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Scientific American's Flawed Broadband Analysis

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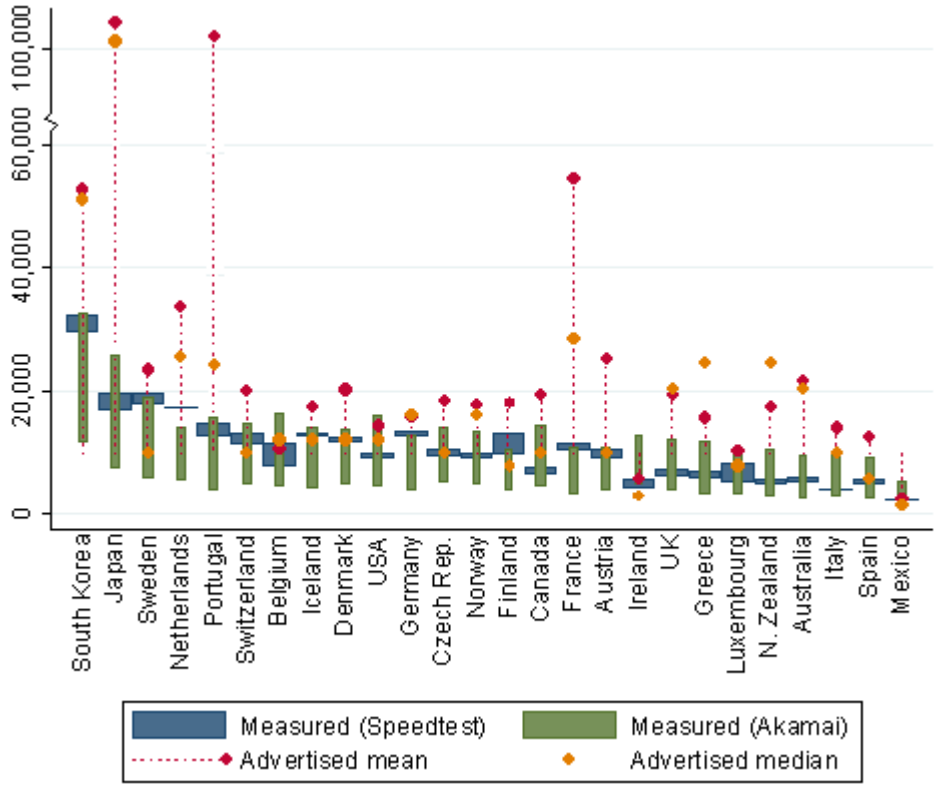
Scientific American's editors declare in its October 2010 issue that broadband prices in the United States are too high and speeds are too low. As a result, the editors implicitly assert, the U.S. has fallen to 40th place in "progressing towards a knowledge-based economy." They conclude that remedying the situation requires unbundling access to local loops, mandating net neutrality, and classifying broadband under Title II of the Telecommunications Act of 1996. *Scientific American* has the right concerns and objectives: ensuring that the United States remains a technological leader and that its broadband market is competitive. However, a closer look at the facts, as explained, for example, by the FCC's National Broadband Plan, reveals a more nuanced story that does not support their confident policy proposals.

The editors' incomplete understanding of the industry causes *Scientific American* to ignore the real policy issues the United States must face to improve broadband adoption, use, and innovation. In particular, the most important policy priority now is to ensure that wireless broadband continues its remarkable advances by making more spectrum available for high-value uses like broadband. The National Broadband Plan emphasized this point when it recommended quickly making an additional 500 MHz of spectrum available for such uses. Arguments that focus on a narrow view of how Americans will connect to the broadband network distract us from the important policy work that nearly everyone agrees is crucial for our broadband future.

Speeds

Average advertised download speeds in many OECD countries are, in fact, faster than they are in the U.S. Yet, taking into account the speeds consumers actually receive tells a different story, as Figure 1 demonstrates. The figure reveals several points. First, the average advertised speeds reported by the OECD are almost always well above the actual, measured speeds, with a few exceptions including Belgium, the United States, and Ireland, where the average advertised speeds appear consistent with measured speeds. Second, the different measurement techniques used by Speedtest.net and Akamai yield somewhat different results, highlighting the difficulty in determining the actual speed consumers receive. Third, even with the different measurement techniques, measured speeds are, with some outliers, quite similar across countries.

Figure 1
Measured and Advertised Download Speeds (in kbps)



Source: Speedtest.net, Akamai, OECD[1]
Note: Speedtest.net (wide, blue bar): median "country daily speed" in Q4 2009 (bar bottom) and median in Q2 2010 (bar top) as calculated by author from Net Index Source data. Akamai (thin, green bar): "average" and "maximum" connection speeds in Q1 2010.

The figure begs the related questions of why measured speeds are so different from advertised speeds and why measured speeds across countries are generally so similar even though their advertised speeds are often very different.

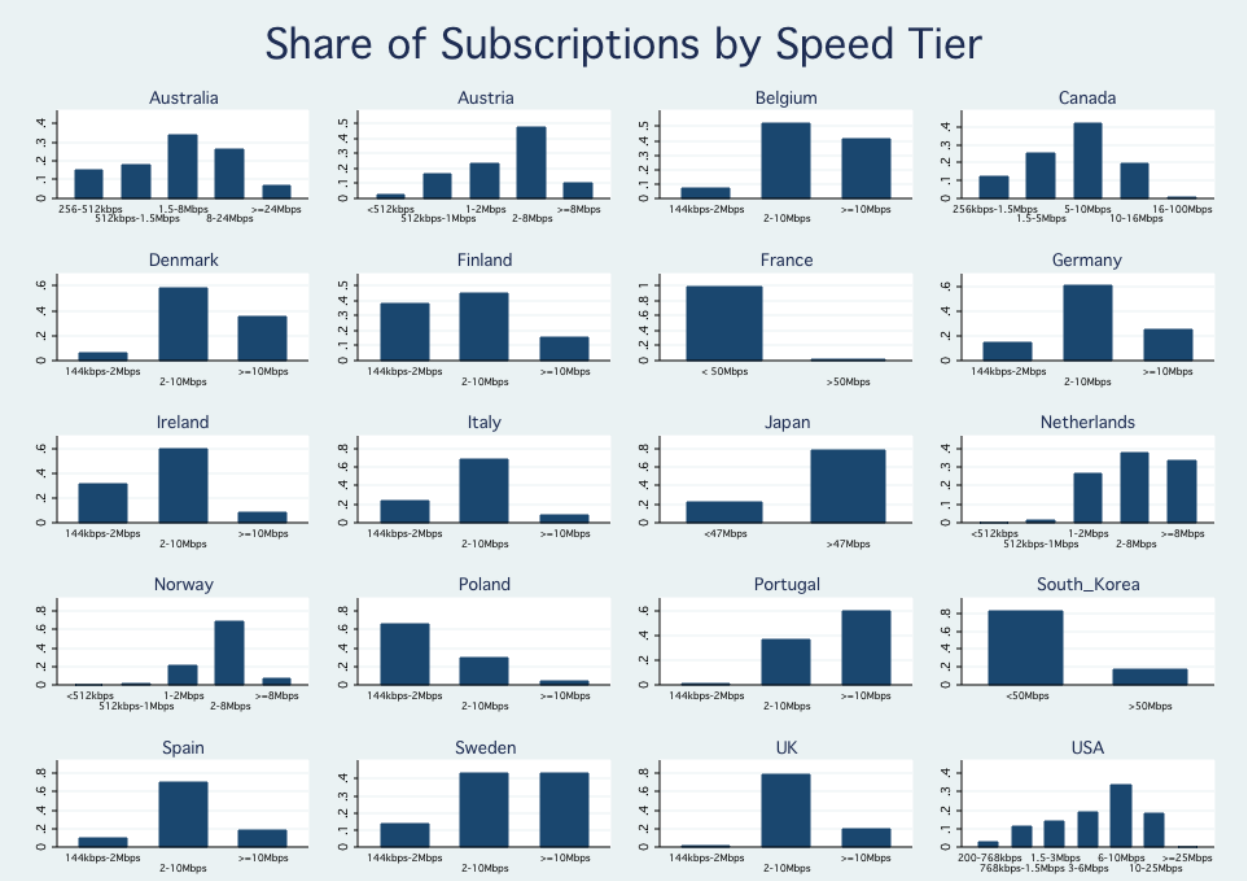
One possible explanation for the difference between advertised and measured speed could be related to the controversy regarding the extent to consumers receive the maximum speeds their subscriptions promise.[2] A gap between an individual subscribers' advertised and actual speeds may be due to many factors including subscribers using older computer equipment incapable of handling fast speeds, network congestion beyond the ISP's infrastructure, or poor provisioning or network management by the ISP itself.

[1] Advertised mean and median for October 2009 as reported in Table 5a of OECD Broadband Portal. Countries are arranged according to a simple average of our most recent measured data from each source (both Akamai points and Speedtest.net for Q2 2010). Akamai does not include Hungary, Poland, Slovak Republic, and Turkey in its quarterly report, so I exclude them here.
[2] See, for example, FCC (2010a) or http://media.ofcom.org.uk/2010/07/27/ofcom-research-reveals-increase-in-uk%E2%80%99s-average-actual-broadband-speed-but-consumers-still-not-achieving-advertised-speeds/

The data, however, suggest a different explanation for the differences between aggregate reported average advertised and measured speeds: consumers do not currently value very high speeds and do not purchase those speeds even when they are available almost regardless of the price. That is, the average or median speeds of advertised plans as reported by the OECD do not reflect the plans that consumers actually purchase.

Consider, first, the distribution of speeds to which residential consumers subscribe in each OECD country for which such data are available (Figure 2). In only a few countries do consumers seem to embrace very high speeds, and even in those countries typical speeds remain well below 50 Mbps. In France—one of the countries touted by *Scientific American* and where prices truly are very low—fewer than two percent of all subscribers have connections that exceed 50Mbps, according to the regulator, even though the OECD reports that the average advertised speed is 55Mbps.

Figure 2



Source: National regulatory agencies and others[3]

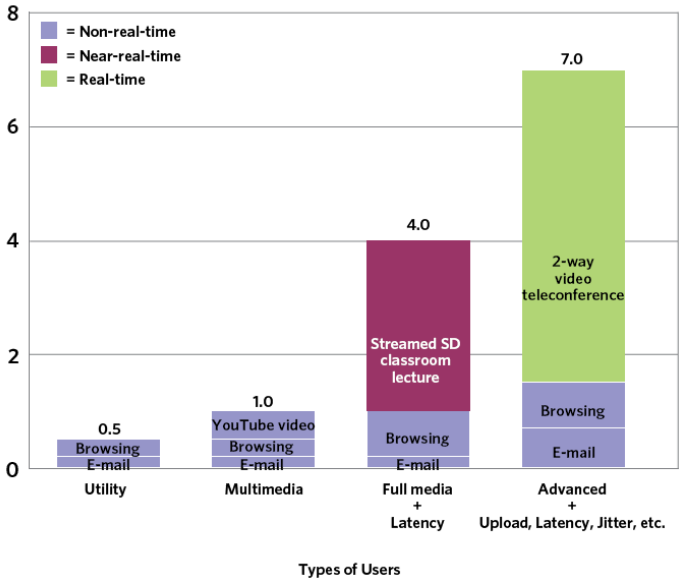
[3] Australian Bureau of Statistics "Internet Activity, Australia, Dec. 2009" [Australia]. IDATE "Broadband Coverage in Europe 2009 Survey" [Austria, Netherlands, Norway]. CRTC "Communications Monitoring Report July 2010" [Canada]. ARCEP. "Quarterly Observatory of the telecommunications market (high-speed and ultra-high speed subscriptions) in France 2nd quarter 2010 - provisional results" [France]. NTT "NTT Financial Results Supplementary Data for the Nine Months Ended December 31, 2009" [Japan]. KT "Investor Relations Factsheet (July 2010)" [South Korea]. FCC "Internet Access Services: Status as of June 30, 2009" [USA]. European

While those distributions run counter to the conventional wisdom that consumers are always better off with faster connections, they are consistent with (U.S.) consumers' willingness to pay for speed and the speed requirements of the online content people consume.

In a detailed study of residential broadband demand in the United States, Rosston, Savage, and Waldman (2010) found that consumers value broadband highly, but place a low incremental value on very vast speeds. In particular, consumers were willing to pay about $80 per month for a reliable, "fast" connection, but were willing to pay only an additional $3 per month for a "very fast" connection.

Relatedly, the FCC's National Broadband Plan (FCC 2010b) notes that applications used by even the most demanding users require only about 7 Mbps (Figure 3). It is likely for these reasons that a recent FCC survey found that 80 percent of U.S. broadband did not know the speeds of their home broadband connections, yet 50 percent of users reported being "very satisfied" and 41 percent reporting being "somewhat satisfied" with their speed. In other words, speed seems to be of so little concern to most U.S. broadband users that 80 percent of them don't even bother to remember or check their own speed and the overwhelming majority of them are satisfied with their speeds. One would assume that if Americans were clamoring for faster speeds more of them would take an interest in the performance of their connections and complain if they were too slow.

Figure 3
Download Speeds Necessary to Run Concurrent Applications



Source: FCC National Broadband Plan (2010b), Exhibit 3-C

Commission "Progress Report on the Single European Electronic Communications Market (15th Report)" [remaining countries]. Note that the distribution of speeds of incumbent telephone company customers are used to proxy broadband market in Japan and South Korea. Distributions from IDATE data are estimated from bar charts.

To be sure, these speed requirements will continue to change over time, as they have in the past. The Internet exhibits a "chicken-and-egg" problem in the sense that applications that require higher bandwidth cannot be deployed on a large scale until large numbers of people have higher bandwidth, yet large numbers of people are unlikely to purchase higher bandwidth until applications they value require such bandwidth. Nevertheless, the typical purchased and available speeds in nearly every OECD country already exceed the bandwidth required for commonly-used applications, and no evidence suggests that pushing speeds even further ahead of applications will yield faster innovation.

In addition, speed is probably over-emphasized as a quality metric even ignoring the point that available speeds are already higher than most consumers can use today. Once a connection achieves certain levels of bandwidth other factors may become more important. Latency and jitter, for example, are also important for applications ranging from gaming to real-time video.[4] Cisco's Telepresence system, for example, provides real-time, high-definition, life-sized teleconferencing but requires only symmetric 2-5Mbps per screen, but very low jitter and latency.[5] In other words, while it is not possible to predict how the interaction of demand and supply conditions will affect broadband innovation and investment, there is little reason to believe that speed will remain the most important broadband attribute beyond some threshold.

Prices

To an economist, price matters because artificially high (or low) prices can affect people's behavior in economically harmful ways. For example, artificially high prices can cause too few people to purchase broadband connections or too few people to subscribe to faster speeds.

As with speeds, the story with price is more complicated than the editorial suggests. Prices are notoriously difficult to compare due to the way ISPs market and consumers tend to purchase broadband in nearly all countries: bundled with other services at promotional prices. Nevertheless, most studies of prices yield fairly consistent results. Relatively slow broadband connections in the United States are priced quite reasonably relative to other OECD countries. Very fast connections, on the other hand, tend to be more expensive in the U.S. than they are in other high-income countries.

At least three possibilities can explain the low-speed, low-price and high-speed, high-price result in the U.S. and (generally) not elsewhere. One possibility is that competition is not sufficient to bring down prices at the high end. A second is that prices in the U.S. reflect the price discrimination inherent in any industry with high fixed costs—even very competitive ones. A third is that price regulations in other countries, not competition, are driving prices down.

The correct answer almost surely contains elements of all three possibilities. Today, most consumers have access to only one provider offering very fast speeds—those over, say, 50Mbps. Even by 2012, the FCC's National Broadband Plan estimates, only 45 percent of the population

[4] See, for example, http://www.fttxtra.com/general/is-latency-the-bane-of-broadband/ or http://gigaom.com/2009/10/01/pain-at-the-pipe-latency-matters/.
[5] http://www.cisco.com/en/US/netsol/ns669/networking_solutions_solution_segment_home.html

will have access to two wireline providers capable of such speeds.[6] Residential consumers who want very fast speeds have little choice of provider, meaning the provider can set prices close to the consumer's willingness to pay.

However, prices in industries with high fixed costs must exceed marginal costs in order to sustain investment. It is generally understood that price discrimination—in the sense of charging more to customers who value a service highly—makes it possible to offer lower price, lower quality options for people who value the service less, bringing more people into the market and increasing consumer welfare.[7] The high variance in U.S. prices—high prices for very high-speed connections and low prices for low-speed connections—is consistent with this type of welfare-enhancing price discrimination. In that case, rules intended to keep the high price down may have the unintended effect of increasing prices at the low end. It is, however, also true that firms with market power can use price discrimination in ways that reduce consumer welfare, and U.S. prices may be consistent with that scenario, as well.

Price regulations also play a large role in determining retail prices in many markets even when those prices are not directly regulated. Infrastructure unbundling requires the regulator to set prices for wholesale access, which then become a key component of the costs faced by any ISP using that access. Low wholesale prices will ultimately bring down retail prices. Regulations that keep retail prices low are good for consumers in the short run, but their long-run effects depend on how they affect investment incentives. France and the UK, for example, appear to have among the lowest retail prices, but—partly as a result—the incumbent telecom providers and their regulators remain mired in arguments over the price of wholesale access, delaying the rollout of next-generation infrastructure.[8]

Thus, the net effects of broadband prices in the United States are unclear. Low prices for low-speed broadband suggest that for the most part price is not artificially holding down broadband adoption, at least relative to other countries. For example, according to the OECD the country with arguably the cheapest residential broadband—France—has a lower household penetration rate than the United States.[9][10] Relatively high prices for very fast broadband in the United States surely discourage Americans from subscribing to higher speeds. Yet the real effects are unclear given the general low willingness-to-pay for very fast speeds and the lack of applications that require those speeds.

[6] See FCC (2010b), exhibit 4-G.
[7] See, for example, Baker (2003) and Baumol (2006).
[8] According to the OECD, at year-end 2009 fiber (to the home or to the building) made up less than one-tenth of one percent of UK broadband connections; in France the proportion was less than four-tenths of a percent. These are far below the rates for the OECD as a whole (11 percent) and the European leaders (Slovak Republic at 28%, Sweden 23%, Norway 13%) (OECD Broadband Portal Table 1L).
[9] OECD Broadband Portal Table 2A (http://www.oecd.org/sti/ict/broadband).
[10] That point is not to be confused with the very important social objective of helping people who do not subscribe—often because the price is too high for them—get online. Subsidies are likely required to connect those groups to the extent that the costs of serving them exceed the benefits to the ISP.

Unbundling

Based on its understanding of speeds and prices, *Scientific American* concludes that the U.S. should immediately mandate wholesale access to broadband infrastructure. However, research on the effects of unbundling on investment is inconclusive, at best. Most empirical research tends to find that facilities-based competition is better at encouraging investment, though other research—mostly case studies—reach different conclusions.[11]

Even setting aside the research, *Scientific American* should be more cautious before offering its advice so confidently given that its own examples of unbundling successes are not all correct. For example, the editors reference Japan as a major success three times and contend that its success is a result of mandatory wholesale access. That assertion is false. Japanese incumbent telecommunications companies did have to offer their copper loops at low wholesale rates, and a number of ISPs offered service over those lines. The same is not true of fiber connections, in which Japan leads the world.[12] Japan legally requires incumbents to make their fiber available wholesale, but regulators have set the price so high that it is not economical for other ISPs to offer service over unbundled fiber.[13] Anecdotes and examples should not be confused with proof—after all, some countries do have unbundling rules and fast speeds—but it is noteworthy that a country *Scientific American* lauds as a success does not, in fact, follow the editors' policy prescriptions.

Broadband and the Knowledge-Based Economy

Despite *Scientific American's* claims, no serious empirical study has linked any aspect of residential broadband to a country's relative competitiveness. One reason for the lack of empirical evidence linking residential broadband and competitiveness is that a "knowledge-based economy"—which probably includes factors like the relationship between ICT use and productivity—is likely related more to business than to residential use of broadband.[14] Unfortunately, little data are available for business broadband.

The lack of consistent data across or even within countries makes it difficult to empirically link measures of competitiveness to broadband, but the available evidence does not support *Scientific American's* assertion that the United States is behind 39 other countries in moving towards a "knowledge-based economy." *Scientific American* presumably relies on a single study to

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[11] A large and contentious literature has developed around the issue of unbundling (Crandall 2007; Crandall and Aron 2008; Faulhaber 2003; Ford and Spiwak 2004; Hausman and Sidak 2004; Hazlett 2005; Wallsten and Hausladen 2009; Frieden 2005).

[12] OECD data indicate that 54% of Japans total broadband connections were fiber in December 2009, leading Korea (49%) and penetration in any other country by over 20% (OECD Broadband Portal Table 1L).

[13] http://www.telegeography.com/cu/article.php?article_id=28976&email=html. NTT (2010), in a response to Benkler, et al (2010), noted that "the success of Japanese FTTH isn't due to an 'unbundled' network or dependant on 'open access'— rather, its growth was driven by 'facilities-based IP competition' between vigorous providers, including NTT, KOpti.com (a subsidiary of the large Kansai Electric Power Company) and STNet (a subsidiary of Shikoku Electric Power Company), as well as many cable television companies. Those broadband providers use almost exclusively fiber that they build, own and operate."

[14] See, for example, Wallsten (2010), for a discussion of the economic effects of residential versus business connectivity.

support this claim, though without attribution.[15] That study's conclusions regarding "progress towards a knowledge-based economy" are based on changes in particular measures from 1999-2009. The methodology practically guarantees that countries with high scores in 1999 will show only small improvements over time.[16]

While all indices are problematic in different ways, most that attempt to measure IT competitiveness put the U.S. at or near the top, including the index *Scientific American* uses. Note that these indices bear almost no relationship to any measures of residential broadband.

[15] Atkinson and Andes (2009).

[16] The report does not show the scores for 1999, so it is not possible to know how any given country's overall rank changed during the time period. One problem with the "rate of change" approach is that many indicators have some optimal—though typically unknown—level, meaning that as countries approach those levels they are unlikely to continue to increase. For example, according to the study, Sweden's government R&D investment as a share of GDP was 0.90 percent in 2009, higher than any other country. However, it ranked only 13th in that indicator's rate of change. Ireland, meanwhile, earned top honors by increasing its government investment as a share of GDP by 52 percent—to 0.39 percent. The rankings imply that Sweden's progress lags Ireland's, and Ireland's increase likely yielded benefits, but it is not obvious that Sweden would have benefited by increasing its government R&D investments beyond its already high level.

Table 1
Popular Composite IT Rankings, 2010[17]

Networked Readiness Index Economist Intelligence Unit		**Connectivity Scorecard** Waverman and Dasgupta		**Digital Economy Rankings** World Economic Forum	
1 Sweden	*100%*	1 Sweden	*100%*	1 Sweden	*100%*
2 Denmark	*99%*	**2 United States**	***98%***	2 Singapore	*100%*
3 United States	***99%***	3 Norway	*97%*	3 Denmark	*98%*
4 Finland	*98%*	4 Denmark	*95%*	4 Switzerland	*97%*
5 Netherlands	*98%*	5 Netherlands	*95%*	**5 United States**	***97%***
6 Norway	*97%*	6 Finland	*91%*	6 Finland	*96%*
7 Hong Kong	*97%*	7 Australia	*89%*	7 Canada	*95%*
8 Singapore	*97%*	8 United Kingdom	*88%*	8 Hong Kong SAR	*94%*
9 Australia	*97%*	9 Canada	*88%*	9 Netherlands	*94%*
10 New Zealand	*95%*	10 Japan	*85%*	10 Norway	*92%*
11 Canada	*95%*	11 Singapore	*84%*	11 Taiwan, China	*92%*
12 Taiwan	*94%*	12 Ireland	*80%*	12 Iceland	*92%*
13 South Korea	*94%*	13 Korea	*80%*	13 United Kingdom	*92%*
14 United Kingdom	*93%*	14 Hong Kong SAR	*77%*	14 Germany	*91%*
15 Austria	*93%*	15 Belgium	*76%*	15 Korea, Rep.	*91%*
16 Japan	*92%*	16 New Zealand	*76%*	16 Australia	*90%*
17 Ireland	*92%*	17 Germany	*73%*	17 Luxembourg	*89%*
18 Germany	*92%*	18 France	*71%*	18 France	*88%*
19 Switzerland	*91%*	19 Czech Republic	*63%*	19 New Zealand	*87%*
20 France	*90%*	20 Spain	*60%*	20 Austria	*87%*
21 Belgium	*89%*	21 Portugal	*56%*	21 Japan	*87%*
22 Bermuda	*88%*	22 Italy	*55%*	22 Belgium	*86%*
23 Malta	*86%*	23 Hungary	*54%*	23 UAE	*86%*
24 Spain	*86%*	24 Poland	*51%*	24 Ireland	*85%*
25 Estonia	*83%*	25 Greece	*43%*	25 Estonia	*85%*

Note: Scores presented as percentage of best-ranked score.

Currently high rankings do not, however, mean that the United States can easily maintain a strong and world-class IT presence. It cannot. One effect of improved communications technology, for example, is that firms can move increasingly more of their operations nearly anywhere in the world.[18] A country leading in any given area today is not guaranteed to remain in the lead tomorrow.

Yet ensuring that the U.S. remains competitive requires adapting policy debates to new technologies and new realities, and that is where the *Scientific American* editorial really misses the mark.

[17] Economist Intelligence Unit (2010), Waverman and Dasgupta (2010), and World Economic Forum (2010).
[18] Many issues are likely to have even bigger effects on innovation in the United States than those discussed here. For example, increasingly restrictive immigration policies, especially for highly-skilled people, are likely to have large negative effects on the U.S. economy (see, for example, Wadhwa et al. 2009).

Forward-Looking Policies Require Focusing on Spectrum and Wireless Broadband

Scientific American does not acknowledge the most dynamic aspect of broadband today: wireless access. Soaring wireless broadband use has implications for the direction of broadband innovation, competition, and adoption. Those changes should bring spectrum policy to the forefront of all broadband policy issues.

First, ubiquitous wireless use will change the type of applications that people tend to use online—that is, it is likely to nudge the direction of innovation away from applications that require fixed lines to cross the "last mile" to the customer to applications that rely on mobile connections. The implication of this change is not yet clear, but it is already apparent in the phenomenal success, at least in terms of numbers of apps available and downloaded, of the Apple and Android app stores.

Second, as wireless technologies continue to improve and as people come to rely more on their wireless connections, wireless will become an increasingly plausible competitor to the wireline network. While wireline and wireless remain, for the most part, complements, two trends may accelerate the effects of wireless as a competitor. The first, discussed above, is that increased wireless broadband use is changing the direction of application innovation, which, in turn, is causing more people to rely on wireless broadband. The second is the rapid rate of technological change of wireless technologies themselves. Wireless does not need to be a perfect substitute to begin imposing price pressure on wireline broadband.[19] It only needs to be the case that a sufficient number of people are willing substitute a wireless for a wireline connection and that ISPs cannot identify who those customers are.

Third, wireless broadband is likely to play an important role in bridging the large, income-based, gap in broadband adoption.[20] This digital divide may not affect global competitiveness or overall productivity, but is increasingly costly to those on the wrong side of the divide and likely results from and contributes to the growing income inequality in the U.S. Wireless broadband access looks like a promising antidote. According to the Pew Internet and American Life Foundation, African Americans and English-speaking Hispanics are more likely to own cell phones and use them more intensively for Internet applications than are white Americans.[21] Any policies that encourage rapid adoption of mobile technologies thus appear likely to help solve the digital divide.

This phenomenal wireless growth and resulting changes in the broadband ecosystem, however, depend crucially on spectrum policy. Countries that make spectrum available for high-value wireless uses, which include but are not limited to broadband, will have advantages in rolling out new technologies and services. Fortunately for the United States, the FCC has been relatively forward-looking in making licensed and unlicensed spectrum available for liberal uses by promoting auctions, facilitating secondary markets, and moving to make white spaces available for services more productive than merely guarding against interference.

[19] See Wallsten and Mallahan (2010).
[20] See, for example, Wallsten and Mallahan (2010), Horrigan (2010), and Prieger and Hu (2008).
[21] http://www.pewinternet.org/Reports/2010/Mobile-Access-2010/Part-2.aspx

Yet, our spectrum remains badly underused. The National Broadband Plan proposed making an additional 500 MHz of spectrum available, in part by creating incentives for broadcasters (the current users of much of this spectrum) to let that spectrum move into higher-value uses. The federal government also controls large swaths of spectrum and historically has been loathe to surrender any of it. Creating incentives that induce government users to use their spectrum more efficiently, as the UK has done, could release even more spectrum into the wireless ecosystem.

"We Must Move Forward, Not Backward"[22]

The *Scientific American* editorial oversimplifies a complicated issue and exhibits a partial understanding of the facts, at best. Not only does it rely on superficial comparisons, it wrongly assumes that residential wireline broadband is a primary indicator of a country's competitiveness in the information economy. More importantly, however, it focuses on the wrong issues, thereby further distracting policymakers from more urgent broadband policy "to-dos."

Editorials like *Scientific American's* help to keep us mired in the seemingly endless debate over net neutrality and infrastructure sharing as the broadband world moves on. The best thing policymakers could do to improve U.S. broadband is to move spectrum into the market to make it easier for existing carriers to offer better services, and cheaper for new competitors to enter the market. Eliminating barriers to wireless broadband growth is far more relevant to the future of broadband and national competitiveness than is the availability or price of 100 Mbps residential broadband.

[22] As profoundly stated by Kodos on *The Simpsons* in "Treehouse of Horror VII." Kodos continued, "upward not forward, and always twirling, twirling, twirling towards freedom."

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