-20.4%
Portugal	1,646,947,934	1,318,125,796	1,013,458,508	1,051,802,363	709,489,592	667,310,137	-16.5%
Slovak Republic	1,145,823	577,241	210,221	372,033	273,648	252,401	-26.1%
Spain	1,053,891,024	1,018,099,305	1,085,480,321	856,870,414	811,603,866	760,252,121	-6.3%
Sweden	858,485,133	816,372,503	828,250,571	778,040,389	673,563,994	677,703,010	-4.6%
Switzerland	949,580,682	654,890,364	480,922,829	521,701,933	519,411,327	539,262,035	-10.7%
Turkey	0	0	0	0	0	0	0.0%
United Kingdom	4,135,400,150	4,445,341,709	4,344,375,428	3,882,283,563	3,138,223,451	3,068,428,075	-5.8%
United States	16,037,469,915	10,496,123,119	10,205,007,622	11,797,973,509	11,840,070,441	13,590,525,060	-3.3%

Table 4 computes an estimate for new consumer surplus indexed to 2010 prices in USD. It is constructed with OECD's price estimates and accounts for users' willingness to pay by assumption. As stated earlier, a decline in real prices generates additional consumer surplus. Such declines are common in all these economies from the combination of general price inflation even with flat or no growth in nominal prices for broadband.

Table 4: Broadband new consumer surplus estimate in 2010 USD

	2006	2007	2008	2009	2010	CAGR
Australia	558,718,852	1,691,174,283	1,811,042,113	1,764,460,218	3,361,381,670	56.6%
Austria	18,750,912	208,945,182	957,793,802	879,848,511	1,083,150,138	175.7%
Belgium	31,560,621	10,191,902	109,495,694	575,464,162	1,016,578,472	138.2%
Canada	1,125,133,400	990,048,750	1,162,328,554	844,740,921	912,860,403	-5.1%
Czech Republic	878,929,391	1,163,046,834	1,398,134,781	1,380,836,803	1,249,775,794	9.2%
Denmark	115,447,117	645,693,662	1,149,424,192	1,093,308,184	1,048,666,954	73.6%
Finland	183,740,483	408,389,768	929,076,050	845,906,383	1,148,640,730	58.1%
France	812,336,372	1,153,986,467	1,378,668,460	2,064,343,690	1,866,538,554	23.1%
Germany	88,486,330	1,461,298,983	103,783,678	124,794,178	194,470,401	21.8%
Greece	14,540,351	38,163,784	58,224,465	55,535,312	53,499,446	38.5%
Hungary	258,622,448	1,245,472,781	1,404,388,642	1,277,099,531	1,322,472,152	50.4%
Iceland	3,489,404	9,705,303	14,082,867	30,248,375	42,751,812	87.1%
Ireland	107,655,002	86,334,812	140,184,920	123,784,727	117,244,627	2.2%
Italy	648,948,979	792,222,894	2,498,753,889	2,382,492,581	2,313,639,886	37.4%
Japan	1,147,450,490	2,807,647,577	2,449,561,890	1,724,466,076	3,076,678,023	28.0%
Korea	98,735,275	763,154,644	1,131,116,744	1,095,858,089	1,507,328,750	97.7%
Luxembourg	17,192,931	21,227,157	24,999,862	23,938,829	24,706,974	9.5%
Mexico	1,244,348,132	1,350,950,627	1,019,706,744	1,196,737,652	1,221,259,099	-0.5%
Netherlands	1,577,633,768	1,794,668,423	2,034,503,478	3,274,312,056	3,157,813,220	18.9%
New Zealand	101,122,766	16,511,883	14,319,812	44,779,544	77,905,489	-6.3%
Norway	153,239,944	256,092,274	313,882,042	512,074,473	708,580,169	46.6%
Poland	398,905,343	682,144,812	1,487,560,702	1,416,716,407	1,495,921,025	39.2%
Portugal	235,372,461	581,505,904	651,681,381	732,187,850	615,336,260	27.2%
Slovak Republic	1,767,473	3,501,030	4,221,394	3,119,324	3,171,822	15.7%
Spain	229,702,248	349,733,226	1,070,412,930	892,851,703	1,201,268,975	51.2%
Sweden	147,263,989	244,481,941	386,379,177	344,633,039	424,838,520	30.3%
Switzerland	670,893,984	838,078,705	955,043,522	917,173,498	959,541,301	9.4%
Turkey	1,659,558,411	3,858,128,449	4,036,080,872	3,509,335,534	3,690,879,115	22.1%
United Kingdom	1,505,456,125	2,190,194,610	2,331,437,613	2,437,549,970	2,484,794,768	13.3%
United States	7,957,935,068	8,040,718,796	15,381,890,344	10,850,570,466	9,115,955,601	3.5%

Surplus grows over time in most cases, but the movement in prices from 2006 shapes the growth rate at any particular point. For example, new consumer surplus increased fairly little in the United States since real broadband prices changed little as well. Other countries, like Austria and Belgium, have experienced remarkable gains in new consumer surplus.

Table 5 considers an alternative formulation of new consumer surplus measured in willingness to pay for download speeds. As discussed above, this partly adjusts for improvements to broadband quality over time. That is, some countries have experienced rapid improvements in broadband quality over this time period, and Table 4 may be severely understating their gains in consumer surplus.

Table 5: Broadband quality-adjusted new consumer surplus estimate in 2010 USD

	2006	2007	2008	2009	2010	CAGR
Australia	1,508,544,999	2,917,109,501	4,764,924,109	4,346,006,059	7,121,522,696	47.4%
Austria	18,750,912	208,945,182	1,033,447,361	1,166,001,764	3,887,563,887	279.5%
Belgium	739,547,018	786,067,406	962,254,622	2,055,048,324	6,080,766,270	69.3%
Canada	1,125,133,400	1,873,180,357	2,079,890,087	5,574,894,564	6,114,718,121	52.7%
Czech Republic	1,882,950,769	2,368,089,630	11,167,812,155	10,396,026,415	10,247,860,944	52.7%
Denmark	115,447,117	742,498,034	1,379,749,271	1,261,840,882	2,177,031,753	108.4%
Finland	183,740,483	589,444,906	1,276,694,436	648,815,760	887,988,420	48.3%
France	1,088,798,271	1,874,511,695	2,255,731,062	6,211,607,620	7,144,449,341	60.0%
Germany	85,850,932	2,416,307,104	922,407,785	1,107,246,702	1,398,045,636	100.9%
Greece	14,540,351	84,808,801	210,525,351	842,004,325	809,563,244	173.2%
Hungary	359,059,618	2,390,654,167	5,845,360,842	9,078,032,830	8,857,968,314	122.9%
Iceland	41,874,024	52,355,017	46,750,601	59,543,728	129,193,671	32.5%
Ireland	107,655,002	86,334,812	690,430,915	1,525,843,223	1,729,848,932	100.2%
Italy	20,279,540,660	22,322,689,755	26,361,590,384	24,933,727,563	23,850,643,941	4.1%
Japan	1,147,450,490	2,807,647,577	2,449,741,373	2,664,071,444	4,306,783,788	39.2%
Korea	1,610,511,050	2,318,127,428	34,083,508,535	29,550,796,448	33,026,225,183	112.8%
Luxembourg	20,511,019	626,002,062	699,561,397	661,403,687	883,195,180	156.2%
Mexico	1,244,348,132	2,608,546,942	2,244,928,632	3,079,770,143	3,323,959,589	27.8%
Netherlands	815,146,100	966,643,778	67,223,297,466	115,462,020,634	141,815,037,814	263.2%
New Zealand	101,122,766	3,098,255,537	2,946,795,682	2,688,950,137	3,141,933,287	136.1%
Norway	667,098,928	819,408,235	933,943,338	1,637,963,096	1,769,060,929	27.6%
Poland	398,905,343	1,506,655,113	2,875,357,873	3,217,594,778	5,467,399,204	92.4%
Portugal	235,372,461	904,342,528	2,500,098,168	5,619,859,692	5,235,009,155	117.2%
Slovak Republic	1,996,588	7,409,534	266,361,903	189,843,471	191,453,466	212.9%
Spain	951,780,164	1,165,401,328	3,342,083,746	2,918,074,097	3,085,713,223	34.2%
Sweden	147,263,989	252,799,040	517,578,167	467,040,948	547,184,835	38.8%
Switzerland	1,486,122,897	1,822,716,563	3,466,838,119	4,631,606,345	7,391,461,952	49.3%
Turkey	1,659,558,411	5,453,214,319	5,838,033,570	5,350,556,285	5,970,435,845	37.7%
United Kingdom	14,248,857,592	16,119,581,465	20,512,712,006	45,237,066,513	45,342,575,373	33.6%
United States	7,957,935,068	8,083,372,945	46,556,196,742	93,752,058,262	95,043,752,646	85.9%

As expected, many countries have higher additional consumer surplus in quality-adjusted terms, and all have experienced a net gain between 2006 and 2010. Some countries, such as the Netherlands, do remarkably well. This is not surprising given the evolution of broadband in the Netherlands. The typical DSL subscriber there paid USD 75 in 2005 for a download speed of 8 MB/s. In 2010, that same consumer paid USD 50 for 40 MB/s – a 33% price decline combined with a fivefold quality improvement. We hasten to note, however, that advertised download speeds may differ from those actually attainable, so these figures may be overstating quality improvements.

Table 6 provides the first set of main results, a broadband bonus estimate that takes broadband revenue less cannibalized dial-up revenue plus new consumer surplus in 2010 USD.

Table 6: Broadband bonus estimate in 2010 USD

	2006	2007	2008	2009	2010	CAGR
Australia	2,269,253,209	4,184,460,121	4,550,942,509	4,231,555,466	4,983,790,899	21.7%
Austria	898,854,357	1,189,022,461	1,568,938,644	1,560,987,899	1,588,084,472	15.3%
Belgium	1,769,056,219	2,295,894,957	2,718,756,095	2,726,590,118	2,748,329,103	11.6%
Canada	4,489,319,056	5,302,389,579	5,560,832,487	5,641,599,799	6,536,457,288	9.8%
Czech Republic	1,208,961,587	1,454,748,379	1,803,466,981	1,670,619,861	1,787,584,982	10.3%
Denmark	947,533,295	1,430,621,947	1,713,239,555	1,618,638,016	1,553,317,186	13.2%
Finland	1,073,233,179	1,340,928,232	1,506,038,463	1,640,483,978	1,695,451,006	12.1%
France	6,094,968,247	8,375,998,524	10,273,402,143	10,218,629,806	10,457,607,100	14.4%
Germany	4,736,927,685	7,667,870,793	10,978,474,734	11,708,380,670	11,805,349,996	25.6%
Greece	165,097,282	392,822,692	469,145,998	557,632,228	624,257,109	39.4%
Hungary	1,469,267,694	1,823,191,919	2,053,698,531	1,830,305,501	1,840,717,873	5.8%
Iceland	92,870,204	117,693,463	91,747,792	66,827,280	67,975,537	-7.5%
Ireland	171,326,556	290,725,197	375,536,384	412,210,731	431,086,010	25.9%
Italy	3,396,787,439	4,807,016,514	5,846,002,232	5,957,779,455	6,144,472,581	16.0%
Japan	7,986,437,793	9,442,239,913	11,013,690,335	12,596,712,802	16,037,489,162	19.0%
Korea	7,033,460,274	7,595,733,247	6,685,112,681	6,042,117,582	6,909,435,862	-0.4%
Luxembourg	87,730,475	135,088,241	160,613,807	166,578,923	173,804,143	18.6%
Mexico	2,218,736,412	2,919,061,342	4,883,636,075	4,058,295,871	5,201,042,620	23.7%
Netherlands	3,829,311,219	4,708,908,743	5,334,530,660	5,224,372,829	5,110,764,958	7.5%
New Zealand	175,859,546	323,861,513	426,848,481	428,589,041	561,756,380	33.7%
Norway	949,735,813	1,282,655,517	1,556,806,636	1,631,215,557	1,819,624,016	17.7%
Poland	2,356,709,034	3,086,317,717	3,681,565,650	3,062,811,215	3,135,730,728	7.4%
Portugal	30,535,065	472,127,036	644,260,817	961,288,303	1,083,773,386	144.1%
Slovak Republic	4,673,154	5,777,801	8,221,613	6,421,059	6,512,674	8.7%
Spain	3,330,278,261	4,500,415,423	5,400,722,723	5,678,121,263	5,840,456,978	15.1%
Sweden	892,117,965	1,290,824,336	1,448,094,574	1,268,175,355	1,383,955,411	11.6%
Switzerland	1,104,164,466	1,542,910,204	1,766,364,578	1,899,751,164	2,095,157,808	17.4%
Turkey	7,028,687,537	7,472,329,573	8,236,883,145	6,932,419,989	7,332,215,006	1.1%
United Kingdom	5,622,771,004	8,057,538,292	8,466,185,627	7,595,183,554	8,040,702,957	9.4%
United States	30,297,456,872	35,341,386,445	37,444,033,873	39,890,590,086	39,789,809,212	7.1%

These results conform with expectations, as there is a positive correspondence between GDP and the broadband bonus among OECD countries in 2010. Economies like the United States, Japan, and Germany enjoy very large broadband bonuses, while smaller countries such as the Slovak Republic and Iceland have correspondingly smaller ones. Perhaps more informative are the growth rates. Portugal has experienced explosive growth in economic value associated with broadband over the past five years, while countries such as Korea and Iceland have stagnated.

Table 7: Quality-adjusted broadband bonus estimate in 2010 USD

	2006	2007	2008	2009	2010	CAGR
Australia	3,219,079,355	5,410,395,340	7,504,824,505	6,813,101,307	8,743,931,924	28.4%
Austria	898,854,357	1,189,022,461	1,644,592,202	1,847,141,152	4,392,498,220	48.7%
Belgium	2,477,042,616	3,071,770,461	3,571,515,023	4,206,174,280	7,812,516,901	33.3%
Canada	4,489,319,056	6,185,521,186	6,478,394,020	10,371,753,442	11,738,315,006	27.2%
Czech Republic	2,212,982,965	2,659,791,176	11,573,144,354	10,685,809,473	10,785,670,131	48.6%
Denmark	947,533,295	1,527,426,320	1,943,564,634	1,787,170,714	2,681,681,985	29.7%
Finland	1,073,233,179	1,521,983,370	1,853,656,849	1,443,393,355	1,434,798,696	7.5%
France	6,371,430,147	9,096,523,752	11,150,464,744	14,365,893,736	15,735,517,887	25.4%
Germany	4,734,292,287	8,622,878,914	11,797,098,841	12,690,833,194	13,008,925,231	28.7%
Greece	165,097,282	439,467,709	621,446,884	1,344,101,241	1,380,320,907	70.0%
Hungary	1,569,704,864	2,968,373,306	6,494,670,730	9,631,238,800	9,376,214,035	56.3%
Iceland	131,254,824	160,343,177	124,415,526	96,122,633	154,417,396	4.1%
Ireland	171,326,556	290,725,197	925,782,380	1,814,269,227	2,043,690,315	85.8%
Italy	23,027,379,120	26,337,483,375	29,708,838,727	28,509,014,437	27,681,476,635	4.7%
Japan	7,986,437,793	9,442,239,913	11,013,869,818	13,536,318,170	17,267,594,927	21.3%
Korea	8,545,236,049	9,150,706,031	39,637,504,472	34,497,055,940	38,428,332,295	45.6%
Luxembourg	91,048,563	739,863,147	835,175,342	804,043,781	1,032,292,349	83.5%
Mexico	2,218,736,412	4,176,657,657	6,108,857,963	5,941,328,363	7,303,743,110	34.7%
Netherlands	3,066,823,551	3,880,884,098	70,523,324,648	117,412,081,407	143,767,989,552	161.7%
New Zealand	175,859,546	3,405,605,166	3,359,324,351	3,072,759,634	3,625,784,178	113.1%
Norway	1,463,594,796	1,845,971,478	2,176,867,931	2,757,104,180	2,880,104,776	18.4%
Poland	2,356,709,034	3,910,828,018	5,069,362,820	4,863,689,586	7,107,208,907	31.8%
Portugal	30,535,065	794,963,660	2,492,677,605	5,848,960,146	5,703,446,281	269.7%
Slovak Republic	4,902,268	9,686,305	270,362,123	193,145,205	194,794,317	151.1%
Spain	4,052,356,177	5,316,083,525	7,672,393,539	7,703,343,657	7,724,901,225	17.5%
Sweden	892,117,965	1,299,141,435	1,579,293,563	1,390,583,265	1,506,301,726	14.0%
Switzerland	1,919,393,379	2,527,548,062	4,278,159,174	5,614,184,012	8,527,078,459	45.2%
Turkey	7,028,687,537	9,067,415,442	10,038,835,843	8,773,640,740	9,611,771,737	8.1%
United Kingdom	18,366,172,471	21,986,925,148	26,647,460,020	50,394,700,098	50,898,483,562	29.0%
United States	30,297,456,872	35,384,040,593	68,618,340,272	122,792,077,883	125,717,606,257	42.7%

Table 7 presents the broadband bonus in quality-adjusted terms. Here, the mapping between each nation's GDP and broadband economy becomes less mechanical—the simple correlation is 0.61 rather than 0.98 for Table 6. The countries that have experienced rapid improvements in quality with declining prices, such as the Netherlands, once again stand out.

Table 8 provides a global total for the broadband bonus in both general and quality-adjusted terms. The sum across the 30 OECD countries is large and growing. Currently, the bonus stands at USD 156.7 billion when not adjusted for quality and at USD 548.3 billion when factoring in quality improvements. In addition, the growth rate for the quality-adjusted broadband bonus is nearly four times as large. This reflects the simultaneous change in quality and price currently underway across the OECD.

Table 8: The global broadband bonus in 2010 USD

	2006	2007	2008	2009	2010	CAGR
Global Broadband Bonus	101,732,120,895	128,850,560,121	146,667,793,820	147,284,885,402	156,786,712,441	11.4%
Global Broadband Quality-Adjusted Bonus	139,984,597,378	182,420,265,422	355,714,218,903	491,201,033,058	548,267,408,930	40.7%

Table 9 presents the ratio of the quality-adjusted bonus to non-quality-adjusted for each nation. These calculations provide a sense of the countries for which not adjusting for quality improvements will lead to grossly understated estimates.

Table 9: Quality-adjusted broadband bonus / broadband bonus estimate in 2010 USD

	2006	2007	2008	2009	2010
Australia	1.42	1.29	1.65	1.61	1.75
Austria	1.00	1.00	1.05	1.18	2.77
Belgium	1.40	1.34	1.31	1.54	2.84
Canada	1.00	1.17	1.17	1.84	1.80
Czech Republic	1.83	1.83	6.42	6.40	6.03
Denmark	1.00	1.07	1.13	1.10	1.73
Finland	1.00	1.14	1.23	0.88	0.85
France	1.05	1.09	1.09	1.41	1.50
Germany	1.00	1.12	1.07	1.08	1.10
Greece	1.00	1.12	1.32	2.41	2.21
Hungary	1.07	1.63	3.16	5.26	5.09
Iceland	1.41	1.36	1.36	1.44	2.27
Ireland	1.00	1.00	2.47	4.40	4.74
Italy	6.78	5.48	5.08	4.79	4.51
Japan	1.00	1.00	1.00	1.07	1.08
Korea	1.21	1.20	5.93	5.71	5.56
Luxembourg	1.04	5.48	5.20	4.83	5.94
Mexico	1.00	1.43	1.25	1.46	1.40
Netherlands	0.80	0.82	13.22	22.47	28.13
New Zealand	1.00	10.52	7.87	7.17	6.45
Norway	1.54	1.44	1.40	1.69	1.58
Poland	1.00	1.27	1.38	1.59	2.27
Portugal	1.00	1.68	3.87	6.08	5.26
Slovak Republic	1.05	1.68	32.88	30.08	29.91
Spain	1.22	1.18	1.42	1.36	1.32
Sweden	1.00	1.01	1.09	1.10	1.09
Switzerland	1.74	1.64	2.42	2.96	4.07
Turkey	1.00	1.21	1.22	1.27	1.31
United Kingdom	3.27	2.73	3.15	6.64	6.33
United States	1.00	1.00	1.83	3.08	3.16

Here, the Netherlands and Slovak Republic stand out. Simpler measures of consumer surplus miss a large portion of the economic value created by broadband in these countries, mostly because broadband quality has improved while prices have declined.

Table 10 provides the ratio of new consumer surplus to broadband revenue. These calculations allow us to understand how much simple GDP figures understate the economic value generated by broadband.

Table 10: Broadband new consumer surplus / broadband revenue in 2010 USD

	2006	2007	2008	2009	2010
Australia	0.15	0.43	0.44	0.45	1.37
Austria	0.01	0.12	0.86	0.77	1.50
Belgium	0.01	0.00	0.04	0.24	0.51
Canada	0.27	0.19	0.22	0.15	0.14
Czech Republic	2.07	3.23	2.90	3.83	1.94
Denmark	0.07	0.44	1.17	1.07	1.07
Finland	0.14	0.31	1.21	0.73	1.39
France	0.12	0.13	0.13	0.21	0.18
Germany	0.01	0.16	0.01	0.01	0.01
Greece	0.06	0.09	0.13	0.10	0.09
Hungary	0.19	1.90	2.02	2.10	2.29
Iceland	0.03	0.07	0.14	0.64	1.33
Ireland	0.53	0.22	0.36	0.28	0.26
Italy	0.13	0.12	0.49	0.46	0.43
Japan	0.11	0.29	0.20	0.11	0.18
Korea	0.01	0.11	0.20	0.22	0.27
Luxembourg	0.14	0.13	0.13	0.12	0.12
Mexico	0.84	0.66	0.22	0.37	0.28
Netherlands	0.36	0.35	0.36	0.78	0.78
New Zealand	0.56	0.03	0.02	0.08	0.12
Norway	0.11	0.15	0.17	0.31	0.43
Poland	0.17	0.24	0.59	0.73	0.80
Portugal	0.21	0.64	0.62	0.78	0.54
Slovak Republic	0.51	1.41	0.97	0.87	0.88
Spain	0.06	0.07	0.21	0.16	0.22
Sweden	0.09	0.13	0.21	0.22	0.26
Switzerland	0.62	0.71	0.72	0.61	0.57
Turkey	0.31	1.07	0.96	1.03	1.01
United Kingdom	0.18	0.21	0.23	0.29	0.29
United States	0.24	0.21	0.45	0.27	0.21

In the United States, for example, new consumer surplus represents more than one fifth of broadband revenue in 2010. In other countries, such as Hungary, consumer surplus constitutes even more of the economic value generated by broadband, as consumer surplus dwarfs revenue there—consumers would be willing to pay much more for broadband access than they currently do. In quality-adjusted terms, these effects become even more pronounced, for the most part, as shown in Table 11.

Table 11: Quality-adjusted broadband new consumer surplus / broadband revenue in 2010 USD

	2006	2007	2008	2009	2010
Australia	0.39	0.74	1.15	1.10	2.89
Austria	0.01	0.12	0.93	1.01	5.37
Belgium	0.34	0.28	0.31	0.85	3.07
Canada	0.27	0.36	0.40	0.98	0.93
Czech Republic	4.43	6.58	23.19	28.81	15.94
Denmark	0.07	0.51	1.40	1.23	2.22
Finland	0.14	0.45	1.66	0.56	1.07
France	0.15	0.21	0.21	0.64	0.71
Germany	0.01	0.26	0.06	0.07	0.09
Greece	0.06	0.20	0.45	1.52	1.31
Hungary	0.26	3.65	8.42	14.90	15.36
Iceland	0.34	0.37	0.46	1.26	4.00
Ireland	0.53	0.22	1.79	3.49	3.79
Italy	4.05	3.46	5.22	4.82	4.47
Japan	0.11	0.29	0.20	0.17	0.25
Korea	0.23	0.33	6.00	5.85	6.00
Luxembourg	0.17	3.72	3.64	3.38	4.45
Mexico	0.84	1.27	0.49	0.96	0.77
Netherlands	0.19	0.19	11.81	27.61	34.98
New Zealand	0.56	6.03	4.68	4.90	4.69
Norway	0.48	0.49	0.49	1.00	1.08
Poland	0.17	0.53	1.13	1.66	2.92
Portugal	0.21	1.00	2.39	5.99	4.61
Slovak Republic	0.57	2.98	60.92	53.10	53.28
Spain	0.23	0.22	0.64	0.52	0.57
Sweden	0.09	0.13	0.28	0.29	0.33
Switzerland	1.37	1.54	2.60	3.08	4.41
Turkey	0.31	1.51	1.39	1.56	1.64
United Kingdom	1.66	1.58	2.05	5.45	5.26
United States	0.24	0.22	1.37	2.29	2.15

Table 12 deflates the broadband bonus to per capita terms. This provides a sense of how much each resident gains from access to broadband. Here, Finland, Luxembourg, the Netherlands, and Norway do very well. Others, such as the Slovak Republic, receive comparatively little per capita benefit from broadband.

Table 12: Broadband bonus per capita in 2010 USD

	2006	2007	2008	2009	2010	CAGR
Australia	108.73	197.05	210.28	191.46	223.07	19.7%
Austria	108.72	143.24	188.20	186.65	189.33	14.9%
Belgium	167.80	216.15	253.91	252.70	254.71	11.0%
Canada	137.81	161.01	166.85	167.21	191.64	8.6%
Czech Republic	117.75	140.92	172.91	159.00	169.97	9.6%
Denmark	174.28	262.02	311.95	293.13	280.19	12.6%
Finland	203.79	253.55	283.44	307.27	316.12	11.6%
France	96.14	131.32	160.17	158.44	162.15	14.0%
Germany	57.51	93.21	133.69	143.00	144.19	25.8%
Greece	14.81	35.10	41.75	49.52	55.44	39.1%
Hungary	145.89	181.31	204.59	182.62	184.07	6.0%
Iceland	305.16	377.95	287.29	209.33	213.76	-8.5%
Ireland	40.21	66.60	84.52	92.26	96.42	24.4%
Italy	57.63	80.96	97.71	98.86	101.96	15.3%
Japan	62.51	73.90	86.38	98.93	125.95	19.1%
Korea	145.63	156.76	137.53	123.95	136.78	-1.6%
Luxembourg	185.63	281.43	328.72	334.76	349.28	17.1%
Mexico	21.18	27.62	45.82	37.77	47.98	22.7%
Netherlands	234.34	287.51	324.48	316.11	309.24	7.2%
New Zealand	42.40	77.15	100.65	100.11	128.61	32.0%
Norway	203.76	272.56	326.51	337.80	372.17	16.3%
Poland	61.80	80.97	96.59	80.28	82.12	7.4%
Portugal	2.89	44.51	60.65	90.41	101.94	143.8%
Slovak Republic	0.87	1.07	1.52	1.19	1.20	8.5%
Spain	75.57	100.29	118.45	123.63	126.77	13.8%
Sweden	98.24	141.10	156.45	135.76	147.56	10.7%
Switzerland	146.09	202.51	229.07	243.59	267.84	16.4%
Turkey	101.25	106.36	115.88	96.42	101.98	0.2%
United Kingdom	92.80	132.14	137.92	122.97	131.06	9.0%
United States	101.31	117.01	122.84	129.73	128.75	6.2%

Table 13 looks at the per capita broadband bonus in quality-adjusted terms. By this measure, the Netherlands, Luxembourg, Switzerland, and the Czech Republic have done remarkably well over the past half decade.

Table 13: Quality-adjusted broadband bonus per capita in 2010 USD

	2006	2007	2008	2009	2010	CAGR
Australia	154.24	254.77	346.77	308.27	391.37	26.2%
Austria	108.72	143.24	197.28	220.87	523.68	48.1%
Belgium	234.95	289.20	333.55	389.82	724.05	32.5%
Canada	137.81	187.83	194.39	307.40	344.14	25.7%
Czech Republic	215.54	257.66	1,109.60	1,017.02	1,025.52	47.7%
Denmark	174.28	279.75	353.89	323.65	483.72	29.1%
Finland	203.79	287.78	348.86	270.35	267.52	7.0%
France	100.51	142.62	173.84	222.75	243.98	24.8%
Germany	57.48	104.82	143.66	155.00	158.89	28.9%
Greece	14.81	39.26	55.30	119.37	122.58	69.6%
Hungary	155.86	295.19	647.00	960.95	937.62	56.6%
Iceland	431.29	514.92	389.58	301.09	485.58	3.0%
Ireland	40.21	66.60	208.37	406.06	457.13	83.6%
Italy	390.68	443.58	496.54	473.08	459.34	4.1%
Japan	62.51	73.90	86.38	106.31	135.62	21.4%
Korea	176.93	188.85	815.47	707.68	760.72	44.0%
Luxembourg	192.65	1,541.38	1,709.32	1,615.84	2,074.54	81.1%
Mexico	21.18	39.52	57.32	55.30	67.38	33.5%
Netherlands	187.68	236.96	4,289.74	7,104.26	8,698.98	160.9%
New Zealand	42.40	811.24	792.11	717.77	830.08	110.4%
Norway	314.01	392.26	456.56	570.95	589.07	17.0%
Poland	61.80	102.60	133.00	127.48	186.12	31.7%
Portugal	2.89	74.94	234.67	550.13	536.44	269.3%
Slovak Republic	0.91	1.79	50.01	35.65	35.87	150.6%
Spain	91.96	118.47	168.28	167.72	167.67	16.2%
Sweden	98.24	142.01	170.62	148.87	160.60	13.1%
Switzerland	253.96	331.74	554.81	719.86	1,090.10	43.9%
Turkey	101.25	129.06	141.23	122.03	133.69	7.2%
United Kingdom	303.14	360.59	434.12	815.88	829.65	28.6%
United States	101.31	117.16	225.10	399.35	406.79	41.6%

To examine whether per capita figures mechanically provide higher bonuses to those countries with higher broadband adoption rates, Tables 14 and 15 consider estimates similar to Tables 12 and 13 but in per subscriber terms. Not surprisingly, the per-subscriber numbers are larger because no nation has full adoption. The rankings between Tables 12 and 14 do change somewhat. For instance, in 2010 the Czech Republic has a much larger per-subscriber bonus than a per-capita one, mainly because the number of broadband subscribers declined as a proportion of its population. Similar findings hold for a comparison of quality-adjusted bonuses in per-subscriber relative to per-capita terms.

Table 14: Broadband bonus per subscriber in 2010 USD

	2006	2007	2008	2009	2010	CAGR
Australia	594.64	866.31	852.88	808.17	992.79	13.7%
Austria	649.56	744.07	886.94	831.28	808.15	5.6%
Belgium	751.00	845.39	917.74	870.04	822.80	2.3%
Canada	566.18	590.74	591.24	548.26	654.46	3.7%
Czech Republic	1,063.52	968.92	1,019.09	820.95	1,052.25	-0.3%
Denmark	548.23	735.22	847.55	783.09	756.81	8.4%
Finland	750.93	829.22	931.44	1,124.39	1,065.65	9.1%
France	479.23	538.65	579.60	521.84	499.65	1.0%
Germany	316.16	392.60	487.24	468.76	450.22	9.2%
Greece	324.30	362.34	311.39	290.64	272.95	-4.2%
Hungary	1,521.95	1,306.37	1,210.40	973.45	989.59	-10.2%
Iceland	1,058.49	1,201.73	884.77	624.13	644.66	-11.7%
Ireland	330.09	378.68	418.96	428.61	504.80	11.2%
Italy	404.72	474.46	518.12	485.10	457.97	3.1%
Japan	302.08	328.43	365.81	398.24	458.07	11.0%
Korea	501.93	516.37	432.00	369.60	401.00	-5.5%
Luxembourg	883.67	1,045.09	1,117.19	1,050.65	1,031.29	3.9%
Mexico	744.95	654.90	648.65	427.69	438.40	-12.4%
Netherlands	756.03	838.20	911.11	852.26	801.31	1.5%
New Zealand	358.85	427.75	466.52	433.36	506.98	9.0%
Norway	759.24	893.06	968.31	998.55	1,085.13	9.3%
Poland	861.08	935.90	921.44	654.05	718.28	-4.4%
Portugal	21.45	311.98	380.70	505.34	510.06	120.8%
Slovak Republic	17.05	13.98	13.28	10.23	9.65	-13.3%
Spain	500.12	569.79	589.79	580.19	543.94	2.1%
Sweden	372.03	464.33	498.48	431.11	464.67	5.7%
Switzerland	534.93	632.83	699.92	680.01	702.01	7.0%
Turkey	2,534.06	1,699.88	1,435.84	1,075.40	1,030.59	-20.1%
United Kingdom	432.68	516.31	490.06	417.01	413.86	-1.1%
United States	499.60	504.47	482.53	502.84	492.59	-0.4%

Table 15: Quality-adjusted broadband bonus per subscriber in 2010 USD

	2006	2007	2008	2009	2010	CAGR
Australia	843.54	1,120.12	1,406.45	1,301.20	1,741.82	19.9%
Austria	649.56	744.07	929.70	983.67	2,235.28	36.2%
Belgium	1,051.55	1,131.08	1,205.60	1,342.16	2,338.92	22.1%
Canada	566.18	689.13	688.80	1,007.94	1,175.30	20.0%
Czech Republic	1,946.75	1,771.52	6,539.67	5,251.05	6,348.94	34.4%
Denmark	548.23	784.97	961.49	864.62	1,306.57	24.2%
Finland	750.93	941.18	1,146.43	989.30	901.82	4.7%
France	500.97	584.99	629.08	733.63	751.82	10.7%
Germany	315.99	441.50	523.57	508.09	496.12	11.9%
Greece	324.30	405.37	412.48	700.55	603.53	16.8%
Hungary	1,625.99	2,126.93	3,827.79	5,122.38	5,040.78	32.7%
Iceland	1,495.99	1,637.21	1,199.80	897.74	1,464.45	-0.5%
Ireland	330.09	378.68	1,032.84	1,886.43	2,393.16	64.1%
Italy	2,743.64	2,599.55	2,633.06	2,321.31	2,063.21	-6.9%
Japan	302.08	328.43	365.82	427.95	493.20	13.0%
Korea	609.81	622.07	2,561.40	2,110.21	2,230.23	38.3%
Luxembourg	917.09	5,723.84	5,809.27	5,071.30	6,125.27	60.8%
Mexico	744.95	937.05	811.38	626.14	615.63	-4.7%
Netherlands	605.49	690.81	12,044.97	19,153.68	22,541.23	147.0%
New Zealand	358.85	4,498.03	3,671.55	3,106.96	3,272.24	73.8%
Norway	1,170.03	1,285.27	1,353.98	1,687.76	1,717.55	10.1%
Poland	861.08	1,185.93	1,268.78	1,038.62	1,628.01	17.3%
Portugal	21.45	525.31	1,472.95	3,074.72	2,684.24	234.5%
Slovak Republic	17.88	23.44	436.86	307.69	288.66	100.4%
Spain	608.56	673.06	837.87	787.13	719.45	4.3%
Sweden	372.03	467.32	543.65	472.72	505.75	8.0%
Switzerland	929.89	1,036.68	1,695.23	2,009.57	2,857.11	32.4%
Turkey	2,534.06	2,062.75	1,749.96	1,361.02	1,351.00	-14.6%
United Kingdom	1,413.31	1,408.87	1,542.49	2,766.92	2,619.79	16.7%
United States	499.60	505.08	884.26	1,547.84	1,556.36	32.9%

Finally, Table 16 presents the broadband bonus as a percentage of GDP per capita. This provides a measure of how much broadband Internet is contributing to each country's economy on a relative basis. Here, Hungary and Turkey have bonuses equivalent to over 1% of their GDP per capita.

Table 16: Broadband bonus as a percentage of GDP per capita in 2010 USD

	2006	2007	2008	2009	2010
Australia	0.28%	0.42%	0.43%	0.43%	0.49%
Austria	0.28%	0.32%	0.38%	0.41%	0.41%
Belgium	0.44%	0.50%	0.54%	0.58%	0.57%
Canada	0.35%	0.37%	0.37%	0.42%	0.48%
Czech Republic	0.85%	0.83%	0.83%	0.88%	0.93%
Denmark	0.35%	0.46%	0.50%	0.52%	0.49%
Finland	0.52%	0.54%	0.55%	0.69%	0.70%
France	0.27%	0.32%	0.36%	0.39%	0.39%
Germany	0.16%	0.23%	0.30%	0.35%	0.35%
Greece	0.06%	0.13%	0.14%	0.17%	0.18%
Hungary	1.30%	1.32%	1.32%	1.42%	1.36%
Iceland	0.56%	0.58%	0.55%	0.55%	0.53%
Ireland	0.08%	0.11%	0.14%	0.19%	0.20%
Italy	0.18%	0.23%	0.25%	0.28%	0.29%
Japan	0.18%	0.22%	0.23%	0.25%	0.32%
Korea	0.74%	0.72%	0.72%	0.73%	0.81%
Luxembourg	0.21%	0.26%	0.28%	0.32%	0.32%
Mexico	0.23%	0.29%	0.45%	0.47%	0.57%
Netherlands	0.57%	0.60%	0.61%	0.66%	0.64%
New Zealand	0.16%	0.24%	0.33%	0.37%	0.47%
Norway	0.28%	0.33%	0.35%	0.43%	0.47%
Poland	0.69%	0.73%	0.70%	0.71%	0.71%
Portugal	0.02%	0.20%	0.25%	0.41%	0.46%
Slovak Republic	0.01%	0.01%	0.01%	0.01%	0.01%
Spain	0.27%	0.31%	0.34%	0.39%	0.39%
Sweden	0.22%	0.28%	0.30%	0.31%	0.34%
Switzerland	0.28%	0.36%	0.35%	0.39%	0.42%
Turkey	1.33%	1.15%	1.13%	1.13%	1.10%
United Kingdom	0.23%	0.29%	0.32%	0.35%	0.36%
United States	0.23%	0.25%	0.26%	0.28%	0.28%

By quality-adjusted measures, shown in Table 17, the Netherlands, Hungary, and Czech Republic, are receiving large benefits from broadband as a proportion of their overall economies.

Table 17: Quality-Adjusted broadband bonus as a percentage of GDP per capita in 2010 USD

	2006	2007	2008	2009	2010
Australia	0.39%	0.55%	0.71%	0.69%	0.85%
Austria	0.28%	0.32%	0.40%	0.48%	1.13%
Belgium	0.62%	0.67%	0.70%	0.89%	1.62%
Canada	0.35%	0.43%	0.43%	0.77%	0.86%
Czech Republic	1.55%	1.53%	5.36%	5.62%	5.59%
Denmark	0.35%	0.49%	0.57%	0.58%	0.85%
Finland	0.52%	0.62%	0.68%	0.61%	0.60%
France	0.28%	0.35%	0.39%	0.54%	0.59%
Germany	0.16%	0.26%	0.32%	0.38%	0.39%
Greece	0.06%	0.14%	0.18%	0.42%	0.41%
Hungary	1.39%	2.15%	4.18%	7.48%	6.94%
Iceland	0.79%	0.78%	0.74%	0.79%	1.21%
Ireland	0.08%	0.11%	0.35%	0.82%	0.93%
Italy	1.24%	1.24%	1.29%	1.35%	1.29%
Japan	0.18%	0.22%	0.23%	0.27%	0.34%
Korea	0.90%	0.87%	4.26%	4.14%	4.48%
Luxembourg	0.21%	1.44%	1.43%	1.52%	1.91%
Mexico	0.23%	0.41%	0.56%	0.68%	0.80%
Netherlands	0.45%	0.50%	8.04%	14.78%	17.87%
New Zealand	0.16%	2.56%	2.58%	2.63%	3.03%
Norway	0.43%	0.48%	0.49%	0.73%	0.74%
Poland	0.69%	0.92%	0.96%	1.13%	1.61%
Portugal	0.02%	0.34%	0.99%	2.51%	2.42%
Slovak Republic	0.01%	0.01%	0.29%	0.22%	0.22%
Spain	0.33%	0.37%	0.48%	0.53%	0.52%
Sweden	0.22%	0.28%	0.32%	0.34%	0.37%
Switzerland	0.49%	0.58%	0.85%	1.14%	1.72%
Turkey	1.33%	1.40%	1.37%	1.43%	1.44%
United Kingdom	0.75%	0.79%	0.99%	2.31%	2.26%
United States	0.23%	0.25%	0.48%	0.87%	0.88%

Conclusions and future developments

This research was motivated by two seemingly simple questions addressed in Greenstein and McDevitt (2011a). What consumer surplus and revenue growth was affiliated with broadband's diffusion in the 30 OECD countries? These questions drew our interest because the economic gains from this new technology were not otherwise readily visible.

In general, our findings support the view that motivated our investigation at the outset. The scale of the broadband bonus in other countries is comparable to the size of the broadband economies in those countries. Countries with large Internet economies, such as the United States, Japan, and Germany, are receiving large economic bonuses from investment in broadband. Countries with smaller Internet economies receive smaller levels of bonuses, but bonuses in proportion to their scale of Internet use.

The results in quality-adjusted terms are intriguing. Many countries do well because they simultaneously experience large improvements in broadband quality and declining real prices. The Netherlands exemplifies this point.

More broadly, we have focused the spotlight on the gains from the diffusion of one technology across several countries. This is clearly part of a broader world-wide trend. We conjecture that detailed analyses of many developing countries would yield similar findings.

There is also nothing about our approach that is unique to broadband. A similar approach could be used for a widely diffusing access technology. In that light, we look forward to another similar process, reborn with another technology and product.

Eventually, we may be able to trace the gains from deployment of mobile broadband access. It will be tempting to perform a measurement 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. Most of this growth occurred in the last two years. In many countries 4G is poised to diffuse.

At this time, however, several issues make it difficult to infer much from a few years experience. First, mobile devices have taken a considerable time to reach a stable market structure, which makes it difficult to define the key features needed for measurement – both price and quantity. Second, it is quite difficult to characterise the earliest experiences in this market as 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 enthusiasm for technology. Third, as of this writing it is unclear whether the majority of users treat their smart phones as substitutes to their home broadband use.

In addition, conducting a similar type of analysis from this paper in emerging markets may require incorporating mobile broadband. Because mobile has leap-frogged fixed broadband in many emerging economies, mobile broadband may be the first broadband experience for many people. In this sense, not only is it unclear whether mobile broadband substitutes or complements fixed broadband, but the extent of substitutability could vary substantially by country according each country's stage of infrastructure development. This portends numerous challenges for extending the results from this report to the next generation of mobile broadband.

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