SCIENTIFIC RESEARCH PROJECT COORDINATED BY ICP-ANACOM AND ANATEL WITH A FOCUS ON MOBILE BROADBAND

Final Report

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We are pleased to present this report to satisfy the proposal to assist the Autoridade Nacional de Comunicações of Portugal (ANACOM) and the Agência Nacional de Telecomunicações (ANATEL) of Brazil in analyzing the adoption, use, and economic impact of mobile broadband within their countries.

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Executive Summary

A primary goal of this study is to extend the existing research on broadband provision and adoption by comparing the factors that determine mobile broadband adoption with those that determine fixed broadband adoption, the patterns of use for each technology, and the substitutability of mobile and fixed broadband. We also draw conclusions about improved data collection and reporting on fixed and mobile broadband deployment, adoption, and usage patterns, and on the impact of nomadic broadband deployment where such analysis is possible.[1]

The two most important papers that we build on are those by Cardona, Schwarz, Yurtoglu and Zulehner (2007), and Lee and Marcu (2008). Cardona *et al*. analyzes residential demand for Internet access in Austria, with a focus on both fixed and mobile broadband Internet access, specified by type (DSL, cable, mobile, and narrowband). The study uses data from a 2006 survey conducted by the Austrian Regulatory Authority for Broadcasting and Telecommunications to estimate elasticities of demand. Based on the finding that the availability of one technology limits other technology providers' abilities to raise prices, the authors conclude that customers view the different broadband technologies as substitutes. Our study is constructed similarly to the Cardona *et al.* study, using data specific to Portugal and applying econometric models we developed for our study.

The second relevant paper (Lee and Marcu, 2008), uses six years of OECD data to analyze the factors that influence the diffusion of fixed and mobile broadband. The authors focus on policy, socio-economic, and demographic factors that drive fixed and broadband deployment and adoption. To our knowledge, Lee and Marcu (2008) is the first study to decipher differences in fixed and mobile broadband. Our more extensive data set allows us to expand upon Lee and Marcu, but because the data differs slightly across years, we are unable to analyze econometrically how policy impacts adoption.

Our data, which was provided by ICP-ANACOM, are at the household level indicating individual preferences and actions. This allows us to analyze data on households that switched providers, and each household's satisfaction with its current provider, among other possibilities. The data also allows us to estimate mobile broadband adoption and usage both independently and with respect to other broadband options such as fixed and narrowband access.

A primary constraint is that currently we have limited information on pricing plan characteristics and some usage characteristics, such as nominal and actual speed, and volume of traffic.[2] The absence of detailed price data requires us to use imperfect approaches to estimating price elasticities and the degree of substitutability between alternative modes of broadband access, as well as between narrowband and broadband. Our primary data sources are 2006 and 2008 surveys of customers in

[1] Nomadic broadband is defined as wireless access whereby the end-user can move among different access locations, such as hot spots.

[2] We know of no studies to date that have been able to fill all such information gaps, which limits much of the existing research in the same way our progress is affected.

Portugal.[3] While we lack specific price information, we do have some information on pricing plans (provided by ANACOM). We do not have information on actual expenditures. More detailed and customer-specific price data would greatly improve the precision with which we generate empirical results.

Within our study, we analyze the factors that drive mobile broadband adoption. We compare these factors to those that drive fixed broadband adoption, with the goal of determining whether mobile broadband consumers differ from fixed broadband consumers. This is important in at least two respects: the more similar the two groups of consumers, the more likely it is that the two technologies are close substitutes; and, it makes subsequent analyses (such as meaningful comparisons of intensity and patterns of use between technologies) possible, because it allows us to control for individual characteristics, as well as previous intensity and patterns of use.

In the second stage we analyze the intensity and patterns of use of mobile broadband consumers, again with the goal of determining whether such consumers differ significantly from fixed broadband users. If significant differences in intensity and patterns of use exist after controlling for individual characteristics identified to be important drivers of adoption in the first stage, then it is less likely that mobile and fixed broadband are close substitutes.

Our results indicate that higher income (measured by proxy as described within the report) and more years of formal education are the primary consumer characteristics that lead to the choice of mobile broadband over fixed broadband. Other results of interest are the degree to which reliability of service is important to Internet broadband users, the propensity of higher-income and more experienced (in terms of years using Internet) respondents to want to switch providers, and the characteristics of individuals who shop, file taxes, and enjoy entertainment online. Our data primarily are from three studies conducted during 2006 and 2008, with information on nomadic access from 2008, and surveys from both years contributing to analysis of substitutability between methods of Internet access.

The results of these analyses have important implications for the monitoring and construction of indicators of broadband adoption.[4] If mobile and fixed broadband are close substitutes, then it may be appropriate to construct and monitor aggregate measures of broadband achievement that include both. If on the other hand consumers

[3] We also have data from a 2007 survey; however, this paper does not incorporate the 2007 data. We were unable to match survey responses to price data (which would have allowed us to generate price elasticities). We chose to run estimates using the 2006 BCS survey data as a base year and 2008 ICSCE survey data as the most recent year of data and found comparable results to our models. For this reason we chose to report results from the more recent data rather than the 2007 data. (We cannot make a panel of all three years of data because some key variables are coded differently and different households were surveyed across the years, meaning we have three cross-sections that cannot be combined.)

[4] Due to the limited number of mobile broadband users completing the 2008 surveys (105 total mobile broadband consumers surveyed in the Inquérito ao Consumo das Comunicações Electrónicas survey, and 234 mobile broadband consumers surveyed in the European Consumer Satisfaction Index (ECSI) survey) our empirical analysis of mobile and fixed broadband substitutability in Portugal is limited; however, we are able draw some conclusions on substitutability based on the data available. This information is provided in detail in the body of the report.

view mobile and fixed broadband as being meaningfully different from each other, then aggregating across technologies would lack validity.

Additional analyses also are possible. For example, after identifying factors of adoption, a meaningful comparison of intensity of use between customers of different mobile operators may reveal differences in quality of service in terms of actual speeds/throughput and reliability. To be meaningful such comparisons should first ensure that the compared groups of customers of different operators are similar. The Portuguese government's e.iniciativas programs are useful for making such comparisons, but with some important caveats. The programs bundle Internet access with the offer of a portable PC, allowing the possibility that some customers might purchase the service primarily to obtain the PC, not broadband. Also, the characteristics of the customers that qualify for the program -- teachers, trainees and pupils – may not be representative of the general population. Nevertheless, the program makes possible some unique analyses because the nominal speeds and prices of plans do not vary among the three operators in the e.iniciativas programs, and information exists about individuals' characteristics and prior intensity of use. Since in reality actual speed/ throughput may vary considerably from the nominal speed advertised, such inferences about quality of service are particularly important.

This raises a concluding question of the manner in which mobile broadband connections might be included in international comparisons of mobile broadband deployment and adoption if appropriate. Determining the relevant information to collect for both fixed and mobile broadband, as well as the manner in which the data might be utilized to inform policymaking is essential to regulatory policy and the promotion of broadband adoption. The rapid diffusion of mobile broadband in Portugal indicates that it is time to answer some of these critical questions and to lay the groundwork for future research in this area.

In addition to the question of international benchmarking of broadband penetration, the issue of whether mobile and fixed broadband are similar from customers' perspectives is important for studies of broadband impacts. Several empirical studies have linked the use and adoption of broadband technology to various measurements of economic and job growth.[5] However, such analyses have not been undertaken specifically with regard to mobile broadband services. Whether mobile broadband service will have a similar level of impact upon social and economic development as fixed broadband services have had has not yet been determined. While the scope of the current study does not allow a direct analysis of the impacts of mobile broadband on social and economic development, we are able to consider whether the uses of mobile broadband are different from those of fixed broadband. Our current results indicate that the uses are similar across fixed and mobile users, suggesting that they are somewhat substitutable from customers' perspectives and raising the possibility that there may be limited differential effects on innovation and other social goals. Currently, using 2006 BCS survey data primarily, we are able to pinpoint characteristics of consumers who use the Internet for various tasks; we anticipate future analyses may provide more substantive results for mobile versus fixed broadband usage.

[5] For example see, Gillett *et al.* 2006; Crandall *et al.* 2007; Connected Nation 2008; Shideler *et al.* 2007; and Van Gaasbeck *et al.* 2007.

For current purposes it is important to note that the Lisbon strategy proposed to form in the EU Member States the most competitive and dynamic knowledge-based economy through widespread, affordable Internet access. Subsequent reports established specific penetration targets and a Broadband Performance Index designed to benchmark Member States. This strong interest in broadband development implies a widespread acceptance of the notion that broadband adoption has numerous economic and social benefits.

I. Introduction

The economic importance of broadband is well accepted, but there is much that we do not know about how various technologies of broadband delivery differ in their commercial viability, effectiveness, and value. In some countries, such as the United States, customers often can choose between fixed technologies (such as DSL, fiber to the home (FTTH), and cable), and can access wireless broadband through WiFi and third generation mobile (3G). In other countries, where cable television is less well developed, customers generally do not have the option of choosing cable for broadband access. Japan is emphasizing FTTH in its broadband policies, but also relies on DSL. There also are countries, such as Portugal, where wireless broadband is expanding rapidly. Whether customers view these various technologies as providing equivalent broadband access is important for public policy reasons: a country that is predominant in one broadband technology may be so because regulatory policies include technology biases. Such a country could be at a competitive disadvantage if its populace would find a different mix of technologies to be more productive economically and socially. On the other hand, if alternative broadband technologies are close substitutes, then a country could waste resources promoting a change in technology mix.[6]

Another important consideration for understanding the roles of various broadband technologies is the context within which broadband penetration occurs. The Global Competitiveness Index measures economic competitiveness by ranking business competitiveness across approximately 130 countries; the index incorporates many factors that are affected by broadband penetration, including education, legal structures, and government and business use of advanced technologies.[7] According to Schwab and Porter (2007), the most competitive economies in the future will be those that are innovation-driven. Broadband is instrumental in creating opportunities for innovation in a modern economy. A study by Van Ark and Inklaar (2005) supports this assertion, finding that the economies that have experienced the greatest economic impacts from information technologies are those that have leveraged those technologies to create entirely new products and ways of doing business. Still, broadband alone does not promote innovation; the Global Competitiveness Index includes numerous economic and legal features of a country that should be present if broadband is to reach its potential impact.

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[6] For example, some countries have experienced a greater growth in mobile broadband than have other countries, with the result that these countries look less favorable in popular broadband rankings. If citizens of these countries view broadband as equivalent to fixed broadband, then the country could waste resources trying to increase the use of fixed broadband relative to mobile if customers find mobile broadband equivalent in value to fixed, or perhaps even superior in value to fixed.

[7] In the most recent report (2008-2009) Portugal ranks 43rd; in the prior year it ranked 40th. The Global Competitiveness Report is published annually by the World Economic Forum. The rankings are calculated from publicly available data and from an annual survey conducted by the World Economic Forum. The number of countries ranked varies based on available survey data within countries. The report is available at http://www.weforum.org/en/initiatives/gcp/Global%20Competitiveness%20Report/index.htm. According to the most recent report, the main purpose of the ranking and report is to improve the understanding of the key factors that determine economic growth, and to explain "why some countries are much more successful than others in raising income levels and opportunities for their respective populations, offering policymakers and business leaders an important tool in the formulation of improved economic policies and institutional reforms."(page xi).

The issues of substitutability across broadband technologies and the context in which broadband penetration occurs highlight the deficiencies of the Organization for Economic Cooperation and Development (OECD) broadband penetration rankings, which are frequently cited in the media with little filtering and which prompt strong reactions from public officials. For example, these rankings were frequently cited by Barak Obama during his run for the President of the United States as evidence that the government needs to play an activist role in broadband deployment and adoption. They also played a role in the recent elections in Australia, prompting the leading parties to promise extensive broadband subsidies and resulting in what is now a US$31 billion scheme to build a national broadband network without direct involvement by leading telecommunications companies.[8] These rankings too often confuse rather than inform important public policy debates. Wallsten (2008), for example, finds the OECD rankings misleading, and explains that the rankings are distorted by differences in household size across countries, that they miss workplace connections, that they are based on data that are inconsistently reported across countries and over time, and that they omit quality differences. Further, the OECD reports overlook relevant data such as subscription for mobile broadband, the fastest growing mode of connectivity in many countries, including, of primary importance for our purposes, Portugal. Ford, Koutsky, and Spiwak (2008) also find numerous deficiencies in the OECD index and, as we describe in more detail below, demonstrate that the index's rankings lead to erroneous conclusions. Nevertheless, the rankings are widely distributed and frequently cited in the media, creating a faulty foundation for public discussion and debate about broadband development.

Questions of data measurement, interpretation, and comparison are particularly critical with regard to the deployment and adoption of mobile broadband service. Studies of fixed broadband adoption and deployment are numerous. Several empirical studies have linked the use and adoption of broadband technology to various measurements of both economic and job growth; however, such analyses have not been undertaken specifically with regard to mobile broadband diffusion. In part, this is due to data limitations that exist due to the relatively recent emergence of mobile broadband technology. In what appears to be the first study that compares adoption of fixed and mobile broadband, Lee and Marcu (2008) find that factors influencing the diffusion of fixed broadband are different in some instances from factors influencing mobile broadband diffusion. However, Lee and Marcu were unable to fully examine those factors.

Prior studies have shown the social and economic impact of telecommunications and Internet access; however, the impact of mobile broadband has not been analyzed. While our data does not permit us to specifically address this issue, we are able to suggest the importance of mobile broadband on social and economic development based on existing research and the new data we employ.[9] Such information will

[8] See "Broadband Promises Crash Aussie Election," The Inquirer, 18 June 2007, http://www.theinquirer.net/inquirer/news/601/1034601/broadband-promises-crash-aussie-election; and "Australia to Build $31 Billion Broadband Network," The New York Times, April 26, 2009, http://dealbook.blogs.nytimes.com/2009/04/07/australia-to-build-31-billion-broadband-network/.

[9] We are unable to quantify the economic and social impacts of mobile broadband in Portugal because we have no measure of economic progress of the surveyed households before and after getting

accompany our econometric analysis addressing the gap in the research on fixed and mobile broadband.

Our report proceeds as follows. Section II provides an extended review of research on broadband penetration and use, and on the economic and social impacts of advanced communications technologies. Section III describes our data and outlines the econometric models we use to answer our primary questions of interest. Section IV provides the results of our analyses. Section V makes recommendations for further study and Section VI concludes. The Appendix contains outputs of our econometric models. Econometric models use unweighted survey results unless they are noted as using survey design. Tables, charts, and graphs also rely on unweighted survey results unless otherwise indicated. All data in charts, graphs, and tables are from ANACOM surveys unless otherwise noted.

II. Background and Literature Review

In this section we review earlier research relevant to our study. We begin by identifying drivers that impact the supply of telecommunications, in particular broadband. Next we turn our attention to demand for broadband, in particular price elasticities and the demographic and economic factors that influence demand. We then review the impacts of broadband on various economic and social factors and draw conclusions regarding broadband indicators.

A. Supply Drivers[10]

It generally is accepted that costs, competition, and demand expectations[11] drive the supply of telecommunications, including broadband. One of the earliest cross-country analyses for broadband supply was Bauer, Kim and Wildman (2003), which used 2001 data for 30 OECD countries to find that costs of deployment and network unbundling are key determinants of fixed broadband penetration. Using more data and incorporating information on mobile broadband, Lee and Marcu (2008) confirmed that higher network deployment costs decrease supply; Cava-Ferreruela and Alabau-Muňoz (2006) reported a similar result.

Network costs can affect supply in two ways. First, the presence of high fixed costs can limit the number of competitors that can profitably serve a market. Second, high marginal costs, if they are present, limit the number of customers who can be supplied with service profitably: customers who value the service less than the marginal costs of deployment would not be served on a commercial basis without a subsidy.

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broadband. We are able to suggest how such impacts might exist and explain the process and mechanics that generate them.

[10] We are unable to analyze supply drivers empirically because our data represent only one country and include only two years in which many of the variables differ across years.

[11] We address demand and demand expectations in the next section rather than here with the supply drivers.

Several factors can cause higher fixed and marginal costs. The most common factor assessed in empirical studies is the population density, based on the understanding that it is more costly per customer to supply low-density populations than high-density populations, where density is measured in number of potential subscribers in a geographic area. (Prieger and Hu, 2008) License fees that do not vary with revenue or output, such as are typically found for radio spectrum, can limit entry because operators view these fees as additional fixed costs. Universal service obligations, if they take the form of license obligations to expand at a specific rate into areas that are not commercially viable, also would increase fixed costs. Increases in license or universal service fees that vary with output (or revenue), income taxes, wages, interest rates, import fees, and the like would all increase marginal production costs and so would lower output, all other things being equal. (Jamison, 2008)

It generally is presumed that unbundling decreases costs of supply for rivals of incumbent service providers and thus stimulates supply. Indeed most empirical studies of telecommunications find a positive correlation between unbundling requirements and market entry (see, for example, Bauer, Kim and Wildman (2003), Lee and Marcu (2008), and Denni and Gruber (2005)). Garcia-Murillo (2005) generally supports this conclusion, but finds that unbundling results in a substantial improvement in broadband deployment only for middle-income countries, not for high-income countries. As Jamison (2004) showed, unbundling has two opposing effects that researchers should take into consideration. One is the impact on entry costs for entrants, which is the focus of most studies. The other effect is on incumbent profits. Jamison found for the United States that if unbundling policies negatively impact incumbent profits then incumbents discourage entry. Examining both the entrant and incumbent effects, Jamison (2004) and Hauge, Jamison, and Gentry (2008) find that the incumbent effect dominates; in other words, regulatory policies that make providing unbundled network elements less profitable for an incumbent than selling the associated retail services result in less entry than policies that are less damaging to incumbent profits.

Studies consistently show that competition increases supply. This is true for both fixed line broadband (Aron and Burnstein (2003); Denni and Gruber (2005); and Distaso, Lupi, and Manenti (2006)) and mobile broadband (Lee and Marcu (2008)). In particular intermodal competition, namely competition between alternative technology platforms, increases output (Bauer, Kim and Wildman (2003); Aron and Burnstein (2003); Distaso, Lupi, and Manenti (2006); Cava-Ferreruela and Alabau-Muňoz (2006); and Lee and Marcu (2008)). Competition increases output because it limits the effectiveness of a service provider's unilateral strategy to raise prices. Whenever a firm in a competitive market seeks to increase its price unilaterally, it creates a positive externality for its rivals who benefit from the unilateral action because they can both raise their prices and increase their output. The increased output from rivals, even if only in relative terms, limits the profit the first mover can capture from the price increase. Indeed the price increase may even be unprofitable for the first mover. Furthermore, the more market share the rivals have, the less the first mover can benefit from the price increase. This effect of competition results in an inverse relationship between market prices and the intensity of market rivalry, and a positive correlation between output and competition.

The impact of competition is found not only in broadband markets, but in traditional voice markets as well. For example Wallsten (2001) develops an empirical fixed-effects regression model to illustrate that competition improves telecommunications availability in developing countries. Using data from 30 African and Latin American countries from 1984 through 1997, he measures competition as the number of mobile operators not owned by the incumbent.[12] He finds that competition is positively correlated with the per capita number of mainlines, payphones, and connection capacity, and that price falls with an increase in mobile competitors. Likewise, Waverman, Meschi, and Fuss (2005) found that reliance on competitive market forces was a key regulatory policy for developing mobile telecommunications. In his study of telecommunications development in Latin America, Gutiérrez (2003) found that "opening of the market to more competition and the free entry of private investors in basic telecommunications services will propel network expansion and efficiency across the sector."

Competition from privately-owned firms appears to be more effective than competition from government-owned providers. In an early study of the effects of ownership on telecommunications output, Gutiérrez (2003) found that private operators in competitive markets in Latin America expanded output more than did government-owned operators. Focusing on the United States, Hauge, Jamison, and Gentry (2008) found that municipally-owned telecommunications providers appeared to have no impact on market competition in the United States. Government ownership can also result in policy biases: Edwards and Waverman (2006) find that state-ownership of incumbent telecommunications providers in Europe results in regulatory policies that favor incumbents over entrants.

B. Demand Elasticity[13]

Demand elasticity provides information about the nature of the product being sold and its market structure. Inelastic market demand could indicate that there are few good substitutes for the product, that the product is important to consumers, and, if regulation is not imposing an upper limit on prices, that markets are constraining market power.

Studies provide inconsistent estimates of demand elasticities for broadband. Cardona, Schwarz, Yurtoglu and Zulehner (2007) show that for Europe, the price elasticity of demand for broadband is as expected with most other goods: it varies with the amount of competition in the market. In two complementary studies of the price elasticity of demand for broadband in the United States, Rappoport *et al*. (2001) found that demand for broadband via cable modems was price inelastic, but that demand for DSL was price elastic. The study also found that DSL and cable modems were substitutes and so attributed the differences in own-price elasticities to differences in penetration. Crandall, Sidak, and Singer (2002) updated the Rappoport *et al*. study and found that the elasticities had not changed substantially. But in their own follow-up study, Rappoport *et*

[12] Brazil is included in the study, which notes that telecommunications reform legislation was passed in Brazil in 1995 and an independent regulator established in 1997; however, as of 1997 there were no mobile telecommunications competitors (see page 10 in Wallsten's work).

[13] Our analysis of demand elasticities is limited by our lack of adequate price data for the primary year of study (2006); some analyses using 2008 data are provided in our results.

al. (2002) found that demand for the services was becoming more price inelastic, perhaps indicating either increasing penetration or that the services were becoming more essential. At about this same time, Varian (2002) examined consumers' willingness to pay for additional bandwidth for an Internet access service offered by the University of California at Berkeley and found that demand was price inelastic. While Varian's study cannot be compared directly with the Rappoport *et al*. studies because Varian considered only users of the Berkeley service, Varian's findings at least are consistent with the latter Rappoport *et al*. study.

Ida and Kuroda (2006) examined the demand for broadband services in Japan. They found that the demand for ADSL in Japan was price inelastic and that the demand for cable modem and fiber to the home was price elastic, perhaps because of the dominance of ADSL in Japan, consistent with the analyses of Rappoport *et al*. (2001, 2002).

C. Demographic and Economic Factors Affecting Demand

Demand studies for broadband access find that demand is positively correlated with income, education, and greater use of other information technologies. Crandall *et al*. (2002), Kridel *et al*. (2001), Garcia-Murillo (2005), and Prieger and Hu (2008) find that lower-income groups are less likely to subscribe to broadband than higher-income groups. Goldfarb and Prince (2008) concur in this finding and add that more highly educated consumers are more likely than less-educated consumers to purchase broadband. Analyzing residential broadband adoption in the United States, Stanton (2004) finds that computer ownership is one of the most significant factors leading to the so-called digital divide. This could have consequences for the effects of race on broadband demand in the US because, as Fairlie (2004) shows using Current Population Survey data in the United States, blacks and Hispanics are less likely to have a computer in the home than are members of other racial or ethnic groups.

Other studies address race and ethnicity more directly. Prieger (2003) and Hu and Prieger (2008) find that race has no impact on suppliers' willingness to deploy DSL, once variations in income and other economic factors are considered. Leigh (2003) finds similar results. However, Flamm and Chaudhuri (2007), GAO (2006), and Prieger and Hu (2008) find that race impacts broadband penetration, perhaps because of differences in computer skills (Krueger, 2003) or network effects (Goolsbee and Klenow, 2002). These race impacts may result from factors correlated with race, but unobserved in the researchers' data or not fully captured in the statistical analysis even if the data are there. For example, Prieger and Hu (2008) discuss whether some blacks and Hispanics lack spare time to be online or find online content less valuable than do other racial groups. Costa (2009) hypothesizes that household income and educational levels may be correlated with race and that the effects of income and education are not fully captured by their respective regression coefficients. It might also be that technology limits may affect supply in some ethnic neighborhoods.

In their survey of 18,439 Americans, Goldfarb and Prince (2008) examine the relationship between demographics and Internet usage. They find that, conditional on

adoption, low-income, less-educated consumers spend more time online than their higher income, more educated counterparts, a result that is best explained by differences in the opportunity cost of leisure time according to the study.[14]

In their study of fixed broadband adoption, Ford, Koutsky, and Spiwak (2008) study the per capita broadband subscription rate for each OECD country as found in the OECD Factbook and the World Bank's World Development Indicators, and include demographic explanatory variables such as country-specific data on income, age, education, and household size, among others. Using stochastic frontier analysis, the authors estimate a broadband efficiency index that indicates the technical efficiency with which a country is able to convert its demographic and economic endowments into broadband subscriptions. Given the developed index, they conclude that most (two-thirds of all) countries perform very well in terms of converting their endowments into broadband subscriptions, and that Belgium, Iceland, and Portugal are exceptional performers.[15] A key result is that such demographic and economic endowments are found to explain 91 percent of the variation in broadband subscriptions across countries. The authors state that "demographic and economic conditions so pervasively drive the broadband subscription per capita number that utilizing the 'ranking' of OECD countries, conditioned only on population, to advocate for or against broadband policy changes is nonsensical."[16] They assert that public policy aimed at reducing adverse effects of poor economic conditions may be more appropriate than any particular broadband policy.

D. Impacts of Broadband on Various Economic and Social Factors

We now turn our attention to the impacts of broadband on a variety of factors. The economic importance of broadband is well accepted, and studies of fixed broadband deployment are numerous. Holt and Jamison (2008) provide an overview of various economic impact studies, but such studies of broadband's effects always suffer from the problem of endogeneity (i.e., information that comes from the model cannot be used to explain the model). For example, if it is observed that economic development and broadband adoption are positively correlated, how does one know whether economic development results from broadband adoption, leads to broadband adoption, or both? The accepted wisdom is that broadband is both a cause and an effect of economic development. This means that the important research question is to determine the net impact of broadband on an array of economic and social variables, given that certain qualities of these variables must be in place before broadband can make its impacts.

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[14] Our findings indicate that broadband usage is increasing in income and education. This contrasts with the Goldfarb and Prince study, but does not contradict it. Their finding relates to all Internet usage and shows that time is less valuable for lower income and less educated households. This time preference could lead lower income, less educated customers to use more dialup Internet than broadband, leaving open the possibility that once a customer has adopted broadband, the customer's usage might be positively correlated with income and education.

[15] "Portugal, with a raw subscription rank of 23rd, is actually the 3rd best performer with a BEI [broadband efficiency index] of 0.983." The country's expected subscription is reduced by its unfavorable endowments for GDP, GINI and education (Ford *et al.*,(2008), page 15).

[16] See Ford *et al*, (2008), page 16.

We begin our discussion of the effects of broadband by considering the impacts on productivity and innovation. We then turn our attention to effects on national wealth or income, job and business development, education, healthcare, and the like.

i. Productivity, Investment, and Innovation Effects

We begin our review of the effects of broadband on productivity and innovation by examining the literature related to the effects of information and communications technologies (ICT) overall.

Economists were long puzzled by an apparent disconnect between the anecdotal evidence of the impact of ICT on productivity and the measureable effects of such impact. This disconnect has not been entirely resolved, but in his Presidential Address to the American Economic Association in 2001, Jorgenson (2001) observed, "The development and deployment of information technology is the foundation of the American growth resurgence." Research by Jorgenson and other prominent academicians has shown that this assertion applies not just to the United States, but to almost every country of the world.

Consider a study by Röller and Waverman (2001) that examined how telecommunications development affected economic growth in the OECD countries from 1971 through 1990. The study's central finding was the existence of a significant positive causal link between telecommunications development and economic growth, especially prevalent when telecommunications infrastructure hits a critical mass, namely the level at which it has achieved nearly universal service. Röller and Waverman found that telecommunications development was the cause for about one-third of the economic growth in the OECD economies from 1971 through 1990, amounting to about US $1,700 per person per year on average. This represents an improvement of about 10 percent in per capita gross domestic product over the base year.

Röller and Waverman explain that the link between telecommunications development and economic growth generally is attributed to spillovers and externalities: when one portion of the economy adopts telecommunications to improve its productivity, this adoption has positive spillovers on the productivity of other portions of the economy. For example, improved methods for managing inventory lower costs for businesses, which lead to lower prices for consumers. These lower prices give consumers additional discretionary income that they can then use for savings, investment, education, or other pursuits that improve their standard of living. Furthermore, when one portion of the economy, say banking, increases its use of telecommunications, other portions of the economy also adopt the use of telecommunications so as to better work with the banking sector.

Waverman, Meschi, and Fuss (2005) addressed similar issues for developing countries. They examined mobile phone development from 1996 through 2003 and found that it had a positive and significant impact on economic growth, and that "this impact may be twice as large in developing countries compared to developed countries." The authors further deduced that "differences in mobile penetration between developing countries

might generate significant long-run growth benefits for the mobile leaders." Because there are significant differences in the penetration and diffusion of mobile telephony across developing countries, the study "results suggest that this gap will feed into a significant difference in their growth rates in the future."

ICTs improve productivity by creating opportunities for further investment and growth, saving costs, and improving labor force skills. According to the International Institute for Communication and Development, ICT development provides small- and medium-sized enterprises (SMEs) with the ability to boost productivity, access international markets, and improve customer service. These opportunities have come about in part because of the drastic fall in ICT prices in the past 10 years, which has made computing, telephony, and Internet affordable for SMEs (iConnecT Online, 2007). In India, for example, mobile phones are enabling fishermen to find the most profitable market in which to sell their daily catch. This opportunity to sell where demand is greatest has eliminated much waste and variations in market prices, causing consumer prices to fall by 4 percent and the fishermen's profits to rise by 8 percent. (Economist.com, 2007).

Using data from 1984-1996, Correa (2006) examined the effects of ICT in the United Kingdom. She found that most industries benefited from the incorporation of advanced telecommunications technology. Advanced ICT had spillover effects for the economy as a whole, in no small part because of lower prices for numerous products. For example, investments in advanced telecommunications lowered prices for basic utilities by 4.3 percent, for transportation services by 10.8 percent, for financial institutions by 27.3 percent, and for telecommunication providers by 56 percent. Overall, prices in the economy were 14.1 percent lower because of the application of advanced telecommunications. In terms of productivity, Correa (2006) found that applying advanced telecommunications improved productivity in the manufacturing sector 31 percent, improved productivity in construction 59 percent, and improved productivity in the financial sector a dramatic 486 percent. Productivity overall improved over 100 percent.

Another way that ICT development has stimulated economic growth is through encouraging investment. Jorgenson (2001) and Jorgenson and Vu (2007) show that declines in information technology (IT) prices were key drivers in the resurgence in economic growth around the world and that the greatest gains were from businesses investing in information technologies, not from changes in those businesses' productivity. For example, in Jorgenson and Vu's study of 14 major economies in the world and the world's seven primary economic regions, he finds that productivity growth accounted for less than one-fifth of the total (economic growth) during 1989-1995, while investment accounted for more than four-fifths. "Similarly, investment growth contributed almost three-quarters of growth from 1995-2000 and more than three-fifths from 2000-2004" (Jorgenson and Vu, 2007). In summary, Jorgenson's and Vu's research demonstrates that IT contributes to growth primarily by transforming an economy. This transformation provides growth by stimulating investment, not merely by making businesses more productive in doing the same thing.

As Holt and Jamison (2008) explain, the impacts of ICT include innovation in addition to productivity and investment. Indeed, as Schwab and Porter (2007) explain, countries

with the most competitive economies are those that are innovation-driven. Success in innovating depends on a country's speed in adopting the latest communications technologies and incorporating such technologies into their businesses to create new products and processes.

Van Ark and Inklaar (2005) provide further insights into the relationship between ICT investments, productivity, and innovation. They find that the effects of ICT within a country may be U-shaped. An initial upswing in productivity is followed by negative productivity growth for a period as businesses learn how to exploit the new technology. During that period, businesses invest in ways that do not immediately translate into added productivity as they reorganize their operations and make personnel changes. After this learning period, the businesses are able to create new products and new ways of doing business, resulting in a higher overall impact of ICT.

ii. Impacts on National Income, Jobs, and Business Development

The studies on productivity, investment, and innovation to date have focused on the impacts of ICT, presumably because the impacts take time to develop and the history of broadband is short. However, some studies are beginning to show that broadband can impact national income.

Crandall *et al*. (2007) applied a cross-sectional data analysis of US broadband penetration data to determine the economic impact of broadband deployment on growth in state-level gross domestic product (GDP) and other economic variables, finding that increasing broadband lines per capita increases GDP. Ford and Koutsky (2005) corroborate this finding with their analysis of a Florida county served by municipal (as opposed to privately provided) broadband. Ford and Koutsky assert that the county experienced a 128 percent growth in sales per capita more than its peers due to the municipal broadband network.[17]

Gillett *et al*. (2006) performed a study for the US Department of Commerce using a cross-sectional panel data set of communities disaggregated by zip code, to analyze the effects of broadband on US communities between 1998 and 2002. The analysis was based on communities with broadband availability in December 1999, and did not distinguish between the type of provider, technology, or speed level. The authors found that broadband contributed to greater job growth and a greater number of businesses than otherwise would be expected without broadband. Crandall *et al*. (2007) also examined job impacts, concluding that increasing broadband penetration increases the number of jobs.

Like the study by Gillett *et al*. (2006) and Crandall *et al.* (2007), Shideler *et al*. (2007) does not address broadband use but rather broadband deployment, and none of the studies differentiate broadband speeds. Still, Shideler *et al*. find that broadband availability contributes to employment growth in most industries to some degree. Ford

[17] As Holt and Jamison (2008) explain, such studies face challenges with respect to the selection of comparable counties because the economies of Florida's counties were affected differentially by the aftermath of attacks on the World Trade Center in New York in 2001 and by hurricanes in 2004.

and Koutsky (2005) corroborate this finding. Additionally, Van Gaasbeck *et al*. (2007) perform a similar analysis using counties in California during the years 2001 – 2006. They find that broadband deployment contributed to employment growth and total payroll growth.

Clearly research has proven that advanced communications technologies have a significant economic impact across countries and increasingly so, as such advanced technologies are more rapidly deployed. Unfortunately, rarely does any research include usage or adoption patterns, and deployment may be considered an imperfect proxy for actual broadband use.

iii. Impacts on Education and Health Care

We do not attempt to provide a comprehensive review of the effects of broadband on education and health care; instead, we highlight some key studies that inform us on the merits of developing broadband indices, which we address below.

One set of studies on the impact of broadband on education has been the reports commissioned by Becta (British Educational Communications and Technology Agency). In the first commissioned report, Underwood *et al*. (2004) focused on largely qualitative evidence from a small sample of schools in the U.K. The goal of the study was to identify potential benefits of a broadband-enhanced learning environment including effective use of video conferencing and online interactions. In the second study (Underwood *et al*., 2005), the authors found that broadband changes the way pupils learn and construct their work, changes the ways teachers organize lessons and work with colleagues, and changes the way schools administer courses. Following the studies of how ICT changes businesses, the study found that broadband technologies increasingly are seen as a catalyst for curriculum change, and that such technologies challenge the current assessment system.

A Canadian survey (Selouani and Hamam, 2007) found similar impacts of broadband use in education. The survey respondents indicated that broadband provided e-learning opportunities, increased research capabilities for students, and allowed for increased long distance interactions for students.[18]

In early research on the impacts of broadband on health care, Wright (1992) showed that broadband could improve management and bring production efficiencies. In a study of the effects of mobile wireless for CTIA-The Wireless Association®, Entner (2008) found that "In 2005, productivity improvements due to use of mobile broadband solutions across the U.S. health care industry were worth almost $6.9 billion. By 2016, that number will triple to $27.2 billion, or twice the size (according to Bizstats.com) of the current vocational rehabilitation sector of the health care industry." A U.K. report (Broadband Stakeholders Group, 2004) found that broadband can improve healthcare for the elderly by allowing them "the support they need to live at home, rather than in

[18] The study also found that broadband decreased travel, gave access to online newspapers, and allowed for financial transactions.

hospital or care homes." Applications include tele-monitoring of health conditions and scheduling appointments.

E. Implications for Broadband Indices and Rankings

As we indicated previously, broadband indices and rankings have proven to be problematic and controversial. Wallsten (2008) and Ford, Koutsky, and Spiwak (2008) highlight problems with the OECD's broadband index, including problems of variations in household size, geographic and economic endowments, and incomplete data. In addition to these deficiencies specific to the OECD index, any broadband index would suffer from the intellectual misconduct of valuing in a single number the multiple effects of the variety of broadband services. The impact studies that we cite above show that broadband affects jobs, income, productivity, education, and the like, and that the effects are not uniform across segments of the economy. A scalar cannot adequately express these multidimensional effects, and indeed may not even be informative. Furthermore as our immediate study and some of the studies that we review above indicate, while different broadband technologies are at least somewhat substitutable, they are not homogeneous, meaning that they cannot easily be combined into a single numerical representation without first converting their quantities into comparable units. Lastly, even if such conversions are made, no single conversion factor can represent all impacts that are of importance.

F. Consideration of Reports and Studies Particularly Relevant to Portugal

In March 2000 the Lisbon strategy proposed to create among the EU Member States the most competitive and dynamic knowledge-based economy by 2010. The strategy included a focus on extending Internet connectivity to result in widespread Internet access availability at reasonable prices. In 2007, the Strategic Report on the renewed Lisbon strategy set targets for high speed Internet usage of 30 percent by 2010, and the June Council Conclusions added a target penetration rate of at least 15 percent. Finally, the Council Conclusions commissioned a Broadband Performance Index designed to benchmark Member States on factors deemed important (such as speed and affordability). Two primary drawbacks, however, are that wireless is not included in the index (or data measuring compliance with the Council Conclusions), and penetration rates do not include information on availability. It is within these conditions that the Portugal broadband Internet access market operates.

Broadband access to the Internet was offered in Portugal through cable modem technology beginning in 1999. In 2000, the telecommunications industry was fully liberalized, and local loop unbundling was mandated in 2001. Subsequently, the telecommunications incumbent Portugal Telecom (PT) began offering broadband Internet access through ADSL, and currently offers broadband Internet access both through DSL and cable.[19]

[19] Pereira and Ribeiro (2006).

Among EU Member States, Portugal has the highest ratio of fixed broadband subscribers using a provider other than the incumbent. However, Portugal also has one of the lowest growth rates in fixed broadband. In fact, by the broadband performance index developed, Portugal ranks poorly - in the fourth of five clusters. The 2008 ITIF Broadband Rankings listed Portugal as 18th, with a composite score only slightly higher than average (10.15 compared to an average of 10.00).[20] These seeming discontinuities can be reconciled with consideration of mobile broadband Internet access. Currently Portugal residents increasingly are using mobile broadband. Portugal makes intensive use of mobile communications services with 58 percent of voice traffic originating from mobile networks. The mobile market also is credited with exhibiting low churn and high customer loyalty. It appears, then, that mobile technologies are important to consider in any measure of broadband Internet access within the country.

A 2008 working document (Indexing Broadband Performance) defines broadband penetration as the number of fixed broadband lines divided by the national population. This measure excludes mobile broadband, which for Portugal may be significant. Pereira and Ribeiro (2006) estimate demand elasticities for broadband Internet access and find that broadband and narrowband access are substitutes in Portugal. This suggests that mobile broadband Internet access should be included in datasets and measurements of deployment and adoption. Two recent studies will be useful in helping to identify whether mobile broadband Internet access is indeed an important component to Portugal's broadband Internet deployment and adoption, and in calculating the magnitude of that importance, if any.

The first paper is a 2007 study by Cardona, Schwarz, Yurtoglu and Zulehner. This paper analyzes residential demand for Internet access in Austria, with a focus on both fixed and mobile broadband Internet access, specified by type (DSL, cable, mobile, and narrowband). The study analyses residential demand for Internet access in Austria using survey data collected by the Austrian Regulatory Authority for Broadcasting and Telecommunications. They include DSL, cable, and mobile broadband via Universal Mobile Telecommunications Service (UMTS) or High-Speed Downlink Packet Access (HSDPA) to determine appropriate market definitions for these advanced services. Results of the study indicate that the different broadband technologies are in fact substitutes in that the technologies constrain one another. Elasticity for DSL is given as -2.545, and elasticities for mobile broadband and cable are similar, though broadband services are found to be more elastic than narrowband services (as found by others).The authors assert that because mobile broadband was not highly utilized, it was not evaluated against DSL and cable together (i.e., it was singled out as narrowband was).

The second relevant paper is by Lee and Marcu (2008). This paper uses 1999-2005 OECD data to analyze the factors that influence the diffusion of fixed and mobile broadband. The authors focus on variables capturing the unbundling of the local loop and the existence of platform competition, as well as socio-economic and demographic factors. They find that PC penetration, population density, and broadband content are associated with faster fixed broadband diffusion, and that market-based multiple

[20] ITIF 2008.

standards policy contributes to the diffusion of mobile broadband services. The paper also provides an informative summary of primary empirical studies on fixed and mobile broadband studies; however, almost all of the studies of mobile broadband were conducted in 2002 or before, prior to mobile broadband Internet access being utilized in any statistically significant degree.[21] Lee and Marcu attempt to discern whether fixed and mobile broadband are substitutes or complements, but the results are inconclusive.

These studies are the primary references that inform the models that we develop. Following is a discussion of the data that we use for our study.

III. Data

In this section we describe the data that we use for our analysis. We draw upon data largely obtained from three surveys conducted in Portugal in 2006 and 2008.[22] The surveys were stratified by geographic regions of the country that correspond generally with the Nomenclature of Territorial Units for Statistics (NUTS II) geographical coding used by the European Union to indicate divisions of countries for statistical purposes.[23]

A. Socio-Economic Characteristics of Regions in Portugal

In order to properly analyze our data, it first is important to characterize that data so that we may fully understand socio-demographic and possibly geographic factors that might affect broadband diffusion and adoption. In the OECD's Territorial Review (2008), Portugal was described as having the fourth highest level of regional disparity in terms of GDP in the OECD.[24] Such disparity indicates that significant differences in other characteristics may exist, and therefore caution must be taken to correctly analyze broadband adoption and diffusion across regions. Below we provide a brief discussion of the representation of respondents in our sample.

Our data is disaggregated into nine regions that correspond generally to the seven regions indicated in Map 1[25]. Map 1 does not differentiate Grande Porto or Interior (which are part of Centro), and Grande Lisboa (which is part of Lisboa). Table 1 maps

[21] See Lee and Marcu (2008), page 19.

[22] Specifically, we use data from the following surveys: 2006 Consumo de Banda Larga survey (broadband consumption survey, abbreviated as BCS), 2008 Inquérito ao Consumo das Comunicações Electrónicas survey (survey of consumption of electronic communication services, abbreviated as ICSCE), and 2008 Índice Europeu da Satisfação de Consumidor (European consumer satisfaction index, abbreviated as ECSI). Surveys also were conducted in 2007 however that data was not utilized in our analyses because we were unable to match survey responses to price data (which would have allowed us to generate price elasticities) and could not generate a panel of all three years of data due to differences in survey design (see the Executive Summary for additional detail).

[23] Although there is a NUTS II categorization in the 2006 survey, we chose to use an alternate geographic segmentation from that survey because the latter allowed more categories and the methodology section of the survey presented the number of observations by region according to that categorization. A listing of the number of observations and frequency by region for each categorization is provided in the Appendix (Tables A.2.1 and A.2.2)

[24] See OECD (2008), page 41.

[25] Map from ICP_ANACOM from the Instituto Nacional De Estatistica available at www.ine.pt.

the nine regions from the survey to the regions shown in Map 1, and provides population per square kilometer and per capita GDP for each region.

Name in Survey	Alternate Name in Above Map	Population in Millions (% of the total)	Area (km^2)	Population Density 2007 (No./ km^2)	GDP per Capita - Current Prices 2007 (base 2000 - €1.000)
Açores	Região Autónoma dos Açores	0.2 (2%)	2,322.00	105.1	13.7
Alentejo	Alentejo	0.8 (7%)	31,551.40	24.1	14.7
Algarve	Algarve	0.4 (4%)	4,996.00	85.3	16.1
Centro Litoral	Centro	2.4 (22%)	28,200.40	84.6	13.1
Grand Lisboa[a]	[Sub region of Lisboa]	0.6 (6%)	85.00	6,650.9	25.2
Grand Porto[b]	[Subregion of Norte]	1.6 (15%)	817.00	1,924.3	n/a
Interior[c]	[Subregion of Centro]	n/a	n/a	n/a	15.3
Madeira	Região Autónoma de Madeira	0.2 (2%)	801.00	308.0	19.6
Norte Litoral	Norte	3.7 (35%)	21,284.60	176.0	12.2

a., b, c.: population density data from Instituto Nacional de Estatistica, available at ww.ine.pt; GDP data from Eurostat News Release (2009). Remaining data provided by ANACOM.

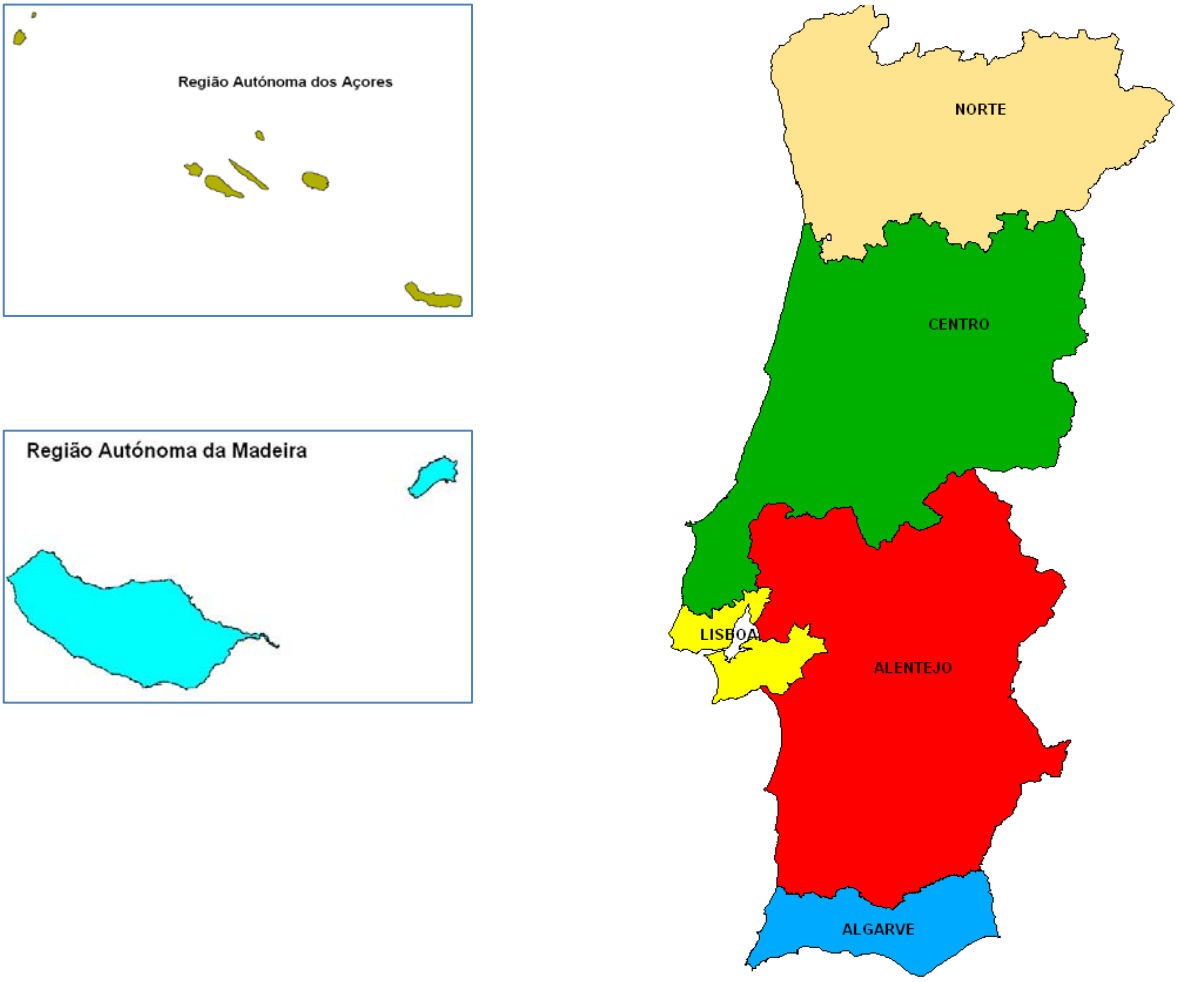
Table 1. Primary indicators by region, 2006

Our analyses are based on the regions as named in the survey rather than on the geographical designations shown in Map 1. Therefore, the primary demographic indicators provided in Table 1 should be considered as reference information useful for categorizing results of our analyses rather than precise factors used in such analyses.

B. Socio-economic Characteristics of Data Included in Our Analyses

Our data are largely obtained from the surveys conducted in Portugal. The 2006 survey titled “Consumo de Banda Larga” was conducted through telephone interviews using a computer assisted telephone interview (CATI) system. The questionnaire was

developed by ICP-ANACOM to obtain information on broadband deployment, adoption, and customer satisfaction, and was adapted by MetrisGfK, which undertook the survey. The field work was completed between 27 October and 21 December 2006 by 65 interviewers, who were recruited and trained by MetrisGfK to conduct the study. All calls were initiated between 18h and 22h.



Map 1. Regions of Portugal

The sample consists of approximately 8,600 responses from interviewees aged 15 and older who reside in Portugal. Households that were called were selected randomly starting from a stratification matrix that included the region and habitat of the population settlements. The matrix crossed the variables gender, age, and education in agreement with the categorization requested by ICP-ANACOM in order to guarantee a proportional distribution of the sample for each region relative to the Portuguese population in general. This method of selection appears to have been successful. Tables 2.1 and 2.2 provide summary statistics of key demographic and socio-economic indicators by region as represented in our 2006 Consumo de Banda Larga (BCS) survey and 2008

Inquérito ao Consumo das Comunicações Electrónicas (ICSCE) survey samples, respectively.

Region	Number Obs. & (% of total)	Age	Education[a]	Two or More Cars[b] *(1 = yes)*	Home Internet Use	Access Internet by Phone (given home use)	No Computer
Açores	189 (2.1%)	42.07	4.69	0.13	29%	84%	6%
Alentejo	421 (4.8%)	49.53	4.74	0.15	30%	60%	2%
Algarve	325 (3.7%)	47.19	4.22	0.09	31%	74%	7%
Centro Litoral	1355 (15.6%)	47.46	4.19	0.24	41%	48% (50% cable)	2%
Grande Lisboa	2244 (25.9%)	46.41	3.80	0.20	46%	46% (51% cable)	4%
Grande Porto	1106 (12.7%)	43.56	3.96	0.34	49%	81%	4%
Interior	1241 (14.3%)	48.04	4.60	0.35	36%	72%	4%
Madeira	197 (2.3%)	43.68	4.62	0.03	43%	80%	1%
Norte Litoral	1598 (18.4%)	42.42	4.46	0.40	40%	38% (61% cable)	3%
Total/Average	8676	45.73	4.22	0.27	41%	61%	3%

a. 1 indicates that the head of the household has a university education (and is the reference group); 2 = polytechnical institute graduate; 3 = high school graduate; 4 = completed nine years of study; 5 = completed six years of study; 6 = completed elementary school; 7 = uneducated/illiterate.
b. This variable serves as an indicator of wealth in our analyses.
Source: authors' calculations based on 2006 BCS.

Table 2.1 Means of responses by region for key socio-economic variables, BCS, 2006

Education levels vary across the regions, with the highest education levels (indicated by low means in Tables 2.1 and 2.2) being in the most urban and highest income areas (Grande Lisboa and Grande Porto), and the lowest education levels being in some of the lowest income regions (for example Madeira and Alentejo). In our econometric models we use cars per household and ownership of a dishwasher as indicators of wealth or income. Other factors influence both these choices, such as whether the household is in an urban area and how many people reside in the household; however,

our models control for these factors, so the remaining variation should be an indicator of income.

Region	Number Obs. & (% of total)	Age	Education[a]	Dish-washer[b] *(1 = yes)*	Home Internet Use	No Computer
Açores	780 (21.67%)	48.17	5.92	0.31	30%	48%
Alentejo	170 (4.72%)	51.76	5.71	0.42	31%	55%
Algarve	87 (2.42%)	47.62	6.06	0.25	14%	85%
Centro	493 (13.69%)	51.83	6.22	0.33	21%	60%
Lisboa	591 (16.42%)	47.47	5.32	0.49	39%	43%
Madeira	780 (21.67%)	43.99	5.96	0.17	32%	49%
Norte	699 (19.42%)	41.33	5.71	0.26	22%	62%
Total/Average	3600	46.48	5.82	0.31	29%	53%

a. 1 indicates that the head of the household has a university education (and is the reference group); 2 = polytechnical institute graduate; 3 = high school graduate; 4 = completed nine years of study; 5 = completed six years of study; 6 = completed elementary school; 7 = uneducated/illiterate. In this table we provide disaggregation by region; in the estimates we use three categories (primary school, high school, and university) because we have too few observations to split the data into as many categories as is done with the 2006 data.
b. This variable serves as an indicator of wealth in our analyses.
Note: There is no column for "Access Internet by Phone" as in Table 2.1. This is because only 103 individuals reported having narrowband. Of these, 77 did not say whether they had another type of Internet access or not. Of the other 26, all but 5 had another type of access that was their main type of access. Hence, the small number of observations and many missing observations render this information unreliable in our view if we further split it by region.
Source: authors' calculations based on 2008 ICSCE.

Table 2.2. Means of responses by region for key socio-economic variables, ICSCE, 2008

On average, in 2006 about 40 percent of Portugal households accessed the Internet from their homes. Of those with home Internet access, 61 percent on average used dial-up Internet access (as indicated by the "Access Internet by Phone" column), but that proportion is shrinking. Norte Litoral, Grande Lisboa and Centro Litoral had greater home Internet access via cable than by phone (as indicated in parentheses in the second-to-last column of Table 2.1). Lack of a computer at home does not appear to be an obstacle to Internet access as on average only 3 percent of households reporting not having a computer.

Table 3 provides summary statistics for the primary characteristics data and additional variables for the aggregated sample from the 2006 survey.

Variable (2006 BCS survey data; all respondents)	Observations	Mean	Standard Deviation	Minimum	Maximum
Age	8676	45.73	18.82	15	97
Gender (1=male; 2=female)	8676	1.52	0.50	1	2
Education (1= university; 7=illiterate)	8676	4.22	1.95	1	7
Employed (1=employed; 2=unemployed)	8676	1.61	0.64	1	2
Number in Household	8619	3.70	1.30	1	20
Child in Household (1=yes;2=no)	8676	1.59	0.49	1	2
Have TV (1=yes)	8676	0.99	0.07	0	1
Have Two or More Cars (1=yes)	8676	0.27	0.44	0	1
Have Two or More Homes (1=yes)	8676	0.07	0.26	0	1
Home Internet Use (1=yes)	8676	1.59	0.49	1	2
No Computer (1=has no computer)[a]	5058	0.03	0.18	0	1
Work Access (1=has work access)[b]	5058	0.02	0.15	0	1

a. Question P.6 in the 2006 survey asks respondents who stated they did not have Internet at home the following question: Could you please tell me what is the main reason why you do not have Internet at home? Those who answered "We don't have a computer" are coded 1 here.
b. Question P.6 in the 2006 survey asks respondents who stated they did not have Internet at home the following question: Could you please tell me what is the main reason why you do not have Internet at home? Those who answered "Have access at work" are coded 1 here.
Source: authors' calculations based on 2006 BCS.

Table 3. Summary statistics for survey data, BCS, 2006

The 2008 survey, titled "Inquérito ao Consumo dos Serviços de Comunicações Electrónicas" or survey of consumption of electronic communication services (ICSCE), was conducted by TNS-Euroteste for ICP-ANACOM. Those surveyed were individuals 15 years of age or older, living in a residential household in Portugal. The sample is representative to level NUTS I.[26] There are a total of 3,600 respondents, the majority (approximately 57 percent) from the continent (rather than Açores or Madeira).

[26] NUTS I stands for the Nomenclature of Territorial Units for Statistics, the statistical regions of Europe as defined by the European Union. Additional information is available at: http://ec.europa.eu/eurostat/ramon/nuts/home_regions_en.html. It is the broadest method of geographical coding in that it divides Portugal between the mainland and the autonomous regions of the Azores and Madeira archipelagos. NUTS II (upon which our more detailed geographic data is based) includes the seven regions referenced above.

Households were selected through a proportional random sampling stratification as was done for the 2006 survey, in accordance with the General Census of the Population (2001) of the National Institute of Statistics (I.N.E.). Surveys were conducted by personal interview attended by computer using Computer Assisted Personal Interviewing (CAPI). All surveys were conducted between November 5 and December 29, 2008.

A primary benefit of the 2008 ICSCE data is that nomadic broadband users are included. While the raw number (133 nomadic respondents total) is too small for most empirical models, we are able to discuss possible patterns and compare nomadic usage factors and socio-demographic characteristics with those of fixed and mobile respondents.[27]

We categorize nomadic users based on their responses to 2008 ICSCE survey question Q.93, "What type of Internet connection do you use at home?" Responses were as follows: modem or ISDN (1), ADSL or other XDSL access (2), cable (3), mobile phone or PDA with broadband Internet connection (4), phone connected to Internet through narrowband (5), broadband wireless connections other than mobile phone and PDA (6), data transmission cards (7), and other or do not know, which also were coded responses. By these categories, respondents answering (6) were considered nomadic users (those answering 4 and 7 were considered mobile).[28] Table 4 provides summary statistics for the 133 respondents reporting nomadic broadband use in the 2008 ICSCE survey.

Figures 1 and 2 provide additional insights into patterns in nomadic usage. Nomadic usage is most prominent in the Alentejo region. This region is characterized by average income for the country, relatively low educational attainment, the lowest population density of all regions, and low home Internet penetration. It also has the highest average age. This may indicate that nomadic is a useful form of access for areas for which fixed line broadband is costly to provide (for example due to high marginal cost in the sparsely populated areas) or difficult to afford (as evidenced by relatively low income and education). The data in Figure 2 also indicate that nomadic broadband is more common among highly educated individuals than among others, perhaps indicating that professionals find nomadic access to be suitable to their careers and lifestyles.[29] We examine the relationship between nomadic subscription and hotspot availability later.

Because there are so few observations of nomadic broadband users, statistical significance is not measurable. Our figures do provide guidelines for further consideration of relevant characteristics of nomadic broadband users as data becomes increasingly available.

[27] Of these 133 respondents, ten also had other types of access that they reported using more frequently than nomadic (from question 94). Therefore, for 122 respondents, nomadic was the reported as being the primary method of Internet access.

[28] The frequency of responses is provided in the Appendix in Tables A.3.1 and A.3.2.

[29] Future research may not compare directly with our data because some education designations in Portugal are changing.

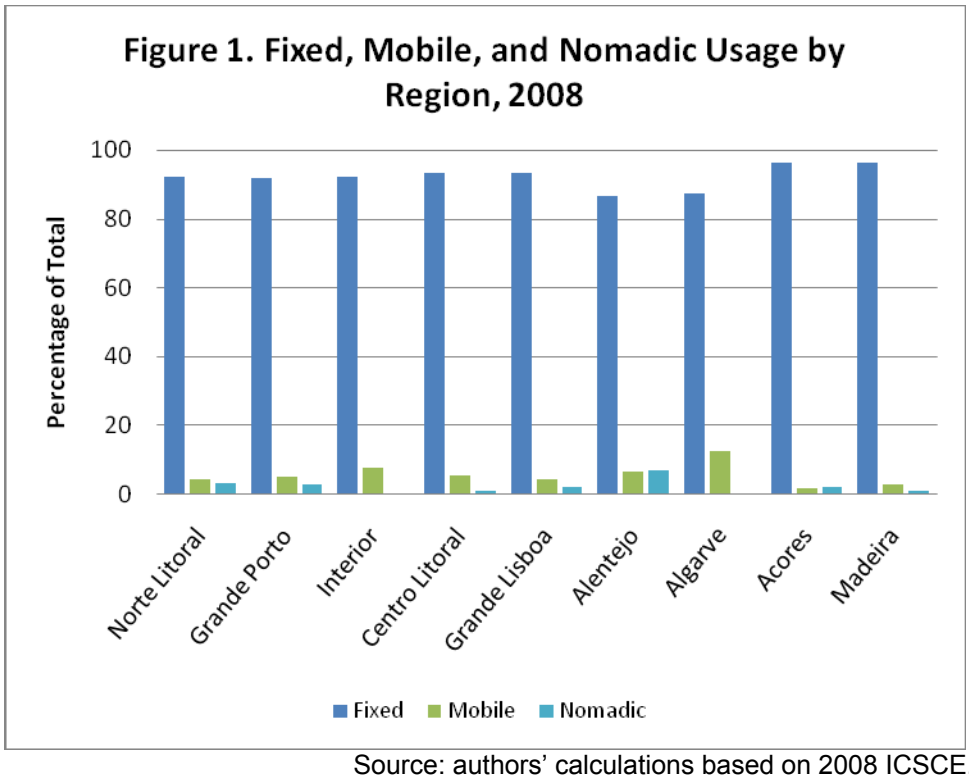
We also obtained data from the 2008 Survey of Consumers of Electronic Communication Services (ECSI), which provides additional information used in various models that follow. Those surveyed were individuals older than 15 years of age living in Portugal in households with fixed or mobile telephone. Surveys were administered over the phone. Households surveyed were randomly selected with equal probability and without replacement. There are a total of 1,243 respondents.

Variable (2008 ICSCE survey data; nomadic respondents)	Mean	Standard Deviation	Minimum	Maximum
Age	32.90	12.80	15	65
Education (1= university; 7=illiterate)	4.51	1.60	1	9
DVD (1 = have)	0.83	0.38	0	1
Gamebox without Internet Access[a] (1 = have)	0.35	0.48	0	1
Frequency of Use (1=daily+; 4= less than weekly)	1.83	0.95	1	4
Level of Overall Satisfaction (1=dissatisfied; 10 = satisfied)	7.14	1.53	1	10
Level of Satisfaction with respect to Speed (1=dissatisfied; 10 = satisfied)	6.97	1.75	1	10
Complaint Filed (1 = yes)	0.076	0.27	0	1
Switched Provider (1 = yes)	0.097	0.30	0	1

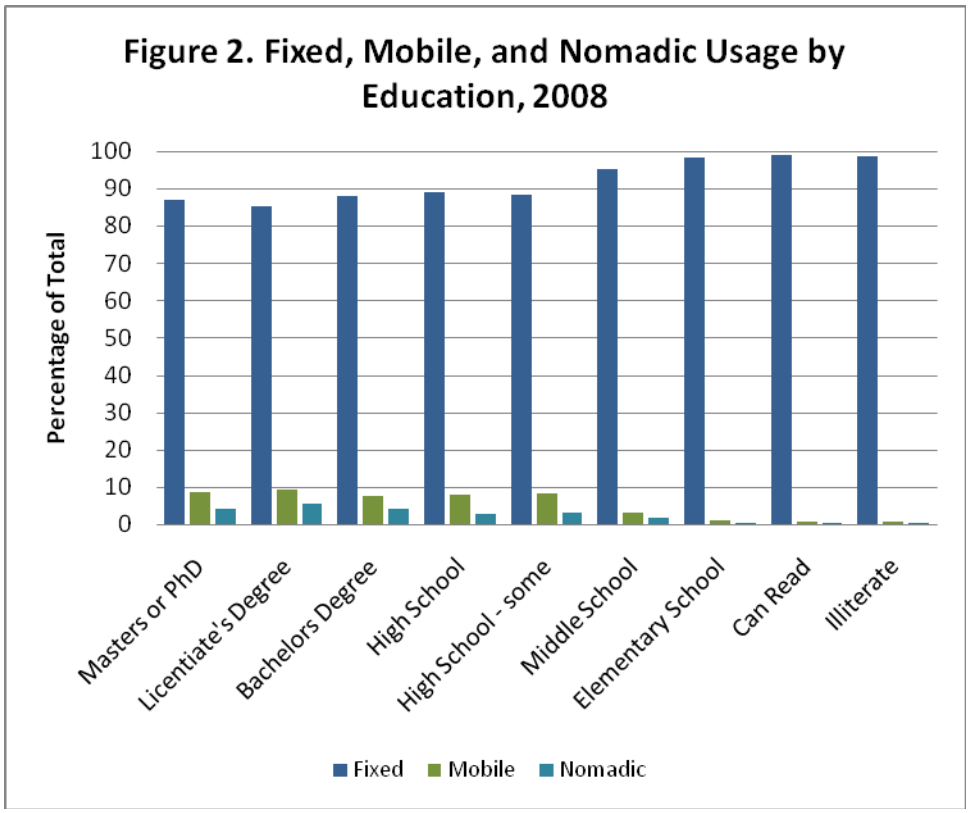
a. There are two questions in the 2008 ICSCE survey about the use of a gamebox: one considers gamebox without Internet access (P12_6), and one considers gamebox with Internet access (P12_7). We used the mean and standard deviation of the former variable. Of the 132 users who had nomadic access, 47 (approximately 36 percent) had a gamebox without Internet access, whereas only 14 (approximately 10 percent) reported having a game box with Internet access. The mean and standard deviation of those (133 users) reporting to have either type of gamebox (with or without Internet access) is 0.402 and 0.492, respectively.

Source: authors' calculations based on 2008 ICSCE.

Table 4. Summary statistics for nomadic broadband users, ICSCE, 2008



Source: authors' calculations based on 2008 ICSCE.



Source: authors' calculations based on 2008 ICSCE.

While this survey data does not include household specific demographic data segregated by region, we do have a limited amount of socio-demographic information. Of the sample, 691 respondents (approximately 56 percent) were male, and the majority (57 percent) was employed; approximately 25 percent were students. Finally, we have information on the educational attainment of respondents. Approximately 33 percent had completed high school, 21 percent completed ninth grade, and 30 percent had earned a licentiate's degree. While the data allow us to conduct some analyses, we are limited in our ability to use models comparable to those employing the BCS, ICSCE, and ECSI data.[30]

Also, while the ICSCE survey data have information about plan speed and type of tariff (prepaid, post-paid, billing by minute), that data does not include how much households actually spent on broadband; therefore, it is not possible to match the data on plan characteristics with the household survey because there are no common identifying variables.[31]

C. Strengths and Weaknesses of the Data

We have identified what we believe to be the strengths of the data with respect to its usefulness for studies that inform mobile broadband adoption and usage patterns. First, household level data allows us to capture socio-economic and demographic characteristics that can be tied to patterns of adoption and usage. Also, we know which respondents switched providers (either due to dissatisfaction or to other reasons) and often, which providers lost and gained customers. Finally, we know the main reason respondents chose a particular Internet provider, or chose not to subscribe to any Internet plan.[32]

We also have identified a number of limitations of the data. The primary drawback is that similar to prior studies and as mentioned above, we have limited information regarding plan characteristics (price primarily, nominal and actual speed[33], and volume of traffic). Indeed the 2006 BCS survey contains no price information. Limited price measures adversely affect our ability to produce robust estimates of demand and the degree of substitution between fixed and mobile broadband, as well as between

[30] The ECSI survey indicates the operator and has some dummies for speed, although this is missing for 569 of the approximately 1200 Internet users. The ECSI survey data does include plans for the same operator with the same speed, and combinations of different bundles, among other data.

[31] Approximately 170 households that have Internet at home could be matched to the plan information collected by ANACOM.

[32] Of note, a consumer with Internet bundled with other services has a lower predisposition to switch providers, and may be tied to fixed rather than mobile broadband due to the nature of bundled options offered in Portugal; therefore, bundles represent an important factor to include in the models. However to date, we have been unable to include the existence of bundles available to residential consumers as only respondents who did not know (or report) the name of their plan were asked questions with respect to bundling. If we include a dummy for bundling we lose approximately 1500 of 2200 observations. We chose to exclude bundling and run the models without the dummy variable because it was insignificant in those cases in which we did incorporate it.

[33] We understand that there may be important differences between business and residential speeds that should be considered. To date, we have been unable to find separate information for residential and business users.

narrowband and broadband. Also, while the 2006 data varies by household, it does not contain information on Internet plan chosen. This prevents us from modeling the choice of different plans, and also the choice between major access categories like narrowband and broadband. Other limitations of the data include too few respondents in several categories (for example only five respondents have broadband over power line, which is not enough observations to include in analysis), and non-informative responses, such as "no particular reason."

IV. Analyses and Results

In this section we provide our analyses and model results.[34] The results of the models are robust and provide interesting insights into broadband usage. These results are provided and discussed based on the objectives as set forth by ICP-ANACOM. Complete model results are provided in the Appendix, also separated by objective.

A. Identification, Comparison, and Analysis of the Adhesion Factors of Fixed, Nomadic, and Mobile Broadband.[35]

Analysis of adhesion, or customers' propensity not to change service providers, is important for understanding how markets are performing. A tendency for customers to change providers implies that customers perceive that the possible benefits of changing providers are greater than the cost and risk of changing providers. The possible benefit of changing is the difference between what the customer experiences as his or her net consumer surplus with the current provider and the expected net consumer surplus with a new provider, where net consumer surplus is the difference between value that the customer believes the operator provides and the price the customer pays. If the benefit provided by the current provider is close to what the customer thinks might be provided by alternative operators, then customers are less likely to change providers. This might happen, for example, if customers perceive that operators provide nearly homogeneous services and similar prices. A customer might perceive significant differences in provider benefits if the customer has recently had a negative experience with a provider such as a significant service outage or impolite customer service representative; service quality

[34] We note at the outset of our analysis that some of the data represents subjective opinions and impressions of the respondents, including statements about what they intend to do. For example, in the next section we examine respondents' statements about their intent to change service providers. Survey respondents' answers to such questions can be imprecise. Cummings et al. (1995) find that when survey respondents are asked whether a product is worth a particular price, more respondents will say "yes" if they are told they have no obligation to buy the product at the stated price than if there is an obligation to purchase at the price. In the case of the survey data we use, respondents' statements concerning their satisfaction, usage and uses, and intent to switch providers might be imprecise. If the errors in their answers are random, then the effect on our research is to decrease the confidence we can place in our statistical results leading us to understate the validity of our findings. If the errors are systematic, in other words, if respondents consistently understate usage, then the effect on our research is to bias our results either up or down, depending on the direction of error. Since we cannot know whether respondents made errors in their answers and, if they did, the direction of those errors, we cannot do better than report our results with this caveat.

[35] Nomadic broadband will be considered at the end of each relevant section where feasible. Nomadic data are from the 2008 ICSCE survey.

has declined, possibly leading to the belief that the decline is unique to the current provider; fresh advertising by alternative providers extol value that the customer does not receive from the current provider; or acquaintances have strong recommendations for alternative providers. Note that a perception of nearly equal benefits does not mean that quality and satisfaction are high; the perception simply means that the current experience is thought to be equivalent to the alternatives.

In addition to benefit analysis, customers consider the costs of change and the risks when assessing whether a switch in service providers might be beneficial. There are at least two types of costs. One type of cost is the switching costs, including any service termination fees, costs of establishing new payment systems, and any new equipment that might be required, for example, in the case of switching from DSL to cable modem. The second type of cost is search costs, namely the cost a customer would incur to learn about service alternatives. Search costs would be high if operators did not advertise or if service territories were unclear. Risks of service change reflect the uncertainty that customers assign to the benefits they perceive and the costs. Uncertainty exists because the customer cannot completely experience the service before purchasing it. For example a customer might expect that an alternative operator has better service and prices than the customer's existing provider, but if the customer believes there is a high probability that the alternative provider's service quality might actually be worse, the customer's risk aversion might keep him or her from switching providers.

To analyze customers' propensity to change providers, we use 2006 BCS survey data to first consider factors that influence a customer's decision to subscribe to home Internet access and then address the decision to subsequently consider switching methods of access, and/or switching providers. Customers are characterized by preferences and limitations. Among those preferences for broadband access is the degree to which they are satisfied with using Internet access elsewhere, for example at work, school, or a library. Limitations include income,[36] time availability, computer capacity, and broadband availability.[37] Of those survey respondents who were not considering changing their Internet access type from narrowband to broadband, the vast majority (72 percent) indicated that none of the possible limitations for upgrading to broadband affected their decision to remain with their current provider; they simply had no reason to switch. The greatest limit to switching to broadband cited was high price (12 percent reported that the broadband price is high and/or is not worth the price). Finally, approximately 13 percent were satisfied with their home Internet access because they have alternate access elsewhere (primarily work, then school, then library) and presumably therefore do not have as great a need for broadband at home.

In the 2008 ICSCE survey, the majority (82.3 percent) of respondents without home Internet access stated they were not considering getting such access within the next

[36] The data do not include reports on household income. As stated earlier, in our analyses, we use other indicators, such as the number of cars the household owns and whether the household owns a dishwasher as our gauges for household income.

[37] Computer capacity refers to the technological ability of the computer to effectively operate via broadband connection.

twelve months;[38] only 12.4 percent stated they did not know or did not respond. Of those with home Internet access, the vast majority (1,086 of 1,309 respondents, or approximately 83 percent) had not switched and had not tried to switch. Of those who did switch (only approximately 7 percent), the primary reason was dissatisfaction with their initial provider's price (27 respondents, or 31 percent of those who did switch, reported price as the main reason for switching providers).

In addition to upgrading to broadband, customers may switch providers either to change access type or to obtain better price or quality (as measured in speed, reliability, and billing). As described above, we assert that each customer makes choices between services and between providers based on the difference between the value the customer expects to receive and the price the customer expects to pay, that is to say, net consumer surplus. We anticipate that customers' expectations of greater net consumer surplus from better prices, better quality, or both will be affected by their actual experiences. These expectations could be shaped by many factors, including the length of time that the customer has experienced his or her current provider, knowledge of communications technologies, and exposure to alternative service providers and other consumers.

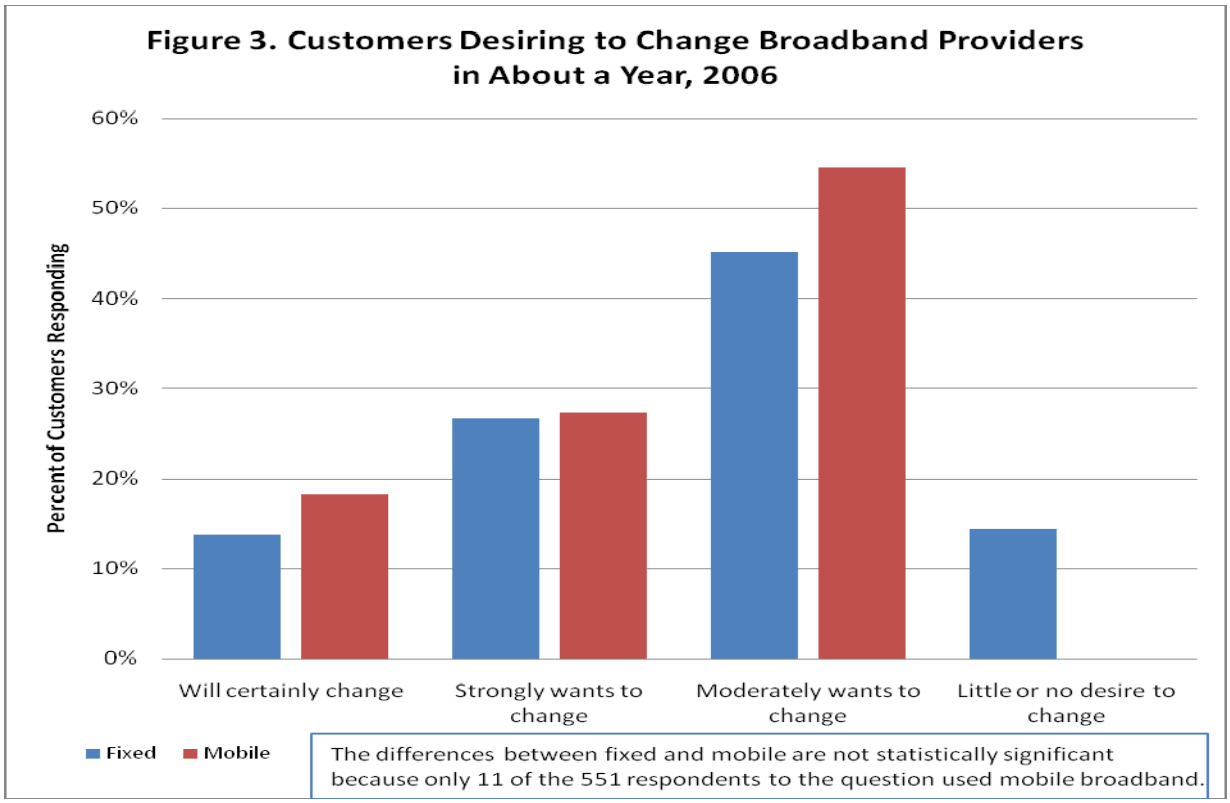
We examine the factors that influence consumers' propensity to switch providers by focusing first on customers who indicated that at some point they have felt that they wanted to change providers. The 2006 BCS survey asked respondents, "To what extent would you say you want to change provider in a year or so?"[39] This question measures the intensity of the desire to switch through four options: will certainly change, strongly wants to change, moderately wants to change, and has little wish to change. We can view the intensity to switch in two ways: as a binary choice in which the first two options imply the respondent is likely to switch and the last two options imply he is unlikely to switch; or, we might view the intensity to change as ordinal in which a higher number (the fourth option – little wish to change) indicates greater satisfaction with the current provider and therefore lower desire to switch.

Figure 3 indicates the responses of fixed and mobile customers with respect to their desire in 2006 to change broadband providers within one year. Interestingly, mobile broadband users are slightly more inclined to want to change providers, although the difference between fixed and mobile broadband users is not statistically significant.

Modeling the decision of mobile and fixed broadband customers to switch providers in 2006 is carried out using consumer characteristics because we do not observe the characteristics of the previous provider or the respondent's satisfaction with the previous operator. Individual and household characteristics are important control variables, but crucial in the decision to switch is the satisfaction of the respondent with the operator's services. We therefore have modeled the impact of dissatisfaction with the operator's services on the respondent's intention to switch providers in the 12

[38] ICSCE 2008 Question Q.119 asks "Is your household considering getting the Internet at home within the next 12 months?" Of the 63.64 percent (2,291 of 3,600 respondents) who reported not having Internet at home, 82.3 percent (1,886 of 2,291 respondents) did not intend to do so within the next year.
[39] Question P.50, 2006 BCS survey.

months following the interview. A drawback of using the intention to switch is that we do not know if the individuals actually do switch.



Source: authors' calculations based on 2006 BCS.

We employ two logit models to analyze the 2006 and 2008 ICSCE survey responses; the first is a standard logit model in which we analyze the intention to switch providers, and the second is an ordered logit model in which we consider the intensity with which a respondent intends to switch providers.[40] The major weakness of the logit is that the choice between alternatives depends solely on the characteristics of those alternatives being compared, excluding the characteristics of any other alternatives possible. In our first model the dependent variable is binary, indicating whether the respondent reported intent to switch providers. Explanatory variables include socio-economic and demographic characteristics, plus data on dissatisfaction with the quality of service and service aspects that induce individuals to switch providers.

Because there are only 105 mobile broadband observations in the 2006 BCS data and 209 such observations in the 2008 ICSCE data, we have limited ability to address intention to switch among mobile broadband users. Thirty-four of these 105 mobile broadband users in 2006 did switch providers; however, we do not have plan specific information, in particular, information about the prior plan (for example satisfaction with the previous plan speed, billing, or reliability) to be able to determine the cause of the switch. Further, as noted above, in the 2008 ICSCE survey while there are more total

[40] A logit regression model represents the choice between mutually exclusive options: for any binary dependent variable y_i and a continuous independent variable x_i, $Pr(y_i=1)=F(x_i' b)$ where b is a vector of parameters to be estimated, and F is the logistic cumulative density function.

mobile observations (209), they represent only 5.81 percent of respondents, and the vast majority of these (approximately 84 percent) have not switched providers and have no intention of doing so in the foreseeable future. Table 5 provides the odds ratios from the 2006 regressions.

Dependent Variable: Intent to Switch Providers	Intent to Switch (n = 2,258)	Intensity of Intent to Switch (n = 471)
Age 66 to 75		7.34** (5.86)
Completed polytechnic school	1.98** (0.65)	
Number in household	0.67** (0.15)	
In Grande Porto= 1 if respondent in Grande Porto		0.35* (0.21)
Norte Litoral	1.76*** (0.35)	1.91** (0.59)
Grande Porto	1.50* (0.31)	2.47*** (0.80)
Interior	1.42* (0.29)	
Centro Litoral	0.58*** (0.12)	
Alentejo	0.33** (0.15)	
Madeira	0.09** (0.10)	
Acores	0.33* (0.21)	
Population > 100,000	1.83** (0.62)	
Complaint = 1 if respondent filed complaint	3.14*** (0.41)	1.58** (0.31)
Satisfied with speed (1 – 4, 4 being very satisfied)	0.49*** (0.06)	0.73** (0.10)
Satisfied with reliability (1 – 4 , 4 being very satisfied)	0.75*** (0.08)	
Satisfied with bill clarity (1 – 4, 4 being very satisfied)		0.76** (0.10)

Only those variables that were significant are reported; complete results are in the Appendix: A-IV.A. 1 and 2. Standard errors are in parentheses.
* Significant at the 5% level; ** Significant at the 1% level; *** Significant at the .1% level
Omitted age group is age 15 to 25.
Omitted education level is university degree.
Omitted region and habitat is Grande Lisboa.
Source: authors' calculations based on 2006 BCS.

Table 5: Intent and intensity of intent to switch providers, 2006

Odds ratios measure the likelihood of an event occurring relative to another event occurring. In this model, the odds ratios represent the likelihood of an event occurring

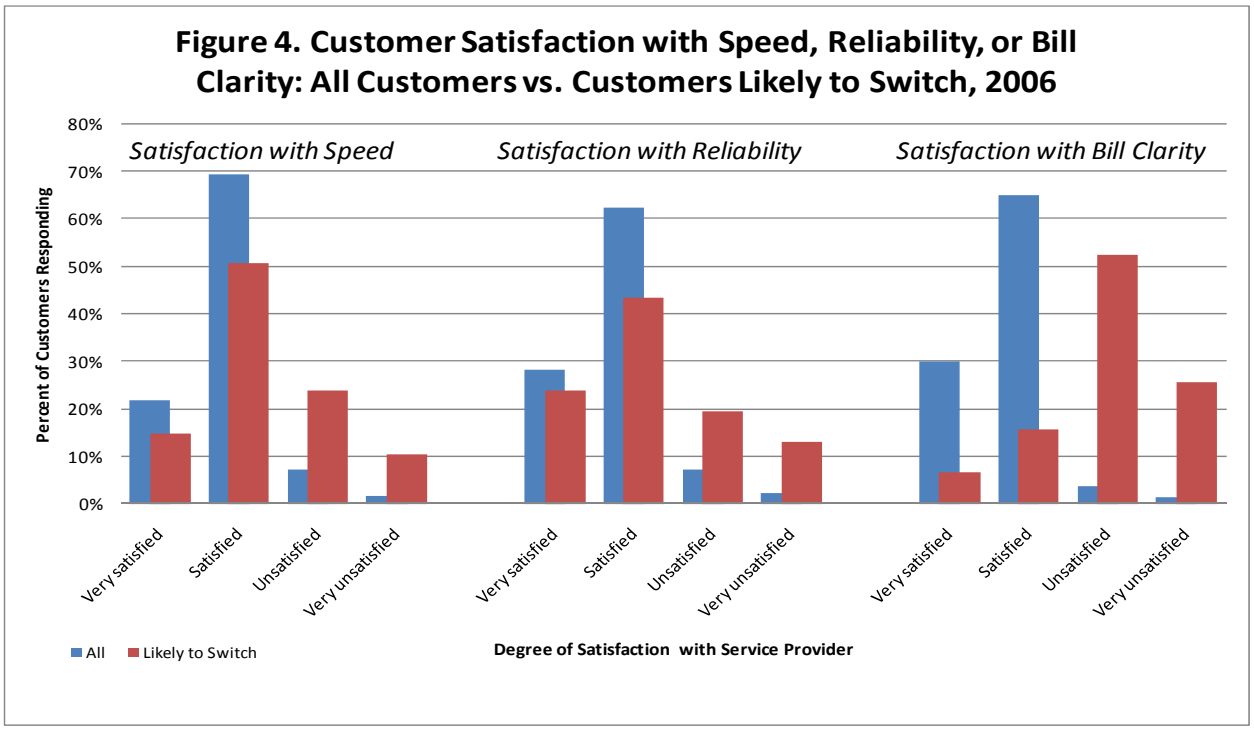
compared to the omitted age group, education level, and region. For example, the omitted region is Grande Lisboa, so the 2.47 odds ratio for Grande Porto in the second column indicates that customers in that region are more than twice as likely as customers in Grande Lisboa to intend to switch providers. If the odds ratio is less than 1, the event is less likely to occur than such occurrence in the omitted group; i.e., a positive association has an odds ratio greater than 1; a negative association as an odds ratio less than 1.

As might be expected, satisfaction with speed and reliability of service make individuals less likely to want to switch. For example, an average customer who is very satisfied with speed is about 50 percent less likely to want to switch providers than is a customer who is merely satisfied with speed. Having filed a complaint also makes one more likely to switch. Regarding education, an interesting result is that those who graduated from a polytechnic institute are more likely to have the intention to switch than those completing a university degree, perhaps because they are more likely to believe that they understand their alternatives, implying a lower risk of change. It also may be that people with university degrees are more traditional than the polytechnic institute graduates, making the university graduates less likely to change their service. Higher income individuals also are slightly more likely to have the intention to switch.

To more closely examine the intensity of intent to switch providers given the empirical results that satisfaction with speed, reliability, and billing clarity affect consumers' desire to switch, we plot customer satisfaction in these three areas against the satisfaction of those more likely to switch. Figure 4 reflects the empirical results provided in Table 5.

Figure 4 illustrates that customers who are likely to switch are similar to all customers in their satisfaction with speed and reliability, but are much less satisfied with bill clarity. Bill clarity affects the intensity of the desire to switch, but not the basic intent (consistent with the regression analyses in Table 5). Among the subset of respondents who reported to be considering switching to broadband, 11 percent connected via cable, 83.7 percent connected via telephone facilities, and 4.4 percent connected via 3G.[41]

[41] This subset of respondents is comprised of those answering yes to question P.16 in the 2006 ICCE survey which asked: "Are you considering switching to broadband in the next 12 months?" Ninety-three people chose yes.

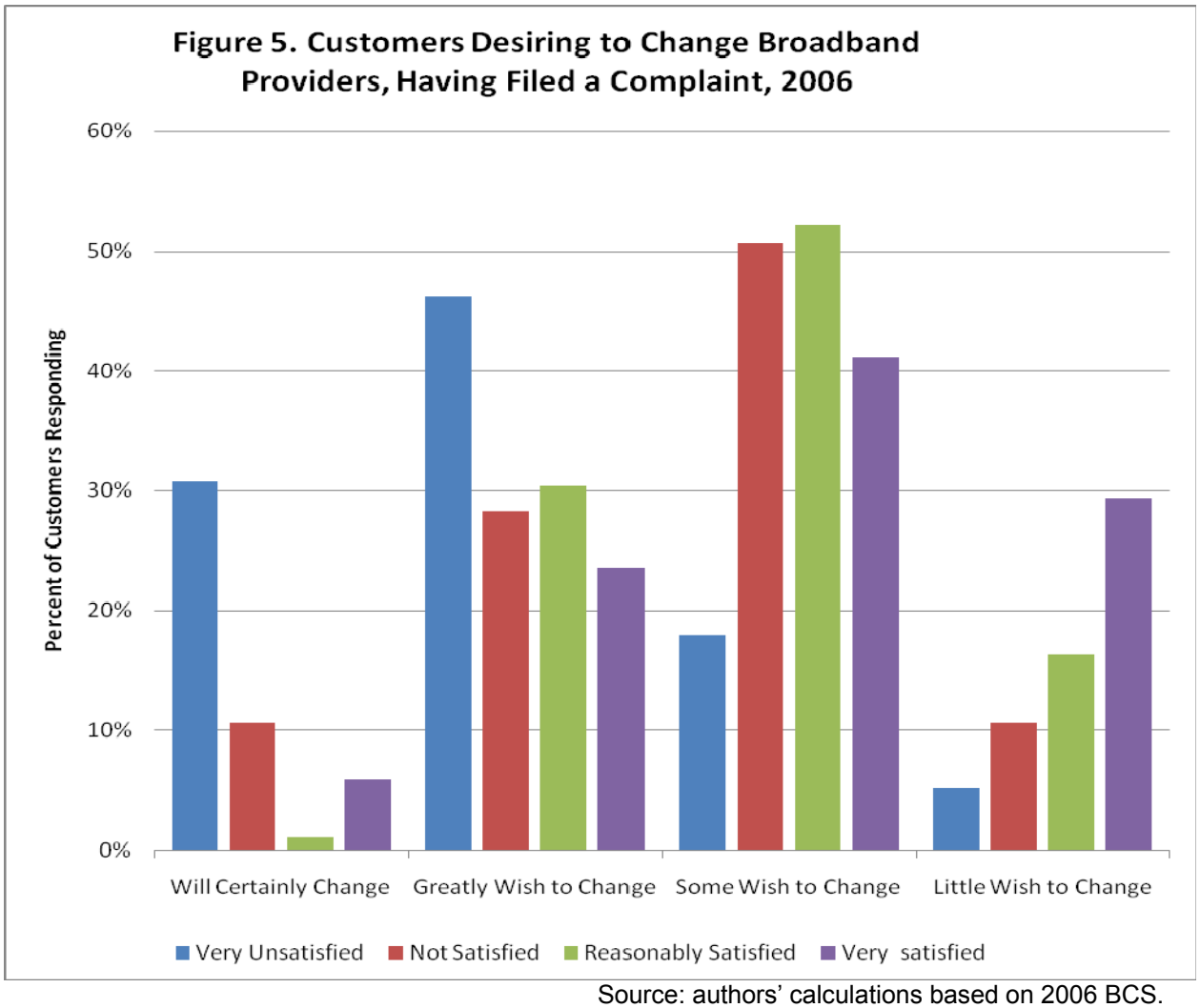


Source: authors' calculations based on 2006 BCS.

Figure 5 indicates those customers who filed a complaint and wanted to change providers, given their level of satisfaction with how the complaint was settled. The figure suggests that customers continue to assess their options for home Internet access regardless of their experiences with complaint resolution. As might be expected, those who were very dissatisfied with how their complaints were handled (only 35 customers in total) were most decidedly interested in changing providers; however, the other groups displayed similar propensity to change overall.

We conclude that customers value speed and reliability more than they do bill clarity. Furthermore, customers who are unhappy with their service are proactive and file complaints with their service providers, although it appears that this does not keep them from planning to change providers.

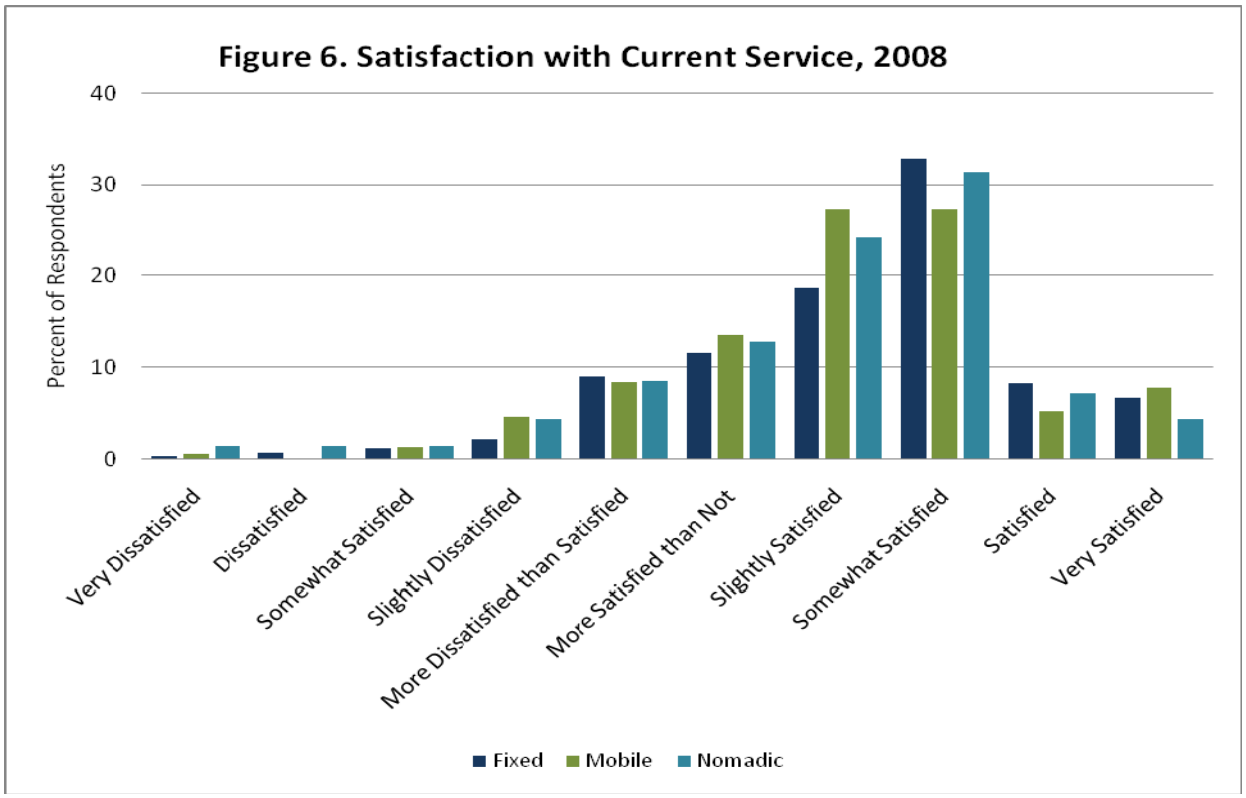
With respect to the 2008 ICSCE survey data, satisfaction with speed is the only comparable variable to the 2006 BCS data characterizing reasons customers might have an intention to switch providers (i.e., the 2008 ICSCE survey does not address reliability and billing). In lieu of the categories of speed, reliability, and billing, overall satisfaction is reported. Figures illustrating these results, and empirical results using satisfaction with overall service from the 2008 ICSCE data are provided in the Appendix (see section A-IV.A).



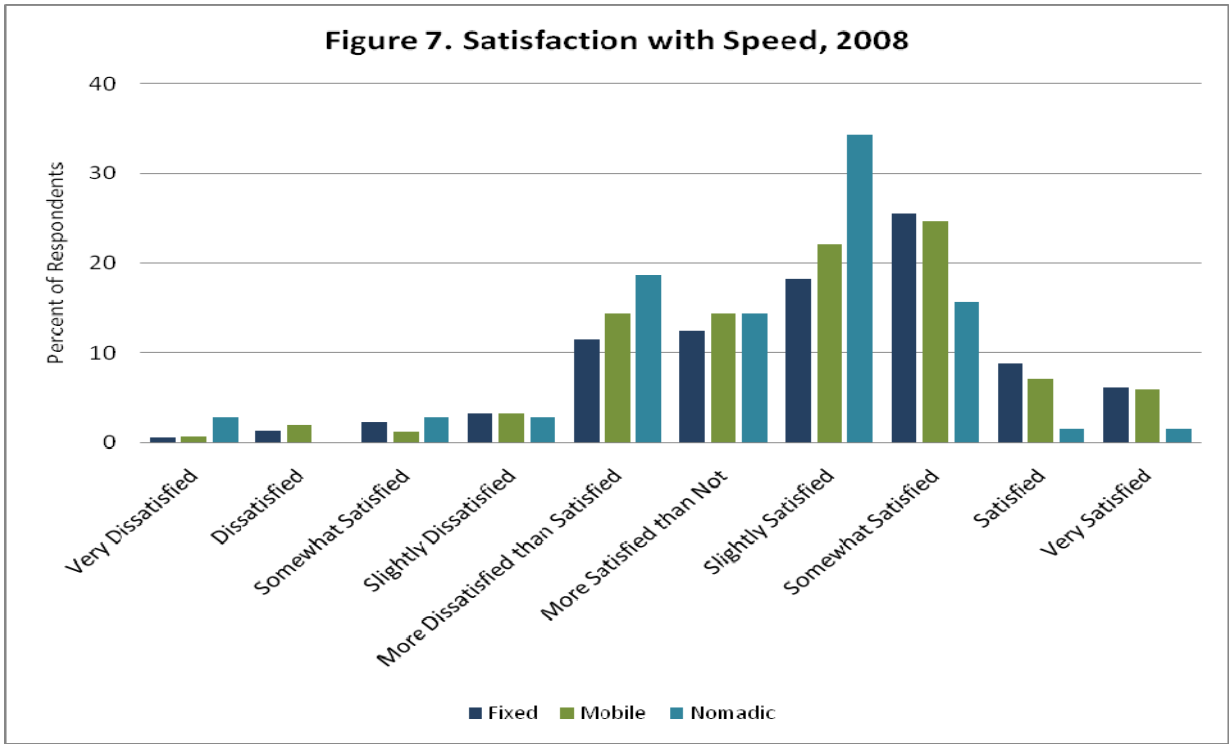
Source: authors' calculations based on 2006 BCS.

Satisfaction with their chosen mode of Internet access also is important with respect to satisfaction. Figure 6 shows respondents' general level of satisfaction with their Internet access in 2008. Customers of all modes of access show similar satisfaction patterns. A large majority are satisfied with their service, although only a few categorize their satisfaction in the range of very satisfied.

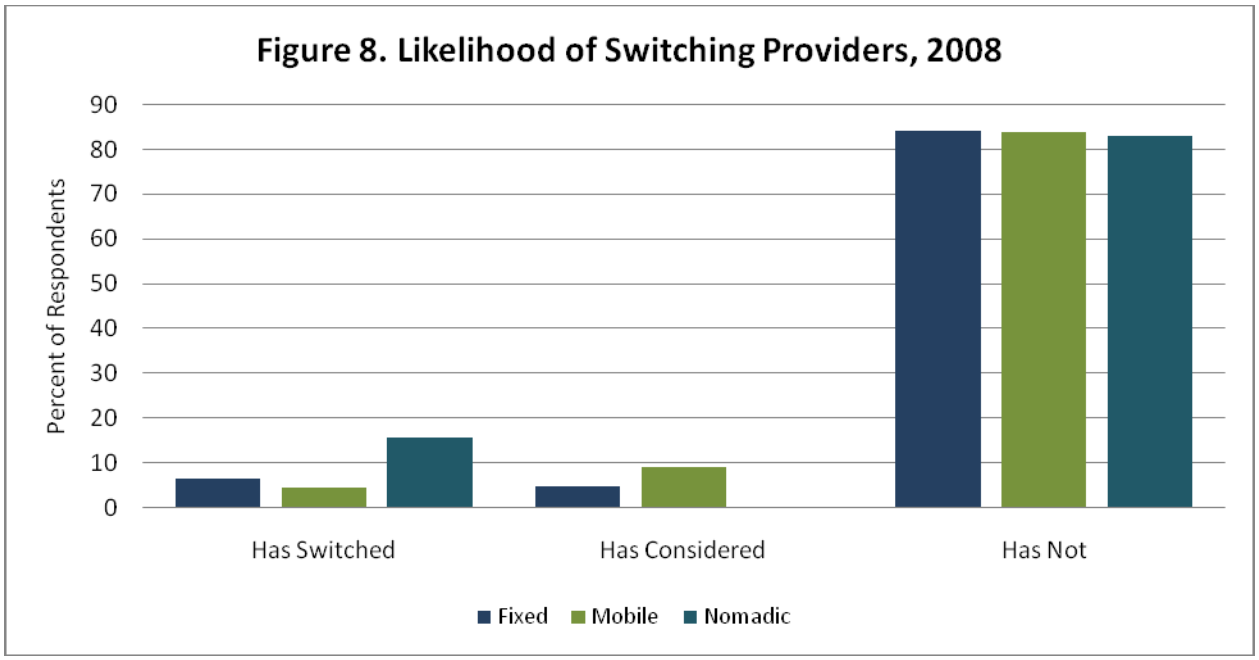
Figures 6, 7, and 8 are based on the 2008 ICSCE survey. Figure 7 relates satisfaction with speed. The pattern here appears very similar to that seen for overall service satisfaction, implying that either speed is an important determinant of satisfaction, or that overall satisfaction is interpreted by customers as satisfaction with speed.



Source: authors' calculations based on 2008 ICSCE.



Source: authors' calculations based on 2008 ICSCE.



Source: authors' calculations based on 2006 BCS.

Figure 8 illustrates the likelihood of switching providers, which is relatively constant across access types. It also shows that most customers do not switch providers; however, the nomadic users had a much greater likelihood of switching providers.[42] Interestingly, none of the nomadic users reported intention to switch and then not doing so. This is an interesting result in that it appears those with nomadic access act upon their desire to switch, while fixed and mobile had a greater likelihood of reporting a desire to switch and yet not doing so. Perhaps this indicates that switching is easier with nomadic access than with other forms.

Alternatively, the difference we do find between nomadic customers and fixed and mobile customers in their propensity to switch might in part be explained by differences in how the service is offered. Some WiFi hotspot providers, such as PT WiFi, offer service bundles that combine mobile voice service with nomadic broadband. This could create a switching cost for nomadic users if the bundling caused them to have to either change mobile providers or change mobile service plans if they wanted to change nomadic service providers. The result could be more stable demand for PT WiFi. In addition the service bundles may encourage customers to purchase nomadic service, thus stimulating demand. It may also be the case that some customers have more than one nomadic service provider, making the notion of switching providers have a different meaning than it would for fixed and mobile broadband customers. More fully understanding the nomadic customers' propensity to switch, and what constitutes nomadic switching, would require more extensive data gathering.

[42] Those respondents reporting nomadic access had approximately the same propensity to file a complaint as their fixed and mobile counterparts: 11 percent compared to 10.9 percent for both fixed and mobile.