

McDonough, Carol C.

Conference Paper

Consumer demand for fixed and mobile broadband

24th European Regional Conference of the International Telecommunications Society (ITS):
"Technology, Investment and Uncertainty", Florence, Italy, 20th-23rd October, 2013

Provided in Cooperation with:

International Telecommunications Society (ITS)

Suggested Citation: McDonough, Carol C. (2013) : Consumer demand for fixed and mobile broadband, 24th European Regional Conference of the International Telecommunications Society (ITS): "Technology, Investment and Uncertainty", Florence, Italy, 20th-23rd October, 2013, International Telecommunications Society (ITS), Calgary

This Version is available at:

<https://hdl.handle.net/10419/88485>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Consumer Demand for Fixed and Mobile Broadband

Carol C. McDonough, Ph.D.
Professor of Economics
University of Massachusetts Lowell
Carol_Mcdonough@uml.edu

Research Question:

The broadband¹ industry has developed using two different delivery technologies: fixed and mobile broadband. Mobile broadband subscriptions have increased dramatically,² now often exceeding fixed-line broadband subscriptions.³ The increased use of mobile broadband raises the interesting question of appropriate regulation of the bimodal broadband industry. Appropriate regulation of the industry requires market delineation and consideration of the likelihood of demand-side market failure. The relationship between fixed and mobile broadband, and the consequent increased complexity of consumer choice, may impact both market delineation⁴ and market failure.

The first section of this paper discusses and compares fixed and mobile broadband. The second section examines the relationship between fixed and mobile broadband. The third section reviews the current regulatory framework for broadband in OECD nations and elsewhere. The final section discusses how the relationship between fixed and mobile broadband may affect the optimal regulation of the broadband industry.

1. Fixed and Mobile Broadband

Fixed broadband has been built out with several alternative technologies: DSL (Digital Subscriber Line) uses existing copper telephone lines. FTTH (fiber to the home) brings fiberoptic cable to each home or business using a passive optical network with optical splitters. Cable/HFC (hybrid fiber coaxial) networks are enhanced cable delivery systems which enable television cable providers to provide broadband.

Within some OECD nations, DSL or FTTH is the predominant fixed broadband technology, while in other nations, cable broadband is more prevalent. The Netherlands experienced early broadband

¹ Broadband is high-speed internet. In the United States, the minimum speed threshold for broadband was set in 2010 to download speeds of at least 4Mbps. and upload speeds of at least 1 Mbps. In Korea and Japan, broadband plans start from a minimum of 2 Mbps

² According to the International Telecommunications Union, based on data from over 200 economies worldwide, the number of mobile broadband subscriptions globally was estimated at 1 billion for 2010, almost double the subscriptions for 2009.

³ According to data from the OECD, mobile broadband subscriptions in the United States now are greater than fixed-line subscriptions: more than sixty-two percent of U.S. broadband subscribers subscribe to a wireless plan, while only thirty-eight percent subscribe to a fixed-line service. In Korea and Japan, the number of wireless broadband subscribers also dominates the number of fixed-line subscribers.

⁴ Srinuan, et. al. (2012) note that telecom regulators should investigate the relationship between fixed and mobile broadband.

rollout from both cable and DSL⁵ providers. In Korea⁶ and Ireland, cable television providers first introduced broadband, although voice telephony providers then entered the broadband market with DSL access. In many Western European nations, telephony providers offering DSL tend to dominate the broadband industry. FTTH is more prevalent in Central and Eastern Europe, and Scandinavia, where the copper infrastructures are less robust and unable to meet data demands.⁷ In the United States, legacy telephone companies provide DSL and/or fiberoptic service, while cable companies have installed hybrid fiber-coaxial networks; cable companies are the major provider of fixed broadband service.

Fixed broadband speed varies by technology. According to the U.S. Federal Communications Commission, fiberoptics has the highest advertised download speed (75 Mbps.) and sustained actual speed (77 Mbps.)⁸ With fiber networks, an information path can be assigned to one single customer, and therefore actual speed is not negatively impacted by number of users. The highest advertised download speed for cable was 50 Mbps., with an average sustained speed of slightly less. Because cable broadband capacity is shared among customers, the actual speed available to a customer may be affected by the usage of other customers in that group. The highest advertised DSL speed was 40 Mbps, with a sustained speed of 33 Mbps. The difference between advertised and sustained speed was the greatest for DSL service. Even at speeds as low as 1.5 Mbps., DSL's actual sustained speeds fell below advertised speeds.⁹

Some providers offer the consumer the choice of speed tiers, with the higher speeds being more expensive. In addition, not all providers of DSL, cable and fiber offer the same speeds to consumers, and the speeds offered by a single provider may differ from region to region. The FCC found that the average subscribed speed in the United States is 15.6 Mbps.¹⁰ The average speed of fixed-line residential broadband connections in the UK reached 14.7 Mbps in 2013, according to [Ofcom](#).¹¹

Overall, the growth of fixed broadband has been accompanied by price reductions. Greenstein and McDevitt (2010) analyzed over 1500 service contracts offered by DSL and cable providers in the United States from 2004 to 2009. Adjusting for qualitative improvements, Greenstein and McDevitt estimated a price decline range from 3 percent to 10 percent for the five year period. Technology Policy Institute (2010) analyzed a data set of approximately 25,000 fixed broadband services provided by OECD countries from 2007 through 2009. The prices of both triple play service and stand-alone service, adjusted for quality and features, were tracked and compared. Most other OECD nations had lower triple play prices than the United States, while approximately one-half had lower standalone broadband prices. United States' residential standalone broadband prices increased insignificantly, while prices in France and Belgium fell about 40 percent and Norway's prices increased approximately 20 percent. Looking at triple-play price changes during this three-year period, Portugal and the United Kingdom showed the largest price decreases. Prices in the United States were relatively

⁵ Correa and Crocioni (2012).

⁶ Broadband Policy Development in the Republic of Korea (2009)

⁷ Storaasli (2012).

⁸ Measuring Broadband America, A Report on Consumer Wireline Broadband Performance in the U.S., Federal Communication Commission, February 2013.

⁹ Ibid.

¹⁰ Ibid.

¹¹ Ofcom, 2013.

unchanged, while Japan, Canada and South Korea had slightly larger price increases. The U.S. prices for business broadband fell by 25 percent during this period, while Canada, Denmark, Norway, Australia, and Japan showed increases in business prices.

*Wireless Broadband.*¹² Cellular wireless broadband is offered by wireless voice telephony providers to consumers with mobile devices such as wireless modems and smartphones. Wireless broadband signals are transmitted via radio spectrum licensed by federal governments.¹³ To provide wireless broadband, cellular providers have upgraded their cellular networks to 3G+ and then 4G standards deploying LTE (Long Term Evolution) or WIMAX technologies.¹⁴ The primary advantage to mobile broadband is its portability or mobility. The user is not tied to a fixed line or to the relatively short-range coverage of a Wi-Fi access point connected to a fixed line.

As increased demand for video and video-related applications has increased bandwidth and speed demands, a major issue for the wireless broadband industry is the ability to meet these demands, because of the scarcity of spectrum. The industry is developing technologies to address issues of bandwidth and reliability. To increase capacity, wireless providers' networks typically include fixed-line backhaul using copper, coaxial or fiber optic cable, sometimes provided by telephone companies. To meet the data demand generated by smartphones and other mobile devices, wireless companies are upgrading their wireless backhaul from T1 over copper to Ethernet over fiber.

According to a recent study, the highest average mobile broadband speed, 4.529 Mbps. was in Canada, followed by the United States (2.074 Mbps), Australia and Japan.¹⁵

Comparison of fixed and wireless broadband

Speed: Wireless broadband currently provides slower speeds than fixed broadband. While not all subscribers require large amounts of bandwidth, the increased usage of video or video-intensive applications do require higher speeds, speeds not currently typically available from wireless broadband.

Price: Wireless broadband tends to be the more expensive form of broadband when price is measured by price per Mbps. However, wireless broadband may be less expensive than fixed broadband when costs are compared for a minimum threshold speed and capacity. For instance, in the United States in the summer of 2011, the prices per Mbps. were wireless (\$17.15), DSL (\$16.40), FTTN (\$8.55), Cable Modem (\$3.83) and FTTH (\$2.91).¹⁶ In many European markets, however, as of June 2008, mobile broadband was cheaper than the incumbent DSL provider for at least 3 GB download per month.¹⁷

Coverage and Usage: Both wireless broadband coverage and wireless broadband adoption have expanded dramatically in recent years. According to the FCC, in 2012, 99.5 percent of the U.S.

¹² The discussion of wireless broadband does not include satellite broadband service.

¹³ Most nations use auction mechanisms to allocate wireless radio spectrum licenses among competing potential providers.

¹⁴ The WIMAX standard was first deployed in South Korea in 2006. The LTE standard was released in Scandinavia in 2009.

¹⁵ Techdrink, Aug 29 2013 How do Mobile Broadband Speeds Around the World Compare? (study by Cisco)

¹⁶ Ross, S. (2011).

¹⁷ Wood, R and M. Hatton (2008).

population had wireless broadband coverage.¹⁸ While in 2003, an estimated 7.5 percent of U.S. mobile subscribers used their phones to access the internet,¹⁹ by 2012, the percentage of mobile telephone subscribers with broadband access was 47.6 percent.²⁰ Moreover, in the United States, at the end of 2011, there were an estimated 184 million mobile devices in use capable of sending or receiving information at speeds exceeding 200 kbps in at least one direction, up from an estimated 152 million at the end of 2010; mobile wireless connections represented approximately 62 percent of the 230.4 million data connections with speeds exceeding 200 kbps in December 2011.²¹ OECD data show that in December 2011, there were 54.3 mobile broadband subscriptions per 100 OECD inhabitants. The percentages ranged from 100.65 percent in Korea to 76.1 percent in the United States, 35.1 percent in Germany and 7.7 percent in Mexico.²²

2. The Relationship Between Fixed and Mobile Broadband

A consumer's demand for fixed and mobile broadband is constrained by the available choices. In many developing countries, wired telephony or broadband services have not been fully built out and many consumers rely on wireless services for voice and data telephony. According to the International Telecommunications Union, an estimated 12 percent of households in developing nations have fixed line telephone subscriptions and an estimated 4 percent of households have fixed broadband subscriptions.²³ Fixed –line penetration in most African markets is quite low, below 10 percent in a majority of countries, and is flat or declining.²⁴ Fixed-line services where they do exist are state-dominated, and often government-owned monopolies.²⁵ However, mobile services are typically provided by multiple competing companies, some with global affiliations.

Evidence from voice telephony suggests that consumers in developed countries consider wireless and wireline voice telephony to be substitutes.²⁶ This evidence should be applied cautiously to broadband. While there are apparent analogies, there are also significant differences between voice telephony and broadband. Voice telephony is a service with well-defined parameters, though there may be quality variations. In contrast, technological advances are continually redefining and expanding the functionalities of broadband.

Demand for Broadband for Consumers with Access to Both Modes of Broadband.

Consumers in developed countries typically have access to both fixed and wireless broadband. In many OECD nations where both fixed and mobile broadband are available, the two modes are offered by competing providers: a legacy phone company and a cable company. Although several telephony

¹⁸ Annual Report and Analysis of Competitive Market Conditions with Respect to Mobile Wireless, Including Commercial Mobile Services, Sixteenth Report (2013).

¹⁹ Annual Report and Analysis of Competitive Market Conditions with Respect to Commercial Mobile Services, Eighth Report (2003).

²⁰ Annual Report and Analysis of Competitive Market Conditions with Respect to Mobile Wireless, Including Commercial Mobile Services, Sixteenth Report (2013).

²¹ Ibid.

²² OECD Broadband Statistics (2011).

²³ MobiThinking (2011).

²⁴ Van-Huyssteen (2012)

²⁵ Ibid.

²⁶ Caves (2011), Sung, Kim and Lee (2000), Barros and Cadima (2001), Barth and Heineshof (2012)

and cable providers have successfully bid on wireless spectrum licenses,²⁷ these providers have not built out wireless networks.

For consumers with access to both fixed and mobile broadband, the relationship between fixed and mobile broadband may be informed, not only by the perceived functionality of the two services, but also by affective and emotional factors. As Vaughn (1986) and Peronard and Just (2011) point out, the motives for choosing broadband could be related to either communal or individual motives. A highly-rational consumer may require large amounts of information about fixed and mobile broadband and may consider it taxing to have to deal with two separate providers. An affective consumer may adopt both modes of broadband as complements if the consumer feels that this will enhance self-esteem. If many individuals in a peer group have adopted both modes of broadband, others in the group may do so to emulate their peers, a sort of bandwagon effect. Then there is the rational consumer who might consider mobile broadband a natural extension of broadband service and routinely adopt both modes of service as complements. Finally, there is the emotionally-driven consumer with no rational need for two modes of broadband access but who subscribes to both as complements as a lifestyle and “feel-good” choice.

Published evidence

Technological advances are continually modifying and enhancing the characteristics and the functionalities of both modes, which in turn may affect the relationship between the two modes. We discuss published reports on the relationship between fixed and mobile broadband with that caveat.

A 2010 survey of 6000 consumers in OECD nations found that 84 percent of mobile broadband subscribers also have a fixed broadband connection. This finding suggests that mobile subscribers view fixed and mobile broadband as complementary. The key factor in motivating mobile subscribers was mobility: more than 70 percent of respondents believed that mobile broadband was slower, less reliable and more expensive than fixed broadband.²⁸ Survey results from Singapore also show some complementarity: in 2010, 91 percent of households with broadband had fixed broadband and 28 percent had wireless broadband.²⁹ Further evidence on the complementarity between fixed and wireless broadband across OECD nations comes from the empirical work of Lee, Marcu and Lee (2011): they report a significantly negative coefficient on fixed broadband price in the mobile broadband penetration equation.

In its most recent report on competition in the wireless industry, the U.S. F.C.C. comments on the substitutability of wireless for fixed line broadband: “The extent to which wireless broadband services can impose competitive discipline on wireline providers depends on many factors, including technologies, prices, consumer preferences, and the business strategies of providers that offer both wireless and wireline Internet access services. Mobile wireless Internet access service could provide an alternative to wireline service for consumers who are willing to trade speed for mobility, as well as consumers who are relatively indifferent with regard to the attributes, performance, and pricing of mobile and fixed platforms.”³⁰

²⁷ Deposit by Sprint Group Leads Wireless Bidders (1994) and Cable Group Spending Big on Spectrum (2006).

²⁸ Scott, M (2001).

²⁹ Infocomm Development Authority of Singapore (2011).

³⁰ FCC (2013)

Survey results from a narrow population, disadvantaged youth and senior citizens with relatively low incomes, provide additional information. In a survey of 330 disadvantaged youth and senior citizens participating in a U.S. Department of Commerce Broadband Technologies Opportunity Program (BTOP)³¹, only fifteen percent said they would subscribe to both modes. At current prices and given relatively low income levels, the majority of these participants considered fixed and mobile broadband to be substitutes. Choice of mode was analyzed as a function of age, gender and education. Participants 55 years and older were significantly more likely to select fixed broadband than younger participants.³² Younger participants were more likely to subscribe to mobile broadband.³³ Younger consumers were also more likely to subscribe to both modes than their older counterparts, i.e., to consider fixed and mobile broadband as complements.³⁴

Srinuan, Srinuan and Bohlin (2012) studied fixed and mobile broadband substitution in Sweden. They found that fixed broadband, especially DSL, was a close substitute for mobile broadband.

3. Overview of Regulation of the Broadband Industry

Government regulation of the broadband sector of the telecommunications industry typically has the twin goals of promoting competition and therefore efficiency, and facilitating sustained investment and innovation in the industry.

The current regulatory framework in most OECD nations has been influenced by the history of the telecommunications industry in each nation. In EU nations, government-owned Post, Telephone and Telegraph (PTT) companies organized as government departments or state-owned enterprises were monopoly telecommunications carriers of voice telephony. As the telecommunications sector was privatized by EU nations in the 1970's, these nations established specialized agencies to regulate the telecommunications industry. Therefore, the EU's telecommunications regulations largely postdate the general business legal regime.³⁵ An exception is New Zealand, which chose to regulate the privatized telecommunications sector via generic competition law.³⁶

Regulatory agencies within the European community have been charged with promoting competition. Ofcom, the regulatory agency in the United Kingdom, defines itself as the independent regulator and competition authority for the communications industries in the United Kingdom.³⁷ In France, the Telecommunications Act of 1996³⁸, which amended Article L.32 of the Posts and Telecommunications Code, states that the telecommunication regulatory authority (ARCEP) shall be responsible for effective and fair competition among network operators and telecommunications service providers, in the interests of users.

³¹ The **BTOP participants** are disadvantaged youth and senior citizens who reside in and near the Merrimack Valley of Massachusetts, U.S. The U.S. Department of Commerce grant was a three-year, \$780,000 grant to University of Massachusetts Lowell, Carol C. McDonough, Principal investigator.

³² The coefficient on the age binary variable was .410, with a t value of 5.33.

³³ The coefficient on the age binary variable was -.156, with a t value of -1.887.

³⁴ The coefficient on the age binary variable was -.370, with a t value of -4.712.

³⁵ Cherry, op. cit.

³⁶ Davies, Howell, and Mabin (2008)

³⁷ Ofcom website

³⁸ The Telecommunications Act of 1996, France.

In 2009, the European Parliament formally approved the EU's telecoms reform package, European authorities agreed on the creation of a new European body of telecom regulators called BEREC (Body of European Regulators for Electronic Communications) The goal of the EU telecoms reform was to bring more competition to Europe's telecoms markets and faster internet connections for all Europeans.³⁹

In the United States and Canada, the telecommunications industry was developed by the private sector as a natural monopoly, with ongoing federal regulation. Within the United States, regulation of the broadband industry is under the jurisdiction of the Federal Communications Commission, established by the Communications Act of 1934, as amended by the Telecommunications Act of 1996. The objective of the 1996 Act was to provide a pro-competitive, de-regulatory national policy framework designed to accelerate rapidly private sector deployment of advanced telecommunications and information technologies and services. The 1996 Act regulated DSL service under the local competition provision.⁴⁰ Regarding cable broadband, the Act provided that regulations do not apply to cable companies "in any geographic area in which the video programming services offered by the operator ... are subject to effective competition."⁴¹ The Act also references a classification "information services" which are not subject to either cable or telephone regulation. The FCC classifies broadband access services as information services in its Cable Modem Declaratory Ruling and Wireline Broadband Access Order.⁴² Section 706 of the 1996 Act provides that the Federal Communications Commission and State Public Utility Commissions must "encourage the deployment ... of advanced telecommunications capability to all Americans ... by utilizing ... measures that promote competition in the local telecommunications market, or other regulating methods that remove barriers to infrastructure investment."⁴³ If it finds the absence of the above, the Commission is required to "take immediate action to accelerate deployment of such capability by removing barriers to infrastructure investment and by promoting competition in the telecommunications market."

In many African nations, the mobile market is largely deregulated, and regulatory guidelines focus on increased competition and industry growth and investment.⁴⁴ In China, the government regulates the three state-owned telecommunications enterprises.

4. Effect of Relationship between Fixed and Mobile Broadband on Regulatory Policy

The relationship between fixed and mobile broadband may influence the design of optimal regulatory policies to promote competition and industry growth and investment: (1) Regulatory policy typically has the goal of promoting the presence of competing firms. How this objective can be implemented for broadband services is affected by the relationship between fixed and mobile broadband. (2) The nature of the relationship between fixed and mobile broadband affects market delineation and the examination of market power. If fixed and mobile broadband are substitutes, regulatory considerations

³⁹ telecoms.com, November 24, 2009

⁴⁰ Chen(2001)

⁴¹ The Telecommunications Act of 1996, Title III, Cable Services, Section 301.

⁴² Therefore broadband access services are not subject to common carriage regulation under Title II of the Communications Act of 1934. Therefore the Commission's regulatory authority over broadband is limited to ancillary jurisdiction under Title I. Cherry (2010)

⁴³ The Telecommunications Act of 1996, Title VII, Miscellaneous Provisions Section 706

⁴⁴ Van-Huyssteen (2012)

of market power must include not only market share of a narrowly-defined homogeneous market but also overall market power in the broader heterogeneous market.⁴⁵ (3) The complexity of the relationship between fixed and mobile broadband may increase the likelihood of demand-side market failure in the industry.

If fixed and mobile broadband are substitutes, then the regulatory goal of promoting competition is more easily implemented. Fixed broadband buildout has high fixed costs. It is estimated that civil engineering typically accounts for 50-80 percent of the total investment requirements.⁴⁶ The level of effective competition in the fixed broadband market varies from region to region, ranging from a competitive marketplace to a regulated monopoly. At one end of the spectrum, there are regions that are large enough, dense enough, and with enough existing infrastructure to support competing fixed broadband providers. At the other end of the spectrum are regions that cannot support a single infrastructure without some form of government subsidy or incentive. To aim for a competitive rollout of several fixed broadband infrastructures in regions at the low end of the spectrum is unrealistic. Competitive fixed broadband buildout is generally more feasible in areas with high population density and existing infrastructure. However, if fixed and mobile broadband are substitutable, regions which cannot support competing fixed broadband infrastructures may still have competition in the broadband marketplace, if less-expensive mobile broadband networks are built out.

The nature of the relationship between fixed and mobile broadband also affects the delineation of the market to be regulated. Market delineation and market share are used within the United States and the European Union to help determine market power. As Pereira and Vareda (2013) state, market definition is essential: “For abuse of dominance cases in the EU, or monopolization cases in the US, market definition helps to determine whether a firm has enough market power to engage in anticompetitive behavior.”⁴⁷

In the United States, the Department of Justice uses market share and market delineation to analyze level of competition and infer market power.⁴⁸ The U.S. Federal Communications Commission reports that the Herfindahl-Hirschman Index (HHI) employed by the Commission to measure market concentration is the most widely-accepted measure of concentration in competition analysis.⁴⁹ The U.S. Federal Trade Commission defines a relevant market as : a product or group of products and a geographic area in which it is produced or sold such that a hypothetical profit-maximizing firm, not subject to price regulation, that was the only...seller ...in that area likely would impose at least a small but significant and nontransitory increase in price.”⁵⁰ The SSNIP test starts with the smallest possible market and determines if a five percent increase in price would be profitable.⁵¹

⁴⁵ See Kaplow (2010)

⁴⁶ Pennings (2008).

⁴⁷ Pereira and Vareda (2013).

⁴⁸ The relevance of market delineation is emphasized by U.S. Department of Justice Werden “Antitrust law has long used market delineation to infer market power. Market delineation is needed to examine the issue of entry and the durability of market power” Werden (1993)

⁴⁹ FCC, Sixteenth Report (2013)

⁵⁰ Federal Trade Commission (1992)

⁵¹ Dippon (2008)

Within the EU telecommunications regulatory framework, market definition is useful in abuse of dominance cases and helps to determine if a market is effectively competitive⁵² Quoting from the EU Directive, a firm “shall be deemed to have significant market power if, either individually or jointly with others, it enjoys a position equivalent to dominance, ...the power to behave ...independently of competitors, customers, and ...consumers.”⁵³ The European Commission has determined that a firm with a large market share may be presumed to have significant market power if its market share remains stable over time.⁵⁴

If consumers consider fixed and mobile broadband to be substitutable, then the relevant market for purposes of competition analysis should include both fixed and mobile broadband. However, if the two modes are complements, then the market consisting of firms offering bimodal broadband service needs to be defined and evaluated. Another, related, market consists of providers of a single mode. Promoting competition in the industry would then seem to suggest the desirability of ensuring that broadband providers of one mode have some form of access to provide the other mode. This is a significant issue: Because of the high fixed costs of wired broadband, providers of this mode have been reluctant to offer open access to potential competitors. For wireless broadband, the spectrum necessary for wireless transmission is limited and licensed by federal regulators. If fixed and wireless broadband are complementary, a provider of a single mode could be forced out of the marketplace by providers who offer consumers a bimodal bundle or what is known as a quadruple play bundle.

Finally, demand-side market failure might result from the complexity of the relationship between fixed and mobile broadband. As Cherry (2010) points out, “antitrust law addresses market failures external to the consumer while consumer protection laws address market failures internal to (or inside the head of) consumers.” One source of market failure is that consumers lack accurate and complete information about prices and product quality. This results in a market with asymmetric information, that is, some parties (namely, providers) know more than others (namely, consumers) about price and quality. A market with asymmetric information can lead to a form of market failure known as adverse selection. Because consumers are not adequately-informed about product quality, they tend to select the lower-quality and less-expensive service. As a result, there is market inefficiency because too many resources are allocated to the lower-quality service and insufficient resources are allocated to the higher-quality service.

Consumers who view fixed and mobile broadband as substitutes may not have complete or accurate information about the relative prices, speed and reliability of the two modes of broadband. Studies have shown a discrepancy between actual and advertised speeds, for both wired and wireless service. While many fixed line providers now offer unlimited usage plans, many wireless providers sell service by MB buckets. Even an educated consumer would have difficulty navigating among all the options available in the broadband universe of plans.

For consumers who consider fixed and mobile broadband as complementary, there are transaction costs when dealing with different providers for fixed and mobile broadband. Because of these transaction costs, the consumer may opt for a bimodal or quadruple play package, even if these packages are not price competitive. If a single-mode provider cannot compete in the bimodal market

⁵² Pereira and Vareda (2013)

⁵³ Framework Directive (2002)

⁵⁴ Dippon, *op.cit.*

because the provider does not have access to either fixed infrastructure or wireless spectrum, this lack of access creates a barrier to the entry of these firms into the bimodal market. The result is market power for the providers who offer bimodal service. This may require regulatory attention.

5. Conclusions

In nations where both fixed and mobile broadband are available, there is no clearcut evidence on the nature of the relationship between the two modes. The nature of the relationship may vary with consumer income and age, and on the specific characteristics of available fixed (i.e., cable, DSL, FTTH) and wireless broadband.

Fixed and wireless broadband are often supplied by different providers. In the United States, fixed broadband providers have been reluctant to offer wireless broadband. Fixed broadband providers that have acquired wireless spectrum leases from FCC spectrum auctions have not built out wireless networks. Cable companies and legacy telephony providers have made a large investment in fixed line networks. Their reluctance to offer wireless broadband may reflect their concern that consumers might view wireless as a substitute for fixed broadband. However, as the overall industry matures, recently some fixed broadband suppliers have begun to broaden their product menu to include wireless broadband⁵⁵ and to expand their WiFi networks⁵⁶.

The relationship between fixed and mobile broadband may ultimately be influenced by (1) technological developments in both fixed and mobile broadband, (2) marketing strategies of the providers and (3) government regulation of the industry.

Because of asymmetric information, a consumers' perception of the relationship between fixed and mobile broadband may be influenced by the marketing strategies of broadband providers offering both modes. The provider's approach to the relationship between fixed and mobile broadband will be evidenced by the menu of options that the provider offers to consumers. A provider may market the modes as complements, bundling the two modes. Bundling may increase the consumers' perception of the two modes as complements, and the bundled price might provide an incentive to subscribe to both modes. Moreover, bundling would eliminate the marginal transaction costs of dealing with two providers and facilitate subscription to both modes. If fixed and mobile broadband are marketed in an unbundled fashion as substitutes, the consumer is more likely to choose one mode rather than the other on the basis of price and other attributes.

⁵⁵ In the United States, a joint venture of major cable providers with broadband spectrum licenses recently agreed to sell its wireless licenses to a wireless provider, in exchange for cross-selling arrangements. In December 2011, Spectrum Co LLC, a joint venture of the major U.S. cable providers, entered into an agreement whereby Verizon Wireless would acquire Spectrum's wireless licenses. At the same time, the companies entered into agreements whereby the cable companies and Verizon Wireless would (1) become agents to sell one another's products and (2) form an innovation technology joint venture for the development of technology to better integrate wireline and wireless products and services. Verizon Wireless News Center (2011).

⁵⁶ Five of the U.S.'s largest cable networks recently combined their WiFi networks into a single network. five of the U.S.'s largest cable networks combined their WiFi networks into a single network. five of the U.S.'s largest cable networks combined their WiFi networks into a single network. Bright House, Cablevision, Comcast, Cox and Time Warner have joined forces to combine their WiFi networks into a single network with over 50,000 hotspots in their markets. Cellular News (2012).

What are the regulatory implications? A provider offering both modes of broadband access would tend to have more market power than a provider of only one mode, whether the two modes are substitutes or complements. Nevertheless, the relationship between fixed and mobile broadband has important implications for governments seeking to increase broadband penetration and to regulate competition in the broadband industry. The nature of the relationship between the modes affects the number of competitors in the marketplace, the appropriate delineation of the market for purposes of assessing market power, and the presence of demand-side market failure. If consumers view fixed and mobile broadband as complements rather than substitutes, the level of competition in the overall broadband market will be reduced, because consumers have fewer options among which to choose. This is so even if the two modes continue to be provided by different providers.

Regulators not only need to keep up to date on technological advances that will shape the nature of the broadband industry. Regulators also need to recognize that their regulatory framework may be instrumental in shaping the nature of the industry and the interplay between fixed and mobile broadband.

REFERENCES

Barros, Pedro Pita and Cadima, Nuno (2001). The impact of mobile phone diffusion on the fixed-link network, Working paper, Lisbon.

Barth, A-K and Heimeshoff, U. (2012). How Large is the Magnitude of Fixed-Mobile Call Substitution? – Empirical Evidence from 16 European Countries, *Dusseldorf Institute for Competition Economics*.

Blumberg, S. and Luke, J. (2006-2011). Wireless substitution: Early release of estimates from the national health interview survey. Division of Health Interview Statistics, National Center for Disease Control and Prevention, Atlanta, GA.

Cable Group Spending Big on Spectrum (2006). *Reed Business Information*, September 25, 2006. (AWS Auctions).

Caves, K (2011). Quantifying price-driven wireless substitution in telephony, *Telecommunications Policy*, 35, 984-998.

Cellular News, *Major U.S. Cable Companies Join Forces for Single Wi-Fi Service*, May 21, 2012.

Che, Jim (2001) The Authority to Regulate Broadband Internet Access Over Cable, *Berkeley Technology Law Journal*, 16, 677-684.

- Cherry, Barbara A. (2010) Consumer sovereignty: New boundaries for telecommunications and broadband access, *Telecommunications Policy*, 34, 11-22.
- Correa, L and Crocioni, P. (2012). Can evidence of pricing power help market power assessment? Broadband Internet in Ireland and the Netherlands. *Telecommunications Policy*, 36, 419-433.
- Davies, J, Howell, B. and Mabin, V. (2008) Telecommunications Regulation, Regulatory Behavior and its Impact A Systems View, *Communications and Strategies*, 70, pp.145-167.
- Deposit by Sprint Group Leads Wireless Bidders (1994). *The New York Times*, November 28, 1994. (PCS Auctions).
- Dippon, Christian (2008) Size Matters: Relevant Market Definition and Competition Review in a World with Intermodal Competition, NERA Global Telecom Review.
- European Commission (2002) Directive 2002/21/EC (Framework Directive) Article 14.
- Federal Communications Commission, (2003) *Annual Report and Analysis of Competitive Market Conditions with Respect to Commercial Mobile Services*, Eighth Report.
- Federal Communications Commission, (2011) *Annual Report and Analysis of Competitive Market Conditions with Respect to Mobile Wireless, Including Commercial Mobile Services*, Fifteenth Report.
- Federal Communications Commission, (2013) *Annual Report and Analysis of Competitive Market Conditions with Respect to Mobile Wireless, Including Commercial Mobile Services*, Sixteenth Report.
- Hamilton, Jacqueline (2003). Are Main Lines and Mobile Phones Substitutes or Complements? Evidence from Africa. *Telecommunications Policy*, 27, 109-133.
- Helfat, C.E. (1997). Know-how and asset complementarity and dynamic capability accumulation : the case of R&D. *Strategic Management Journal* 18, 339-360.
- Infocomm Development Authority of Singapore (2011) *2010 Annual Survey on Infocomm Usage in Households*.
- Kaplow, L (2010) Why (ever) define markets? *Harvard Law Review*, 124, 437-516.
- Kim, J. and S. Finkelstein (2009). The Effects of Strategic and Market Complementarity on Acquisition Performance: Evidence from the U.S. Commercial Banking Industry, 1989-2001, *Strategic Management Journal* 30, pp.617-646.
- Lee, S., Marcu, M., and Lee, S. (2011). An empirical analysis of fixed and mobile broadband diffusion, *Information Economics and Policy*, 227-233.

MobiThinking (2011). *Global Mobile Statistics*.

Milgrom, P. and Roberts, J. (1990). The economics of modern manufacturing: technology, strategy and organization, *American Economic Review*, 80, 511-528.

OECD Broadband Statistics (2011). Oecd.org/sti/ict/broadband.

Pennings, C. (2008) NGA Regulation-A European perspective, *Communications and Strategies*, 72, 157-161.

Pereira, P and Varela, J. (2013). How will telecommunications bundles impact competition and regulatory analysis? *Telecommunications Policy*, 37, 530-539

Ross, S. (2011). FTTH: Life After the FIOS Build, *Broadband Communities*, 32, 34-40.

Sachs, J (2011). Mobile Phones to Speed Healthcare Delivery in East Africa, *The East African*.

Scott, M (2001). Operators should position mobile broadband as a complement to fixed broadband, not a substitute. *Analysismason*.

Srinuan, P, Srinuan, C and Bohlin, E. (2012). Fixed and mobile broadband substitution in Sweden, *Telecommunications Policy*, 36, pp.237-251.

Storaasli, Olaf. (2012). Is Europe Ready for the Zettabyte Era? *Broadband Communities*, 33,2, 28-30.

Sung, Nakil, Kim, Chang-Gun and Lee, Yong-Hun (2000). Is a POTS Dispensable? Substitution Effects Between Mobile and Fixed Telephones in Korea. Working paper, Seoul.

Tanriverdi, H. and Lee. C.H. (2008). Within-industry diversification and firm performance in the presence of network externalities: evidence from the software industry, *Academy of Management Journal*, 51, pp.381-397.

U.S. Federal Trade Commission (1992) 1992 Horizontal Merger Guidelines, Section 1.

Van-Huyssteen, Johan (2012). Africa: a continent offering a world of opportunity. *Communications Review* 17, pp. 8-13.

Verizon Wireless News Center (2011) Comcast, Time Warner Cable, And Bright House Networks Sell Advanced Wireless Spectrum to Verizon Wireless for 43.6 Billion.

Werden, G. (1993) Market delineation under the Merger Guidelines: a tenth anniversary retrospective. *The Antitrust Bulletin*, 517-600.

Wood, R. and Hatton, V. (2008). *Mobile and fixed broadband: co-habitation or competition?* analysismason

Xia, Jun. (2012) Reprint of: Competition and regulation in China's 3G/4G mobile communications industry – Institutions, governance, and telecom SOEs, *Telecommunications Policy* 36, 798-816.

