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# Broadband un-adopters

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### ABSTRACT

An important but understudied aspect of the current broadband adoption situation is households that once had Internet connectivity but no longer do. These households, termed “un-adopters,” comprised 12% of all non-adopting households as of 2013. In comparison with their “never-adopter” counterparts, un-adopters are significantly more likely to cite cost, the potential to use the Internet elsewhere, and the inadequacy of their computer as reasons for their discontinued use. Using national data from the 2013 Current Population Survey, a multinomial logit model assesses the reasons that these households no longer maintain a broadband connection. The findings suggest that to reach un-adopters, subsidized access may be warranted for households with incomes up to \$40,000, and that programs on broadband awareness may be most effectively targeted towards retirees. These results are reinforced with recent data from the FCC’s Low-Income Broadband Pilot Projects, where approximately 22% of those signing up for the program were previous un-adopters. Understanding and engaging un-adopters will be crucial as the FCC Low-income Broadband program and other adoption-oriented policies move forward.

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## 1. Introduction

Internet connectivity through a broadband, or high-speed, connection has soared for U.S. households since 2000, with adoption rates increasing from 3% to approximately 70% as of 2013 (Fig. 1).<sup>2</sup> As the percentage of non-adopters has shrunk, however, there are more opportunities for households to join a small but relevant group of those who have had their Internet connections discontinued. These households, termed “un-adopters,” comprised 12% of all non-adopters in both 2011 and 2013 – about 3–4% of all U.S. households. This group is in the unique position of having experienced the Internet at home but ultimately failing to maintain that connection. For these households, from an economic perspective, the relevant costs of a residential broadband connection outweighed the benefits. Although clearly relevant to the overall broadband picture, un-adopters have not been featured in many mainstream studies related to broadband adoption. Several recent broadband studies have suggested that future policy efforts should be more focused on encouraging demand, as opposed to past policies more geared towards pushing out infrastructure (Hauge & Prieger, 2010; Katz, Matsaganis, & Ball-Rokeach,

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<sup>2</sup> As of 2015, broadband access is defined by the Federal Communications Commission (FCC) as connections with download speeds of at least 25 megabits per second (mbps) and upload speeds of at least 3 mbps. This definition has changed over time. More generally, broadband connections are viewed as those significantly faster than dial-up modems which provide service at 56 kilobits per second (kbps).

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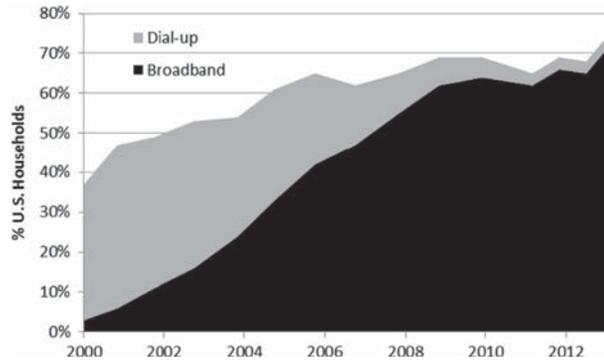


Fig. 1. Residential broadband and dial-up adoption in the U.S., 2000–2014. Source: PEW Internet and American Life Surveys 2000–2014.

2012; Whitacre, Strover, & Gallardo, 2015). As policy efforts (including the restructuring of the federal Lifeline phone program to include broadband, and the Obama administration's recent 'ConnectHome' initiative) move towards digital inclusion for all, understanding and engaging un-adopters will be particularly important given their previous interactions with the technology.

The term "un-adoption" was perhaps first introduced in a broadband context by Dailey, Bryne, Powell, Karaganis, and Chung (2010) in their study of broadband adoption in low-income communities. Their qualitative work included a relatively small survey of 92 low-income non-adopters, and showed that 24% fit the un-adoption classification. Their work also highlighted that income fluctuations among the respondents were a significant driver of the change in broadband status. A more comprehensive look at un-adopters, including how common this practice is among higher-income households, and the underlying reasons for stopping their connection, is generally lacking from the literature. This paper takes a deeper look at broadband un-adopters by using nationally representative Current Population Survey (CPS) data to assess the general characteristics of un-adopters and to explore the reasons for discontinuing their Internet connections. The findings suggest that in terms of un-adopters, cost is a driving factor for households with incomes up to \$40,000, that providing adequate computers should be a focal point for metropolitan areas, and that digital literacy programs should be effectively targeted at retirees and seniors.

The CPS data is supplemented with newly available data from the Federal Communication Commission's Broadband Lifeline pilot program, which subsidized broadband access for low-income households in 14 projects across the country during 2012–2013 (FCC, 2015). At an aggregate level, roughly 22% of all participants were previously broadband un-adopters (making them significantly over-represented), but this number varied dramatically across the 14 projects. The design and marketing of the various projects provides additional insight into how un-adopters might respond to incentives to reconnect their households.

## 2. Literature review

### 2.1. Broadband adoption

Broadband adoption has been widely defined as an individual's ability to subscribe to high-speed Internet services at home (Gant, Turner-Lee, Li, & Miller, 2010; Horrigan, 2005). A significant amount of research has gone into determining the factors that influence broadband adoption, and generally accepted determinants include income, education, race, and geographic location (Dwivedi and Lal, 2007; Flamm & Chaudhuri, 2007; Prieger & Hu, 2008; Whitacre & Mills, 2007). In particular, many of these studies focused on "digital divides" or why rates of broadband Internet adoption diffused differently across multiple sectors of society. Alternatively, a large portion of the diffusion literature has used deductive approaches, including social cognitive theory and user acceptance models, to explain and predict the factors leading to technology adoption at home (Brown & Vankatesh, 2005; Brown & Vankatesh, 2008; Choudrie & Dwivedi, 2006; Dwivedi & Irani, 2009; Irani, Dwivedi, & Williams, 2009; Tsai & LaRose, 2015). Much of this literature can be traced to the work of Everett Rogers and his classic book on the Diffusion of Innovation (2003) (Rogers, 2003). In these seminal pieces, Rogers explained the five stages of the adoption process (awareness, interest, evaluation, trial, and adoption) with the goal of being able to predict how individuals and organizations in a range of industries and contexts adopt and use innovations to achieve social and economic outcomes.

More recent studies have focused on the economic impacts of broadband, and have also generally found positive results (Holt & Jamison, 2009; Kolko, 2012; Koutroumpis, 2009; Whitacre, Gallardo, & Strover, 2014a, 2014b). Others have argued that there are societal benefits to broadband adoption, including the building of social capital (Pigg & Crank, 2004; Stern & Adams, 2010). Thus, there is wide agreement that attempting to increase broadband adoption rates is a beneficial policy goal.

## 2.2. Barriers to adoption

As the research on broadband adoption continued, two significant efforts helped to frame the issues relating to adoption barriers across the country. First, John Horrigan began looking much more deeply at home broadband adoption rates in a series of Pew Internet & American Life studies beginning in 2005 and continuing over the next several years (Horrigan, 2005, 2006, 2009). Horrigan's work provided additional insights to comprehend the key elements that influence an individual's decision to adopt broadband. These studies not only focused on how specific demographics like income, race, and age impacted rates of broadband adoption; they also provided information on the rationale among those who chose not to adopt. Secondly, the National Telecommunications and Information Administration (NTIA) continued their work on documenting various gaps in both computer and Internet access (NTIA, 1999, 2000, 2002); in particular they drew attention to the fact that poverty remained a persistent problem in bridging the digital divide (Servon, 2002). Later versions of these surveys also documented the most often-cited reasons for non-adoption, which included cost (both for monthly fees and any associated equipment), a lack of relevance, and the ability to use the Internet in some other location (such as a library or friend's house). These and other studies helped to highlight and predict the factors that lead to successful broadband adoption and effective use as well as the barriers to broadband adoption, particularly among low-income and communities of color.

In 2010, as nationwide efforts to improve access to the Internet and home broadband adoption expanded, the Federal Communications Commission published a foundational study that detailed the three main barriers to broadband adoption in the U.S.: (1) cost, (2) digital literacy, and (3) relevance (Horrigan, 2010). The report explained that 36% of non-adopters cited cost as the main barrier to adoption, while 22% indicated digital literacy or comfort with using a computer, and 19% did not believe that the content delivered using broadband was compelling enough to justify purchasing it. In contrast to the FCC study, however, Dailey et al. (2010) found that even among the most vulnerable (low-income) populations "with profound histories of marginalization...no one needed to be convinced of the importance of Internet use or the value of broadband adoption at home" (p. 15). These striking differences demonstrate that interacting with a specific cohort can dramatically influence perceptions of barriers for that particular group – for example, relevance is likely an important topic of discussion for senior citizens who are non-adopters, while cost is more likely to be of the primary topic of interest for low-income households.

While the studies cited above have played a significant role in helping scholars, policymakers, and digital inclusion practitioners gain a deeper understanding of broadband adoption and barriers to adoption, fewer studies have presented a comprehensive investigation of broadband "un-adopters." This third category of people (in relation to "adopters" and "non-adopters") has been described as those individuals who have had an Internet connection at home and have lost it for some reason or another (Dailey et al., 2010; Horrigan, 2009). The Pew (Horrigan, 2009) study reported that 9% of Internet users canceled or cut back their online service in the past year, primarily due to cost. Dailey et al. (2010) reported that 24% of their small sample of low-income non-adopters included individuals had canceled their broadband service. Importantly, however, the Dailey et al. study found that cost was not the only factor that impacted this un-adopting population. Rather, Dailey et al. found that low-income populations face a wide array of overlapping challenges, including skill/language barriers, problems with providers on billing or service issues, and technical issues such as a broken computer or one rendered useless by a virus. Our study contributes additional data and statistical analysis of the un-adoption population, which will be particularly useful as broadband policies move towards sustainable adoption. Given that the un-adopter cohort has previously experienced residential broadband access, exploring their rationale for stopping (and potentially re-connecting through various incentive programs) will contribute to the "systematic observation and analysis of the social layer of broadband access" (Gangadharan & Byrum, 2012). Engaging un-adopters could essentially serve as picking the low-hanging fruit when it comes to increasing overall broadband adoption rates.

## 3. Data and methodology

A primary source of data for studying household-level broadband adoption is the Current Population Survey (CPS), a monthly, nationally-representative survey of roughly 50,000 U.S. households conducted by the Census Bureau. The CPS first asked questions relating to Internet use in 2000. These questions have been used in a wide array of broadband-related research, including early efforts to define digital divides (NTIA, 2000), studying the rural – urban digital divide (Whitacre & Mills, 2007), exploring the rise of mobile Internet (NTIA, 2014), and even assessing broadband's role in digital piracy (Smith & Telang, 2010). Although supplemental surveys on Internet use were conducted in 2001, 2003, 2007, 2009, and 2010, questions allowing for the identification of un-adopting households were not included until 2011. In particular, a negative response to the question "Does anyone in this household use the Internet from home?" combined with a positive response to the question "Has anyone in this household ever used the Internet from home?" allows un-adopting households to be identified.<sup>3</sup> These households also answer the follow-up question "What is the MAIN reason you no longer use the Internet

<sup>3</sup> Note that the wording of these questions could potentially allow for households previously having only dial-up access to be classified as un-adopters. Given that less than 2% of all households used dial-up as of 2013, we assume that un-adopters are previous broadband users.

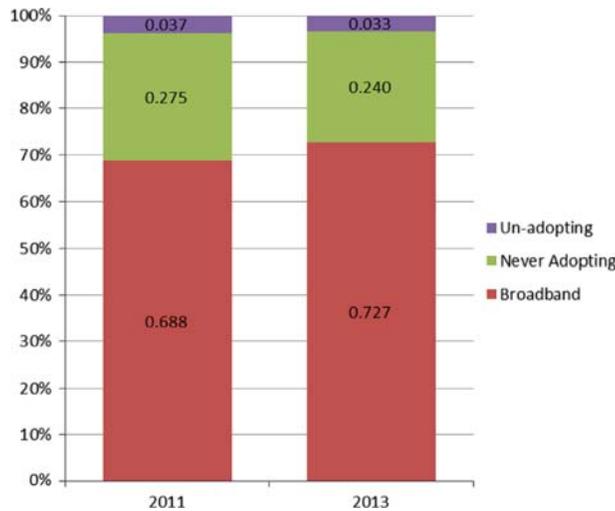


Fig. 2. Rates of broadband adopting, never-adopting, and un-adopting households, 2011 and 2013. Source: Current Population Survey (CPS) Computer and Internet Use Supplement, 2011 and 2013.

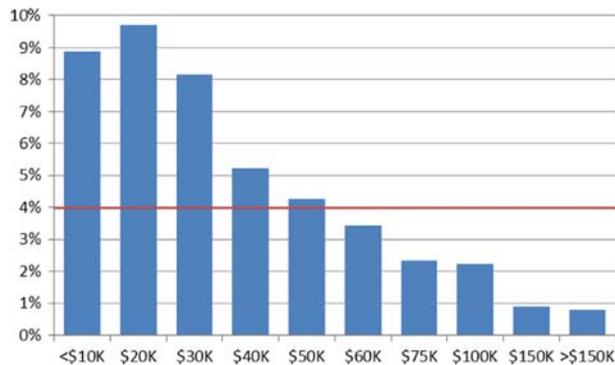


Fig. 3. Rates of Broadband Un-adoption (among all households with prior connection), by income, 2013. Source: Current Population Survey (CPS) Computer and Internet Use Supplement, 2013.

at home?" with seven categories of responses. A similar set of responses is then collected for those that have never adopted the Internet – i.e. those who answered negatively to both the 'current' and 'ever' Internet use questions.

The overall rate of un-adopting households declined slightly from 3.7% in 2011 to 3.3% in 2013, a difference that is significant at the  $p=0.05$  level (Fig. 2).<sup>4</sup> Because income levels influence both adoption and non-adoption, Fig. 3 looks at un-adoption from a different perspective. It denotes the percentage of all households within each income category that chose to un-adopt, but only among the subset of households that previously had a broadband connection. As expected, lower-income households have higher rates of un-adoption when viewed in this way (compared to the national average of around 4%).

Demographic characteristics of un-adopters and never-adopters from the 2013 CPS are presented in Table 1, and a comparison of responses for why each group does not have the Internet at home is provided in Table 2. Even with over 70% of households maintaining a broadband connection, the CPS is large enough to have meaningful samples of un-adopting (1,115) and never-adopting (7,731) households.

In terms of demographic characteristics, un-adopting households are less likely to have lower levels of income (< \$20,000) than non-adopters. They are more likely to have incomes ranging from \$40,000 to \$100,000, suggesting that policies focusing on un-adopters may need to cater to more than very low-income households.<sup>5</sup> Un-adopting households are also more likely to have some college education and have a graduate degree, while being less likely to have less than a high school degree. Interestingly, there are no racial or ethnic differences between un-adopters and non-adopters. Employment is significantly higher among un-adopters; however, unemployment is also higher. This counterintuitive finding is possible because rates of retirement are dramatically lower in un-adopters when compared to never-adopters.<sup>6</sup>

<sup>4</sup> The slightly different broadband adoption rates for 2013 between Fig. 1 (70%) and 2 (72.7%) are due to two different surveys being used (PEW Internet, CPS).

<sup>5</sup> Note, however, that nearly two-thirds (64%) of all un-adopting households still have income levels less than \$40,000.

<sup>6</sup> Note that the 'default' category here is households with heads that are neither in the labor force (i.e. employed or unemployed) nor retired.

**Table 1**  
Demographic characteristics of un-adopting and never-adopting broadband households, 2013.

	Un-adopters	Never-adopters
<b>Income</b>		
< \$10,000	0.128	0.185***
\$10–\$19,999	0.195	0.266***
\$20–\$29,999	0.190	0.202
\$30–\$39,999	0.129	0.144
\$40–\$49,999	0.090	0.060***
\$50–\$59,999	0.073	0.046***
\$60–\$74,999	0.083	0.038***
\$75,000–\$99,999	0.068	0.028***
\$100,000–\$149,999	0.026	0.020
> \$150,000	0.016	0.011
<b>Education</b>		
No HS	0.294	0.382***
HS	0.394	0.405
Some college	0.215	0.146***
Bach degree	0.064	0.049
Grad degree	0.032	0.018**
<b>Race/ethnicity</b>		
White	0.750	0.744
Black	0.186	0.195
Asian	0.022	0.026
Other	0.043	0.035
Hispanic	0.168	0.191
<b>Employment</b>		
Employed	0.467	0.327***
Retired	0.194	0.359***
Unemployed	0.096	0.049***
Self-employed	0.057	0.036**
Percent with Children in house	0.185	0.134***
Age	46.14	54.86***
# Obs	1115	7731

\*Statistically significant differences between means at the  $p=0.10$  level.

\*\* Statistically significant differences between means at the  $p=0.05$  level.

\*\*\* Statistically significant differences between means at the  $p=0.01$  level.

**Table 2**  
Reasons for never (or un-) adopting broadband, by U.S. households in 2013.

	2013	
	Un-adopters	Never-adopters
Percentage of all non-adopters	0.121	0.879***
<b>Reasons for never (or un-)adopting</b>		
No need	0.216	0.509***
Too expensive	0.401	0.265***
Can use elsewhere	0.052	0.026***
Not available	0.011	0.011
Computer inadequate	0.177	0.117***
Privacy concerns	0.018	0.007**
Other reason	0.125	0.064***
Observations	1115	7731

\*Statistically significant differences between means at the  $p=0.10$  level.

\*\* Statistically significant differences between means at the  $p=0.05$  level.

\*\*\* Statistically significant differences between means at the  $p=0.01$  level.

Un-adopters are also younger (again, likely because many never-adopters are elderly) and are more likely to have children in the household.

Table 2 clearly indicates that un-adopters are much more likely to suggest that cost, the ability to use the Internet elsewhere, and the presence of an inadequate computer are the reasons for their lack of residential Internet access when compared to never-adopters. Conversely, the category of “no need” makes up nearly half of all never-adopter responses compared to only 22% of un-adopters. It is interesting to note, however, that “no need” still ranks as the second highest

**Table 3**  
Reasons for un-adopting broadband, by metro status/children/low-income (2013).

	Metro	Non-metro	Children	No children	Low income (< \$30,000)	Higher income
Percent un-adopting (among all non-adopters)	0.122	0.115	0.159	0.114***	0.099	0.158***
Reasons for un-adoption						
No need	0.210	0.235	0.145	0.232***	0.183	0.251**
Too expensive	0.402	0.398	0.497	0.379***	0.462	0.337***
Can use elsewhere	0.054	0.048	0.076	0.047	0.035	0.071**
Not available	0.010	0.016	0.014	0.011	0.009	0.014
Computer inadequate	0.188	0.136*	0.138	0.185	0.181	0.173
Privacy concerns	0.019	0.020	0.012	0.019	0.015	0.021
Other reason	0.119	0.147	0.119	0.126	0.116	0.134
Obs	803	312	202	913	579	536

\* Statistically significant differences across categories at the  $p=0.10$  level.

\*\* Statistically significant differences across categories at the  $p=0.05$  level.

\*\*\* Statistically significant differences across categories at the  $p=0.01$  level.

reason for un-adopting, suggesting that even among those with prior access to the Internet, a significant number of households did not see enough value added to continue paying for the service. Another takeaway is that having prior access to broadband allows households to realize that the computers they own are inadequate for what they intend to do online, since un-adopters claim this reason at a rate 6 percentage points higher than never-adopters. Privacy concerns and the lack of availability of broadband represent only very small portions of the responses (2% and 1% overall, respectively), though the privacy concerns are significantly higher for those with prior broadband connections.

It may be the case that the reasons for un-adoption vary by certain demographic characteristics. For example, rural households may be more likely to claim that broadband was not available where they lived (although the fact that they had a prior connection makes that unlikely), and households with children may be more likely to cite privacy concerns. Table 3 looks across certain demographics to see if the reasons for un-adoption vary by either metropolitan status, the presence of children, or income status (where low-income is defined as less than \$30,000).

The only difference observed across metro and non-metro households is a higher tendency for metro households to claim an inadequate computer as their reason for un-adopting. More interesting differences are found across child/no child households and low/high income households. Higher rates of un-adoption (16% vs. 11%, among all non-adopting households) are seen in households with children, and they are much more likely to claim cost as the reason for un-adoption compared to un-adopting households without children. These households with children are also much less likely to claim “no need” as their reason, giving credence to those suggesting that residential broadband connections are particularly important for youths during their primary schooling years. In terms of low-income vs. higher-income households, it is unsurprising that cost ranks much higher for the lower-income residences. Interestingly, higher-income households are more likely to claim that they can use broadband elsewhere, even though most community anchor institutions offering broadband access (such as libraries) are often geared towards lower-income residents (Jayakar & Park, 2012). This may be due to higher-income un-adopters using broadband access at work as a substitute for a residential connection.

### 3.1. A modeling structure to understand reasons for un-adoption

While these descriptive statistics provide some insight into which factors may affect different reasons for un-adoption, the decision process is formally modeled with a multinomial logistic specification (Greene, 2002). In this model, the probability that the  $i$ th household selects the  $j$ th reason for un-adopting is estimated based on a series of household characteristics ( $X_i$ ). These could include any of the demographics discussed above, such as income, metropolitan status, or age. The choices to be examined in this model are: (1) no need, (2) too expensive, (3) can use elsewhere, (4) broadband not available, (5) computer inadequate, (6) privacy concerns, and (7) other reason. The probability that household  $i$  will choose reason  $j$  is expressed as

$$Prob(Y_i = j|X_i) = \frac{\exp(\beta_j'X_i)}{1 + \sum_{k=1}^6 \exp(\beta_k'X_i)}$$

for  $j = 1, 2, \dots, 7$  and  $\beta_7 = 0$ . (1)

To estimate the probabilities, a reference category must be chosen in order to construct the resulting  $J-1$  log-odds ratios. In this example, we choose reason (7) – other reason – and set the associated parameter vector  $\beta_7$  equal to zero. Instead of comparing parameter coefficients, which can be confusing and difficult to interpret, marginal effects are calculated. A marginal effect measures the expected change in the likelihood of selecting a particular reason for un-adoption, given a one-unit change in the variable of interest (such as income). All other variables are held constant. For continuous variables, the marginal effect is calculated by taking the derivative of Eq. (1) with respect to  $x_i$ . Marginal effects of dummy variables are

**Table 4**

Weighted marginal effects of household characteristics on reasons for un-adopting broadband, 2013.

Variable	No need	Too expensive	Can use elsewhere	Not available	Computer inadequate	Privacy concerns
<b>Income</b>						
< \$10,000	-0.034	0.252	-0.011	0.005	0.046	-0.227
\$10-\$19,999	-0.094**	0.179***	-0.114***	-0.002	0.055*	0.001
\$20-\$29,999	-0.035	0.118***	-0.049**	-0.002	-0.015	0.008
\$30-\$39,999	-0.029	0.124***	-0.036*	0.006	-0.027	0.008
\$40-\$49,999	-0.014	0.109	-0.025	-0.161	0.055	0.014
> \$50,000	Default					
<b>Education</b>						
No HS	-0.012	0.086	-0.054	0.159	-0.056	-0.007
HS	-0.004	0.016	-0.031	0.159	-0.024	-0.007
Some college	0.005	0.004	-0.022	0.161	-0.032	-0.029
Bach Degree+	Default					
<b>Race/ethnicity</b>						
White	Default					
Black	-0.013	-0.047	0.031*	-0.008	0.000	0.014
Asian	0.233	0.086	0.044	-0.155	-0.036	-0.219
Other	-0.066	-0.010	0.013	0.004	-0.006	0.022
Hispanic	-0.061	0.067	0.015	0.000	-0.023	0.001
Metropolitan status	-0.005	-0.014	-0.014	0.003	0.060**	-0.003
<b>Employment</b>						
Employed	0.014	0.019	0.055**	-0.002	-0.099***	-0.007
Retired	0.105**	-0.143***	0.051	0.007	-0.002	-0.001
Unemployed	-0.007	0.258	-0.002	-0.161	-0.056	0.001
Self-employed	0.034	0.029	0.013	-0.156	0.009	0.008
Percentage with children	0.011	-0.010	0.009	0.005	-0.056	0.001
Age	0.002**	-0.002**	-0.001**	0.000	0.000	0.000
Age <sup>2</sup>	-0.038	0.033	-0.014	-0.002	0.039	-0.011

\* Statistical significance at the  $p=0.10$  level.\*\* Statistical significance at the  $p=0.05$  level.\*\*\* Statistical significance at the  $p=0.01$  level.

obtained by calculating the differences in predicted probabilities between when the dummy variable takes value one and when it takes value zero.

A separate data source on un-adopting households comes from the recently completed FCC Low-Income Broadband Pilot Project (FCC, 2015). Under this project, 14 telecommunications providers were funded to subsidize broadband access to households qualifying for the current Lifeline (i.e. phone subsidy) program but not having a broadband connection. The projects differed in terms of subsidy amounts offered, marketing strategies, conditions for receiving service, and the type (mobile/wired) and speeds of broadband offered. Each project gathered data on the individuals signing up for the different programs, including whether they participated for the full duration of the study (typically 12 months) and whether they retained their broadband connection after the project was over. Because all data was collected in a single format, compiling information across the projects is relatively straightforward. In total, out of the 8104 recipient households across the 14 projects that responded to the question, 22.4% were previous broadband un-adopters. This percentage ranged from 9% to almost 50% across the 14 projects, suggesting that un-adopters might respond differently based on the specific characteristics of the program. The FCC pilot project data is used to build on the findings of the multinomial logit model regressions.

#### 4. Results

The weighted marginal effects from the multinomial logistic regression for un-adopters are displayed in Table 4.<sup>7</sup> For comparison purposes, a similar table is constructed for never-adopters (Appendix). Note that the default categories in

<sup>7</sup> From a technical perspective, the multinomial logit model assumes the independence of irrelevant alternatives (IIA). This assumption basically says that choosing alternative  $i$  over alternative  $j$  should be independent of what choice set ( $i, j$ ) is selected. We test for IIA using the Hausman specification test (Hausman and McFadden, 1984) and find that IIA is not rejected ( $\chi^2$  of 11.9 for un-adopters ( $p$ -value=0.75), 12.2 for never-adopters ( $p$ -value=0.86)). Thus, the multinomial logit is an appropriate specification for this dataset.

both tables generally represent those most likely to adopt broadband: higher income, higher education, white, and metropolitan. The overall fits of these models are reasonable, with pseudo  $R^2$ s of 0.08 (un-adopter) and 0.12 (never adopter) and over 52 (63) percent of all observations correctly predicted (i.e. where the predicted probability of the chosen reason was higher than probabilities for all other reasons). By comparison, a model that always predicts the most popular option for all households would only have correctly predicted 40% for un-adopters and 51% for non-adopters. Statistically significant results for the un-adopter regression are relatively sparse, which is somewhat expected given the small percentages selecting reasons such as “not available” or “privacy concerns.” Each category of results is discussed in turn.

#### 4.1. No need

The only factors impacting the likelihood of choosing “no need” as a reason for un-adopting were income levels between \$10,000 and \$20,000, retired status, and age. Being retired and being older both increased the likelihood of choosing “no need.” This is consistent with previous results indicating that 67% of those over 65 lack interest in the Internet, compared with only 26% of those aged 16–44 (NTIA, 2011). The current results, however, are focused solely on households that previously had an Internet connection, and suggest that there may be a role to play for educational programs regarding what a broadband connection can offer for households with these characteristics. Perhaps surprisingly, the presence of children in the household does not have a statistical impact on this reason for un-adoption, despite having the expected negative sign in the results for never-adopting households (Appendix).

#### 4.2. Too expensive

As expected, households with lower income levels are more likely to select this reason for un-adopting. Interestingly, however, this holds for households with incomes up to \$40,000 – significantly higher than the current threshold for the FCC’s Lifeline program. Retired households and those with older household heads are less likely to select this reason, perhaps due to the accumulation of wealth over years of working or a higher propensity to select “no need” as documented above.

#### 4.3. Can use elsewhere

Lower income levels are again statistically significant for this un-adoption reason, but are negatively related. This suggests that, even if alternative Internet sites such as libraries or community centers are available to low-income households, the benefit of such access is not enough to encourage un-adoption. African-American household heads, however, are more likely to select this reason, meaning that alternative places for connecting provided enough incentive for some Black households to un-adopt. Employed individuals are more likely to choose this reason, which implies that at least for some households, Internet access at work is serving as a substitute for residential access.

#### 4.4. Computer inadequate

As the only un-adopting reason that is statistically impacted by geography, it is interesting to note that this reason is more likely to occur in metropolitan areas. This provides evidence that subsidizing adequate computers may be a policy of importance in more urban locations. Employed households are less likely to choose this reason, suggesting that workplace-based policies that focus on residential computer provision may not be appropriate.

#### 4.5. Not available/privacy concerns

There are no statistically significant results for the “not available” and “privacy concerns” reasons for un-adoption. In contrast, the never-adopter results demonstrate lower likelihoods of selecting “not available” for lower-income households, Hispanics, and metropolitan residents (Appendix). Households with children and older household heads were more likely to select “not available” as their reason for not adopting; however availability is based on the perception of the respondent and was not independently verified.

Overall, the regression results for un-adoption demonstrate a remarkable lack of significance for education, race, geography, or the presence of children. This contrasts with the outcomes for never adopting (Appendix). For example, among never-adopting households, lower-education households are more likely to claim an inadequate computer as their reason and less likely to select “can use elsewhere.” Hispanic households are less likely to select “no need” and “not available” but more likely to select “too expensive.” Households with children are more likely to select “too expensive” or “not available” but less likely to select “no need.” Taken as a whole, the results for un-adopters indicate that attempts to re-engage these households should mostly focus on income, employment, and age characteristics. For never-adopters, on the other hand, policies could also incorporate the findings associated with educational, racial, and

**Table 5**  
FCC Low-Income Broadband Pilot Project Subscriber Data.

	Un-adopter	Never-adopter
Variable		
% of all participating households	0.22	0.78***
Household income		
< \$5000	0.33	0.63***
\$5-\$9999	0.24	0.22
\$10-\$19,999	0.28	0.12***
\$20-\$29,999	0.07	0.02***
> \$30,000	0.08	0.01***
Age	42.91	45.25***
Number using BB in household	2.08	2.04
Accepted Digital Literacy training offer	0.26	0.37***
Completed training program somewhere	0.31	0.20***
Participated for full duration (12 months)	0.53	0.55
Retained BB 1 month after service ended	0.43	0.52***
Retained BB 3 months after service ended	0.41	0.48***
Reasons for not using		
Cost	0.77	0.76
No need	0.06	0.29***
Equipment did not work	0.07	-
Do not know how to use computer	0.01	0.14***
Uncomfortable with Internet	0.01	0.04*
OK with dial-up	0.00	0.01
Access elsewhere	0.04	0.06
Number observations	1664	6252

\*Statistical significance at the  $p=0.10$  level.

\*\*Statistical significance at the  $p=0.05$  level.

\*\*\*Statistical significance at the  $p=0.01$  level.

metropolitan household characteristics – for instance, emphasizing broadband skills training among Hispanic or rural households.

#### 4.6. FCC Low-Income Broadband Pilot Project results

Descriptive statistics from the roughly 9000 people who participated in the FCC Low-Income Broadband Pilot Project during 2012–2013 help shed some additional light on un-adopters. Approximately 22% of those who participated in the program were previous un-adopters, with rates ranging from 9% to nearly 50% across the 14 projects. Although instances of missing data limited inference in some cases, several meaningful differences between un-adopters and never-adopters<sup>8</sup> were found. This is true for both the demographic composition and in broadband-related outcomes of the groups. As Table 5 demonstrates, un-adopters had higher levels of income and were younger than their previously never-adopting counterparts in the program – similar findings to those for the CPS data (Table 1). Perhaps more interestingly, un-adopters were significantly less likely to accept an offer to enroll in a digital literacy program upon enrollment; however, they were more likely to already have completed such a program. There were no statistical differences between the groups in terms of how many participated for the full 12 months of the project. Importantly, un-adopters were less likely to retain the service both one and three months after the subsidized access ended.

For both groups, cost ranks as the overwhelming number one reason why the household did not currently have a broadband connection. This is unsurprising, since all subscribers were recipients of one other type of federal or state public assistance (Medicaid, Low-income Energy Assistance, Temporary Assistance to Needy Families, etc.) and almost all observations in this dataset were ultimately enticed to adopt by subsidized monthly access costs.<sup>9</sup> Even so, significant differences between un-adopters and previous never-adopters' reasons for not using broadband are expected and are also documented in Table 5, including never-adopters citing 'no need,' 'don't know how to use a computer,' and 'uncomfortable with Internet' more often than un-adopters.

Continuing with the aggregate subscriber data, it appears that un-adopters had a preference for wired connections. They were more likely to select wired connections (13.2% vs. 7.6%,  $p < 0.01$ ), while previous never-adopters were more prevalent

<sup>8</sup> "Never-adopters" are households who never had a residential broadband connection prior to their participation in the FCC Low-income Broadband Pilot Project.

<sup>9</sup> A very small portion of subscribers across the projects were in 'control' groups where monthly costs were not subsidized. However, all subscribers were eligible to receive one other type of federal or state public assistance.

**Table 6**

Comparison of subscribers for high un-adopter projects (Frontier, Tracfone, Virgin, PCI) vs. all other projects in FCC Low-income Broadband Pilot Program.

	High un-adopter projects	Other projects
Percentage un-adopters subscribing	0.38	0.19***
Percentage adopting wired	0.12	0.10
Monthly costs paid by subscribers (\$)		
Wired	11.93	24.18***
Wireless	8.76	17.65***
Equipment costs paid by subscribers (\$)		
Wired	0.00	91.00***
Wireless	14.39	91.29***
Digital Literacy Offer provided (%)	0.45	0.44
Data limit (GB) selected by wireless subscribers	1.00	2.18***
Number observations	1840	6867

\*\*\* Statistical significance at the  $p=0.01$  level.

among those who selected wireless (particularly mobile) connections (data not shown in tables). Un-adopters were also more responsive to specific pricing strategies than previous never-adopters, but only for these wired connections: their monthly wired connections cost just \$16.22 compared to \$24.45 for never-adopters ( $p < 0.01$ ). Both groups paid an average (subsidized) monthly cost of around \$17 for wireless connections. The one-time equipment costs of un-adopters was also significantly lower (\$48) than for previous never-adopters (\$72), which is intuitive since most un-adopters may already have items such as a computer or modem from their previous broadband experience. Un-adopters were also more likely to expect to use their new connection with a desktop, laptop, or tablet; while a higher percentage of previous never-adopters expected to use a smartphone. In terms of speeds selected, un-adopters and previous never-adopters were strikingly similar for the download speeds among wired connections (4.5 MB vs. 4.8 MB,  $p=0.23$ ); however, un-adopters chose lower rates of download speeds among mobile connections (5.9 MB vs. 7.3 MB,  $p < 0.01$ ) and also had lower data limits (1.83 GB vs. 2.08 GB,  $p < 0.01$ ).

In an effort to find specific attributes that un-adopters were particularly receptive to, details of the 14 pilot projects were reviewed and subscriber data was broken into alternative categories. Rates of participation by un-adopters were particularly high for four specific projects: Frontier (47%), TracFone (42%), Virgin Mobile (34%), and Partnership for a Connected Illinois (32%).<sup>10</sup> A review of the final reports prepared by these companies, compared to those prepared by companies with lower rates of un-adopter participation, do not turn up any notable differences in marketing approaches (most used mailed flyers to households eligible for the current Lifeline phone program). The percentages of subscribers taking wired vs. wireless connections, or that were offered digital literacy programs also do not differ greatly. However, three specific (and statistically significant) differences were found between these four “high un-adopter” projects and the remaining projects (Table 6). First, the monthly costs of the high-unadopter project subscribers were significantly lower, both for wired (\$11.93 vs. \$24.18,  $p < 0.01$ ) and wireless (\$8.76 vs. \$17.65,  $p < 0.01$ ) connections. Second, the one-time equipment costs of the high-un-adopter project subscribers were also significantly lower, both for wired (\$0 vs. \$91,  $p < 0.01$ ) and wireless (\$14.39 vs. \$91.29,  $p < 0.01$ ) offers. This may be because un-adopters were more likely to accept offers that did not require equipment purchases. Finally, high un-adopter project subscribers selected plans with markedly lower data limits (1 GB vs. 2.18 GB,  $p < 0.01$ ).<sup>11</sup>

For the majority of the 14 FCC Broadband Pilot Program projects, consumers were presented with an opportunity to obtain a specific type of discounted broadband connection. They could either accept or decline the offer. However, there were three specific projects in which subscribers were allowed to choose from distinct plans – allowing an opportunity to observe differences in the choices of un- vs. never-adopters. In the Nexus project (274 observations), subscribers could choose among various levels of data allowance (ranging from 200 MB to 5 GB monthly), but paid more for larger plans. In the National Telecommunications Cooperative Association project (NTCA) (49 observations), subscribers chose among packages with different speeds (from 768 KB to 12 MB download) – and again paid more for faster speeds. In the Puerto Rico Telephone Company project (352 observations), consumers were able to choose between wired and wireless connections, and also between speed options for each.

The relatively small sample sizes led to no statistical differences in choices regarding data allowance, cost of the connection, or download speeds between un-adopters and previous never-adopters in either the Nexus or NTCA programs. In the Puerto Rico Telephone Company project, however, the data show that un-adopters were more likely to select wired connections (87% vs. 73%,  $p < 0.01$ ) even though the associated subsidy was lower (\$5 for wired vs. \$18.50 for wireless). These led to slightly higher monthly prices paid by un-adopters (\$36.80 vs. \$32.60,  $p < 0.01$ ). The download speeds selected

<sup>10</sup> The data for one project, Xchange, indicated that 100% of participants were un-adopters; we chose to assume this variable was tainted and ignored its observations.

<sup>11</sup> Only wireless projects have associated data limits; these statistics only apply to offers for wireless connections.

by the two groups were not statistically different contingent on wired/wireless selection. These results from a choice-based experiment (specifically the preference for a wired connection) mirror those for the aggregate project data when subscribers either accepted or declined one specific plan.

## 5. Conclusion

Broadband un-adopters currently make up about three percent of the nation's households. The demographics show that these households have higher income and education levels, are younger, and are more likely to have children than their never-adopting counterparts. Their reasons for non-use are strongly skewed towards cost, with lack of need and inadequate computers ranking 2nd and 3rd. Re-engaging this cohort is an important part of policy efforts geared towards sustainable broadband adoption. The analysis in this paper, based on two distinct data sets, makes three basic points with policy applications: (1) un-adopters with income levels up to \$40,000 would benefit from a broadband subsidy program, (2) retired and older un-adopters should be targeted for digital literacy / broadband educational efforts, and (3) un-adopters favor wired connections and are extremely price-conscious in their decisions to re-adopt. Each of these points can be built upon by policy makers attempting to increase rates of broadband adoption.

Several current federal policy efforts should be discussed in this framework. The modernization of the Lifeline program to include broadband access recognizes the importance of this technology for today's households (FCC, 2012). However, the focus of the Broadband Lifeline program on the lowest-income households may miss a significant portion of the population who have un-adopted due to cost. The analysis in this paper show that households with incomes up to \$40,000 have above-average rates of un-adoption (Fig. 3), and that they are more likely to select cost as the reason for non-adoption (Table 4). Generally, Lifeline subsidies are available to those making less than 135% of the federal poverty guidelines, which amounts to \$21,500 for a 2-person household (or \$32,700 for a 4-person) in 2015. Thus, the FCC's low-income broadband program may want to explore increasing the income eligibility criteria. Additionally, carriers introducing the Broadband Lifeline to their subscribers should emphasize wired connections to prior un-adopters, and also offer low-cost options for both wired and wireless plans.

The Obama administration has also recently announced the "ConnectHome" program, which seeks to make broadband Internet more adoptable, more valuable, and to make the adoption of broadband more sustainable – particularly for low-income households. This effort, led by the Department of Housing and Urban Development (HUD), will include partnerships to deliver affordable connectivity; collaboration with non-profits to make Internet access more valuable through skills and digital literacy training; and requiring that new HUD-funded projects support broadband connectivity (White House Fact Sheet, 2015). The analysis in this paper suggests that efforts to re-engage un-adopters should include this type of digital literacy training targeted at low-income households with older or retired heads. A particularly aggressive (though politically challenging) policy might be for all HUD housing recipients over a certain age to be required to participate in such training as a term of their enrollment.

The results from the Lifeline pilot program stop short of offering any prescriptions related to marketing to un-adopters, or for encouraging participation in digital literacy training. In fact, the FCC notes that "requiring [providers] to offer or provide digital literacy training does not appear to be an efficient or effective model for converting non-adopters to adopters" (FCC, 2015, p. 2).<sup>12</sup> However, prior work has noted the importance for low-income digital inclusion efforts to focus on participation in community affairs and the creation of meaningful content (Bach, Shaffer, & Wolfson, 2013). As the Broadband Lifeline and ConnectHome programs mature, they should take such digital inclusion suggestions into consideration – particularly if the goal is *sustained* broadband adoption. Such programs should also incorporate experimental designs to test the efficacy of different approaches to engaging both un-adopters and non-adopters. It is important to recall that previous un-adopters actually had lower rates of broadband retention once their subsidized access from the FCC pilot program ended (Table 5), suggesting that limits on the length of program participation can negatively impact long-term adoption rates. Overall, opportunities exist for reaching out to broadband un-adopters, and minor modifications to current and upcoming programs can have an impact on long-term broadband adoption rates across the U.S.

## Appendix A

See Table A1.

<sup>12</sup> Note that requiring all providers to offer training to everyone is different from our suggestion that HUD housing projects require such training, or that the training be targeted to specific demographics such as retirees.

**Table A1**

Weighted marginal effects of household characteristics on reasons for never adopting broadband, 2013.

Variable	No need	Too expensive	Can use elsewhere	Not available	Computer inadequate	Privacy concerns
<b>Income</b>						
< \$10,000	-0.087***	0.113***	-0.020***	-0.016***	0.019	-0.004
\$10–\$19,999	-0.047**	0.084***	-0.022***	-0.013***	0.013	-0.006*
\$20–\$29,999	-0.028	0.079***	-0.015***	-0.013***	0.010	-0.002
\$30–\$39,999	-0.008	0.038***	-0.017***	-0.008**	0.008	0.001
\$40–\$49,999	0.031	0.005**	-0.009	-0.012**	0.000	-0.004
> \$50,000	Default					
<b>Education</b>						
No HS	0.046*	-0.026	-0.037***	-0.004	0.042**	-0.003
HS	0.035	-0.014	-0.029***	-0.009*	0.039**	-0.003
Some college	0.005	-0.006	-0.008	-0.002	0.014	-0.004
Bach Degree +	Default					
<b>Race/ethnicity</b>						
White	Default					
Black	-0.016	0.030**	-0.003	-0.007	0.009	-0.003
Asian	-0.022	0.086	0.009	-0.008	0.013	-0.101
Other	-0.064**	0.036	0.002	0.005	0.022	-0.006
Hispanic	-0.040**	0.056***	-0.006	-0.009*	0.011	-0.002
Metropolitan status	-0.038***	0.035***	0.001	-0.014***	0.024***	-0.002
<b>Employment</b>						
Employed	0.002	-0.013	0.017***	0.000	0.002	0.000
Retired	0.102***	-0.085***	-0.001	0.003	-0.016	0.002
Unemployed	-0.106***	0.081***	0.017**	0.004	0.006	-0.005
Self-employed	0.030	-0.005	-0.020*	-0.007	0.002	-0.008
<b>Percentage with children</b>						
Age	-0.081***	0.085***	0.002	0.006**	-0.014	0.002
Age <sup>2</sup>	0.004***	-0.004***	-0.001***	0.000***	0.001**	0.000
Age <sup>2</sup>	-0.039**	0.032***	-0.001	0.000	-0.004	0.003

\* Statistical significance at the  $p=0.10$  level.\*\* Statistical significance at the  $p=0.05$  level.\*\*\* Statistical significance at the  $p=0.01$  level.

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