ESTIMATING WILLINGNESS-TO-PAY FOR BROADBAND ATTRIBUTES AMONG LOW-INCOME CONSUMERS: RESULTS FROM THE FCC LIFELINE PILOT PROJECTS

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Abstract: Recent studies have confirmed that broadband adoption (as opposed to simply having access to broadband infrastructure) is positively linked with economic growth. In light of this, federal policy efforts have switched from focusing mainly on the provision of infrastructure to more explicit adoption-oriented efforts. One of those efforts was the Federal Communications Commissions (FCC's) Low-income Broadband Lifeline Pilot Projects, which ran from 2012 to 2013. The program worked with 14 private telecommunications firms to subsidize household broadband adoption for low-income households by providing discounted monthly and equipment costs. Low-income households are an important component of the broadband adoption puzzle: between 2003 and 2013, the adoption gap between low-income and high-income households actually increased by 5 percentage points. Further, the most recent data suggests that only half of households making less than $25,000 have a residential connection as compared to 95% of households earning more than $100,000. Thus, if increasing broadband adoption is a policy goal, focusing on low-income households is a good starting point. This paper focuses on three specific FCC Broadband Lifeline Pilot projects (Nexus, Puerto Rico Telephone Company, and National Telecommunications Cooperative Association) that allowed consumers to make choices among different options, such as data allowance, speed, and wireless vs. wired connections. Conditional logit models are used to develop estimates of consumer's willingness-to-pay for specific broadband attributes. The results indicate that low-income consumers have a preference for smartphone connections (versus aircards) – and that this effect is even more pronounced for those households earning less than $20,000; that low-income consumers have a preference for wired connections (vs. wireless); and that there is evidence that low-income consumers are willing to pay for an extra GB of data each month – but not for the speed of their connection. These results will be useful for the future versions of the Broadband Lifeline Program. In particular, understanding the willingness-to-pay for specific broadband attributes among low-income households will be useful as the federal program defines its baseline. Effective policies built on these results should lessen the adoption gap between different levels of household income and potentially impact the larger economy.

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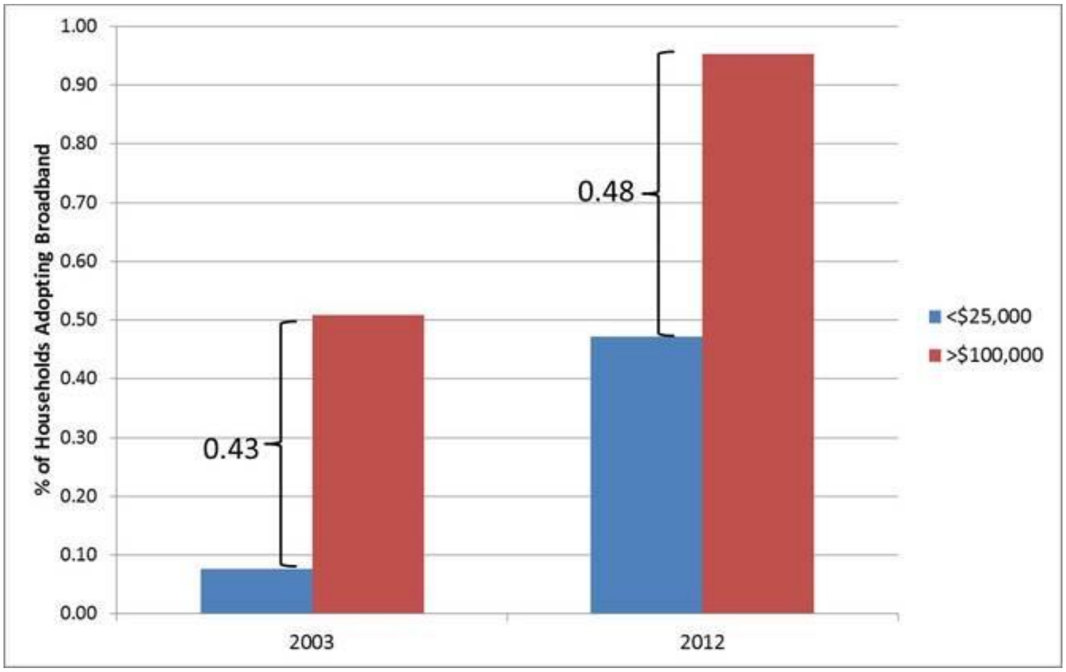
CHAPTER I

INTRODUCTION

An important policy debate is currently underway as broadband[1] access becomes increasingly common across the United States. Despite a significant amount of funding for broadband infrastructure and programs focused on sustainable adoption, broadband adoption rates are still very low for low-income households (CBO Report, 2012). Wheeler (2015) found that only half of low-income households who earn less than $25,000 adopt broadband, while adoption rates are 95% for people who earn more than $100,000. Whitacre (2015) pointed out that the gap between low-income and high-income households has even increased 5 percentage points between 2003 and 2012 (Figure 1). Even though low-income households' adoption rate was extremely low in 2003 (7%) and had a significant increase to 47% in 2012, the fact that the adoption gap between low and high income households grew over that decade indicates that more should be done to help lower income households obtain and maintain a broadband connection.

[1] In 2015, Federal Communications Commission (FCC) has defined broadband access as 25 megabits per second (mbps) for download speeds and 3 mbps for upload speeds.

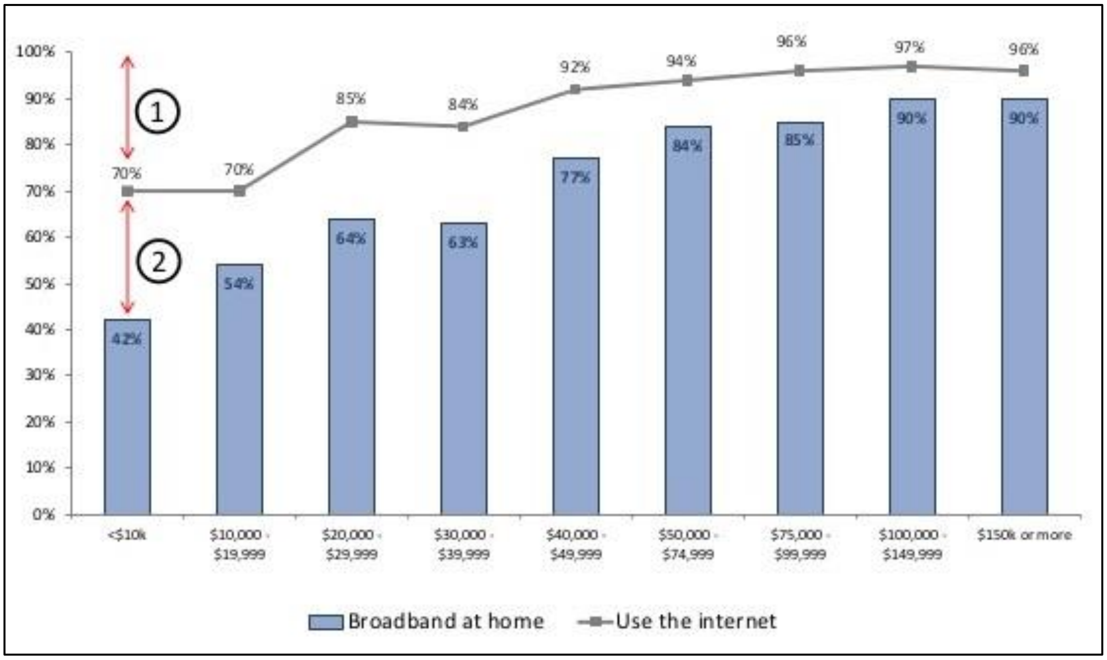
Figure 1. Broadband Adoption Rates for Low and High Income Households.



Source: Whitacre, 2015.

For decades, a problem across the United States has been the income-based disparity of digital literacy. Despite various programs and digital inclusion efforts, broadband adoption rates among low-income households are still relatively low. Smith (2013) found that the rate of internet use and broadband installed at home varies dramatically by the level of income. Figure 2 shows that this rate rises gradually as the level of income increases. Specifically, rates of broadband adoption are notably lower for those households with incomes less than $40,000.

Figure 2. Internet Use and Broadband Installation Rate at Home.



Source: Smith, A. 2013.

There are two recent programs focusing on trying to increase broadband adoption rates by low-income households. First, President Obama has announced ConnectHome, a new pilot initiative to help low-income households obtain broadband connections. Along with the Department of Housing and Urban Development (HUD), this new pilot project initially supports low-income households in twenty eight communities by subsidizing high-speed internet subscriptions at home. It also helps nearly 200,000 children use high-speed internet at school and gives grants to regional communities to collaborate in digital literacy training programs (White House Fact Sheet, 2015).

In addition, in 2012 the FCC established the Low-Income Broadband Pilot Projects to test ways for low-income consumers to overcome cost barriers associated with broadband. These pilot projects were run by 14 private telecommunications firms, and sought to determine the best ways to include broadband as part of the Federal Lifeline phone subsidy program. The Lifeline Program was started by Federal Communications Commission (FCC) in 1984, originally aimed at helping the low-income households paying the cost of telecommunications services via a traditional, land-line phone. The Lifeline Program was eventually reformed to include cell phone service in 2005, and is in the process of being updated to include broadband access. As part of the broadband pilot project, all participants had to be eligible for the traditional Lifeline Program. Each of the 14 pilot projects offered their participants different subsidy amounts, hardware costs, conditions of digital literacy, technologies, and types of service. Each provider varied the subsidies given for residential broadband access, and low-income households typically either accepted or declined the offers made. The subsidies continued for 1 year, and generally began in early 2013. Despite the projects gathering consistent data on the subscribers to the various options, the implications of what they mean for low-income households and broadband adoption have yet to be evaluated. As the FCC moves forward to include broadband as part of the Lifeline Program, understanding what low-income residents want and are willing to pay for in such a program will be important to identify.

This study assesses the pilot projects, specifically focusing on the case of Nexus, Puerto Rico Telephone Company (PR Telephone), and National Telecommunications Cooperative Association (NTCA). The selected Nexus, PR Telephone, and NTCA are the only projects that allow consumers to make choices among different plans, since most projects just let households either accept or decline a specific offer. Specifically, Nexus varied data limits, PR Telephone allowed consumers to choose from either wireless or wireline connections, and NTCA offered a choice of download speeds; all at different monthly prices. Based on the data collected, consumer’s willingness-to-pay can be calculated regarding each attribute and further policy implications can be suggested. These results will be important with the Broadband Lifeline Program moving forward and attempting to spur adoption among low-income households.

The purpose of this research is to determine willingness-to-pay for specific broadband attributes among low-income consumers. This study uses data from the FCC’s Broadband Lifeline Program and evaluates how each project’s structure relates to the impact on broadband adoption. These results will be useful for the future versions of the Broadband Lifeline Program. In particular, understanding the willingness-to-pay for specific broadband attributes among low-income households will be useful as the federal program defines its baseline. Effective policies built on these results should lessen the adoption gap between different levels of household income and potentially impact the larger economy.

CHAPTER II

LITERATURE REVIEW

The following literature review will be broken into 4 sections. They focus on income's impact on broadband adoption, how low-income broadband adoption will impact the overall economy, public policies associated with broadband adoption, and what previous research related to the Lifeline Program has found.

Income Impact on Broadband Adoption

Household income has been the major socio-demographic factor highly associated with broadband adoption (Whitacre and Mills, 2007; Prieger and Hu, 2008; Horrigan, 2009). Higher incomes are linked to higher adoption rates, regardless of the empirical methodology used. However, despite their lower adoption rates, Dailey et al. (2010) find that low-income households clearly understand the importance of broadband access. Low-income households are vulnerable to costs such as monthly fees, device costs, and service fees when considering broadband adoption. According to their survey of 171 low-income households, Dailey et al. (2010) find that 99% of respondents among non-adopters reported cost as the biggest reason for non-adoption. Thus, it can be hypothesized that discounts aimed at non-adopting low-income households such as those in the Low-Income Pilot Projects will lead to higher broadband adoption rates. Along these lines, a multi-state survey among non-adopters estimated the elasticity for broadband demand and found that a 15% decrease in price achieves a 10% increase in broadband adoption (Carare et al., 2015). However, other demographic factors as well as income also influence broadband adoption. Figure 3 indicates that higher broadband adoption rates are associated with higher education level, higher income, and lower age. It also suggests a racial component to the digital divide, with Whites having higher adoption rates than Hispanics or Blacks. Moreover, Whitacre and Mills (2007) suggest that rural-urban disparities in education as well as income are the primary reasons for the geographical high-speed internet access gap. As an update to this analysis, Whitacre, Strover and Gallardo (2015) found that differences in Internet infrastructure account for roughly 40% of the rural-urban broadband adoption gap in 2013.

Figure 3. Broadband Adoption Rates by Demographic Segments.

		% with home broadband
All Americans ages 18+ (n=2,252)		**70%**
a	Men (n=1,029)	71
b	Women (n=1,223)	69
Race/ethnicity		
a	White, Non-Hispanic (n=1,571)	74[bc]
b	Black, Non-Hispanic (n=252)	64[c]
c	Hispanic (English- and Spanish-speaking) (n=249)	53
Age		
a	18-29 (n=404)	80[cd]
b	30-49 (n=577)	78[cd]
c	50-64 (n=641)	69[d]
d	65+ (n=570)	43
Education attainment		
a	No high school diploma (n=580)	37
b	High school grad (n=374)	57[a]
c	Some College (n=298)	78[ab]
d	College + (n=582)	89[abc]
Household income		
a	Less than $30,000/yr (n=417)	54
b	$30,000-$49,999 (n=320)	70[a]
c	$50,000-$74,999 (n=279)	84[ab]
d	$75,000+ (n=559)	88[ab]
Urbanity		
a	Urban (n=763)	70[c]
b	Suburban (n=1,037)	73[c]
c	Rural (n=450)	62

Source: Zickuhr and Smith, 2013.

Economic Impact of Broadband Adoption

A significant amount of research has found that broadband access and adoption has positive economic impacts. Kolko (2012) indicates a positive causal relationship between broadband expansion and employment growth. Notably, the causal relationship was prominent in high technology industry areas from 1999 to 2006. In addition, Katz and Suter (2009) estimated the employment impact of the American Recovery and Reinvestment Act (ARRA) of 2009, where a significant amount of funding ($7.2 billion) was invested in rural broadband infrastructure and service. According to their input-output analysis, 32,000 jobs were created per year by the ARRA broadband funding. Holt and Jamison (2009) review the literature to date and found that broadband initiatives and connections positively affect growth in jobs. Moreover, Whitacre, Gallardo and Strover (2014a) identified that high levels of broadband adoption causally impacted the higher level of growth in household income between 2001 and 2010 in rural areas. Beside income and employment, they also showed that high levels of download speed cause more creative class workers and lower poverty levels in rural areas. In a separate paper, Whitacre, Gallardo and Strover (2014b) found a positive relationship between rural broadband adoption rates and jobs or income as of 2012. Furthermore, Ross (2014) found a correlation between broadband and population growth. The research classified the counties in the United States in the order of broadband availability. Interestingly, the bottom half of the broadband-access rankings showed only very low rates of population growth between 2010 and 2013 (0.27%), while the top half of them had significantly higher growth rate (2.79%). Koutroumpis (2009) suggests that broadband penetration positively affects economic growth, especially on GDP per capita when significant investments in infrastructure exist. To the extent of OECD countries, Czernich et al. (2011) examined the effect of broadband supply on economic growth. The study found that annual GDP per capita growth rises approximately 1 percentage point as broadband threshold increases by 10 percentage points.

Generally, all of these studies support the idea that more broadband infrastructure and adoption is good for the economy. In particular, several studies stress the importance of adoption as opposed to simple access (Whitacre, Gallardo and Strover, 2014a; 2014b). Given the dramatic impact that broadband adoption can have an economic growth, it is not surprising that policies are being implemented to focus on improving adoption rates among low-income households. The Broadband Lifeline Program is one of those. Since low-income households have some of the lowest broadband adoption rates, improving those rates could have a potentially large effect on the overall economy.

Public Policy on Broadband Adoption

Historically, most federal programs have focused on providing broadband infrastructure access as opposed to trying to increase adoption. Kandilov and Renkow (2010) assessed that the United States Department of Agriculture (USDA) Broadband Loan Program worth $180 million and started in 2002 had stimulative impacts on economic outcomes such as employment and income level in recipient communities. LaRose et al. (2011) discussed the results of a natural field experiment on broadband projects by the USDA Rural Development Community Connect Program of the Rural Utilities Service, which extended high-speed internet access in rural areas to benefit rural residents. The appropriations for these grants varied from $9 million to $20 million between 2002 and 2013 (Kruger, 2013). When programs implemented funding for both infrastructure and public education, LaRose et al. (2011) found evidence of increased broadband adoption. Although LaRose et al. (2011) documented increasing broadband adoption rates in these cases, the study could not identify the impacts on individual economic development activities and community satisfaction. One study that used a qualitative approach, Powell, Bryne and Dailey (2010) suggested that social infrastructure as well as technical infrastructure should be used to fill the gap between high broadband demand and low adoption rate among low-income households. In particular, they indicate that funding allocated to community services such as school systems, libraries, and regional organizations would benefit low-income residents having limited internet access in-person. Whitacre and Rhinesmith (2015) also find evidence that rural libraries help to spur local broadband adoption rates. Most of all, broadband penetration and adoption create the positive externalities in the consumer surplus as well as employment or firm productivity (ITU, 2012). Specifically, Greenstein and McDevitt (2009) estimated that the consumer surplus took up 7.5 billion dollars among 28 billion dollars in total broadband surplus in 2006.

As one of the most influential public efforts, the National Telecommunications and Information Administration (NTIA) was funded to perform the Broadband Technology Opportunities Program (BTOP) through the American Recovery and Reinvestment Act of 2009. Hauge and Prieger (2015) conducted a study to find the impact of the BTOP and value whether the spending was worthwhile. However, they did not find any evidence that adoption-oriented policies worked. Furthermore, Hauge and Prieger (2010) tested the impact of demand-stimulus programs on broadband adoption. Hauge and Prieger studies show that there is evidence that some demand-side programs work. Along with Hauge and Prieger (2010), Whitacre, Strover and Gallardo (2015) addressed the importance of demand-side programs. They indicate that over 50% of the rural-urban broadband adoption gap is due to differences in characteristics such as income and education. They suggest that public policy should be focused on increasing adoption along with funding geared towards infrastructure provision.

This body of evidence suggests that the FCC’s Broadband Lifeline Program can be improved and made to be more effective at increasing broadband adoption rates among low-income households. This research will explore the ways that improvements to the Lifeline Program can be made.

Previous Lifeline Research

The overall goal of the traditional Lifeline Program has been helping make phone services affordable to eligible households (Hauge, Jamison and Jewell, 2008). However, since the telecommunications environment is changing continuously, the FCC has attempted various Lifeline Program modifications to increase household participation. Evidence from Florida suggests that the participation rate of the Lifeline Program was quite low (12%), even among those eligible for the program (Hauge, Jamison and Jewell, 2008). Thus, it was important to provide program information to eligible households to encourage participation. However, Hauge, Chiang and Jamison (2008) pointed out that 90% of low-income households in Florida had telephone service in contrast to their low Lifeline participation rates. Only 12% of the households eligible for the program took advantage of the discount and half of the households were even purchasing cellular phone service. The low-income households' participation in the Lifeline Program increased when the price of local telephone services was high, while it decreased when their use of cell phones increased (Hauge, Chiang and Jamison, 2008). Thus, the study concluded that regardless of a discount/subsidy amount, it is vital to understand the choices of low-income households.

According to a U.S. Government Accountability Office (GAO, 2015) report, the traditional Lifeline Program first aimed at wireline telephone services began in the 1980s. This report gave the phone Lifeline Program partial credit for reducing the number of low-income houses without phones. However, similar to Hauge, Jamison and Jewell (2008), the report also revealed that many low-income households still had telephone service regardless of whether or not they participated in the Lifeline subsidy (Olga Ukhaneva, 2013). The GAO study also raised a question on the FCC's action to expand the number of eligible households. Thus, there has been some evidence that the traditional Lifeline Program is not operating efficiently. In 2005, driven by a shift towards cellphone use by the general population, the program began funding cellphone service. The Lifeline Program is currently being updated to allow for subsidized monthly broadband access. Identifying the most effective ways to encourage broadband adoption among low-income households will be important as the Broadband Lifeline Program moves forward.

CHAPTER III

DATA AND METHODS

This study analyzes the FCC's Broadband Pilot Program, especially the projects of Nexus, PR Telephone (PRT), and NTCA. In contrast to other projects, Nexus, PRT, and NTCA are the only projects that allowed consumers to make choices among different plans. Table 1 provides specific descriptions of these 3 projects.

Table 1. Plan Descriptions of Nexus, PR Telephone, and NTCA

<table>
<tr><th></th><th>Subscribers</th><th>States</th><th colspan="2">Attributes</th></tr>
<tr><td rowspan="4">Nexus</td><td rowspan="4">274</td><td rowspan="4">OH, MI, IA, NY, CA, LA, MS, NJ</td><td>Subsidy</td><td>$0 / $15 / $20</td></tr>
<tr><td>Digital Literacy</td><td>Yes / No</td></tr>
<tr><td>Device</td><td>Aircard / Smartphone</td></tr>
<tr><td>Data Allowance</td><td>200MB / 500MB / 1GB / 2GB</td></tr>
<tr><td rowspan="3">PRT</td><td rowspan="3">354</td><td rowspan="3">Puerto Rico</td><td>Subsidy</td><td>Wireline: $5
Wireless: $18.50 for stand-alone</td></tr>
<tr><td>Speed (Wireline)</td><td>Voice service
2MB/1MB, 4MB/1MB</td></tr>
<tr><td>Data Allowance (Wireless)</td><td>2GB / 3GB</td></tr>
<tr><td rowspan="2">NTCA</td><td rowspan="2">45</td><td rowspan="2">NM</td><td>Subsidy</td><td>$25</td></tr>
<tr><td>Speed</td><td>DSL / FTTH
768KB/512KB
1.5MB/768KB
3MB/1MB
5MB/1MB
5MB/1.5MB</td></tr>
</table>

Source: FCC, 2015.

Table 2. Broadband Purchase Options for Each Subscriber

	Option	Data Allowance / Speed	Device	Monthly Cost	Equipment Cost	Consumer Choice	Number of Subscribers
Nexus	1)	200MB	Aircard	$24.99	$49.99	Data Allowance & Device	274
	2)	200MB	Smartphone	$24.99	$49.99		
	3)	500MB	Aircard	$29.99	$49.99		
	4)	500MB	Smartphone	$29.99	$49.99		
	5)	1GB	Aircard	$39.99	$49.99		
	6)	1GB	Smartphone	$39.99	$49.99		
	7)	2GB	Aircard	$49.99	$49.99		
	8)	2GB	Smartphone	$49.99	$49.99		
PRT	1)	2MB/1MB (DSL w/voice)	Tablet (Wifi)	$42.49	$180.00	Data Allowance & Speed	354
	2)	4MB/1MB (DSL w/voice)	Tablet (Wifi)	$49.50	$180.00		
	3)	2GB (Mobile BB)	Tablet (SIM)	$31.24	$150.00		
	4)	3GB (Mobile BB)	Tablet (SIM)	$41.24	$150.00		
	5)	2GB (Mobile BB)	Tablet (SIM)	$24.99	$150.00		
	6)	3GB (Mobile BB)	Tablet (SIM)	$34.99	$150.00		
NTCA	1)	768KB/512KB	DSL	$28.99	$49.99	Speed	45
	2)	1.5MB/768KB	DSL	$39.99	$49.99		
	3)	3MB/1MB	DSL	$49.99	$49.99		
	4)	5MB/1MB	DSL	$59.99	$49.99		
	5)	5MB/1.5MB	FTTH	$59.99	$49.99		

Source: FCC, 2015.

Table 3. Amount of Monthly Subsidy and Equipment Discount

	Monthly Subsidy Amount	Equipment Discount
Nexus	$0.00 $15.00 $20.00	$0.00
PRT	Wireline: $5.00 Wireless: $18.50 (stand-alone)	$0.00
NTCA	$25.00	$49.99

Source: FCC, 2015.

Table 2 summarizes what each subscriber in the 3 projects (Nexus, PRT, and NTCA) could potentially purchase. In addition to Table 2, Table 3 shows how much they would receive for subsidy and equipment discounts. Based on this, their total payment for each option can be calculated. As Table 3 shows, there were 3 potential subsidy amounts for Nexus (these were randomly selected for each household), while PR Telephone consumers received different subsidy amounts for wireline vs. wireless service. For example, if one Nexus subscriber is in a group with $20.00 subsidy and chooses the second purchase option (smartphone / 200MB / $24.99 / $49.99), the subscriber should pay $4.99 (= $24.99 - $20.00) per month and additional $49.99 for non-discounted equipment fee. And for the subscribers in NTCA (IA), the monthly subsidy amount decreases by $10.00 for each quarter. For example, if the subscriber of NTCA (IA) chooses the first purchase option (3MB/512KB / DSL-Bundled / $39.95 / $49.95), the monthly amount charged for the third quarter is $19.95 (= $39.95 – $20.00) and the fourth quarter is $29.95 ($39.95 - $10.00), with $0.00 (= $49.95 - $49.95) of equipment cost. Importantly, the monthly subsidy amount is typically random when it varies, so the effective cost can be different for subscribers choosing the same plan.

Table 4. Specific Options in each Broadband Pilot Projects and the Subscribers' Choice

Nexus : 274 observations						
	option	bbcost	limit (MB)	smartphone	subscribers	
	1	13.32	200	0	36	
	2	13.32	200	1	96	
	3	18.32	500	0	8	
	4	18.32	500	1	95	
	5	28.32	1000	0	1	
	6	28.32	1000	1	20	
	7	38.32	2000	0	2	
	8	38.32	2000	1	16	
PRT : 354 observations						
	option	bbcost	wired	limit (GB)	speed (MBPS)	subscribers
	1	37.49	1	240	2	170
	2	44.5	1	240	4	95
	3	12.74	0	2	1.5	70
	4	22.74	0	3	1.5	9
	5	6.49	0	2	1.5	9
	6	16.49	0	3	1.5	1
NTCA : 45 observations						
	option	bbcost	speed (KBPS)	bundled	subscribers	
	1	4.99	768	0	14	
	2	14.99	1500	0	8	
	3	24.99	3000	0	18	
	4	34.99	5000	0	3	
	5	34.99	5000	0	2	

Based on data collected, this study uses the conditional logit model to analyze a conjoint choice experiment and calculate low-income consumer's willingness-to-pay (WTP) for each specific broadband attribute.

The Conditional Logit Model

The conditional logit model takes the form:

$$U_{nkj} = \beta_1 x_{1kj} + \cdots + \beta_m x_{mkj} + \epsilon_{nkj}$$

where U_{nkj} represents the utility of person n for alternative j among the choice set k. Here, $\beta_1, \cdots, \beta_m$ are the coefficients to be estimated, and x_{mkj} is the m^{th} attribute value for alternative j in choice set k for respondent n. U_{nkj} is the functional form of the utility function and ϵ_{nkj} represents the stochastic error term. Based on the m-dimensional vector x_{kj} and β, and independent and identically distributed error term, the probability that respondent n chooses alternative j in choice set k can be expressed as:

$$P_{nkj} = \frac{\exp(x'_{kj}\beta)}{\sum_{i=1}^{J} \exp(x'_{ki}\beta)}$$

As can be seen, the x's vary across choices, while β's are constant (Vermeulen et al., 2008).

The Marginal Willingness-to-pay (WTP)

When the trade-off between the attributes is made, the marginal willingness-to-pay is called the marginal rate of substitution (MRS). In definition, MRS is the rate that an individual gives up a good or service in exchange for another while the utility is constant. Then, the trade-off between the attribute x_m and price p can be expressed as:

$$\mathrm{dU} = \beta_m dx_m + \beta_{price} dp = 0$$

And the willingness-to-pay (WTP) can be written as:

$$WTP_m = \frac{dp}{dx_m} = -\frac{\beta_m}{\beta_{price}}$$

where β_m is the marginal utility of the m^{th} attribute and β_{price} is the marginal utility of price. The estimated WTP would be used to find low-income household's price elasticity for a specific attribute related to broadband adoption. Specifically, this WTP represents the price at which the consumer will be indifferent between 2 options.

For Nexus, the subscribers were made to choose a device and data allowance. Accordingly, the monthly costs varied from $24.99 to $49.99, with $49.99 of one-time equipment cost. By deducting the amount of subsidy ($0 or $15 or $20) received, the actual total amount to be paid would vary. For PR Telephone, the subscribers' monthly costs varied from $24.99 to $49.50 with $150.00, $180.00, and $200.00 of one-time equipment cost. They received a $5 subsidy except for those who chose the stand-alone plans, in which case they received $18.50. Likewise, there would be 2 "price" variables which are monthly cost and one-time cost. Each of them can be subsidized, so what really matters is the "effective" cost (price – subsidy) for both monthly and one-time cost. This study will provide information on what future Broadband Lifeline Program consumers are willing to pay for specific types of access.

Data Summary

Each of the pilot projects asked the subscribers to answer specific demographic questions, reasons for non-adoption, and questions related to the plan and price selected. The data also notes whether participants retained their service after the subsidies ended. Table 5 shows the number of responses and mean value for each variable.

Table 5. Variables Used in Broadband Pilot Projects and the Estimates

	total (across 14 projects)		**nexus**		**pr telephone**		**ntca**	
	observations	mean	observations	mean	observations	mean	observations	mean
Digital Literacy								
litoffer	8707	0.437	274	0.018	354	1	49	0.041
litaccpt	8707	0.358	274	0.000	354	0.387	49	0.041
% Retaining broadband after subsidy								
retain1	2580	0.396	0	-	357	0.633	49	0.816
retain2	2580	0.377	0	-	357	0.608	49	0.735
retain3	2581	0.370	0	-	357	0.580	49	0.735
Discounts / Costs								
bbdsct	8867	20.783	274	16.496	357	8.441	47	25.000
bbcost	8895	15.993	274	13.165	357	33.210	47	17.756
feecost	5911	9.535	274	0.000	357	88.487	50	0.000
feedsct	8945	5.488	274	0.000	357	0.000	50	61.457
eqpdsct	5911	61.370	274	0.000	357	0.000	50	49.988
eqpcost	5911	59.549	274	49.990	357	172.353	50	0.000
Demographics								
age	8106	44.726	274	39.686	354	46.777	15	47.600
income	7771	1.670	274	1.712	354	1.398	15	3.733
numusingbb	7932	1.562	274	2.036	180	2.011	15	2.400
bbinpast	8104	0.224	274	0.219	352	0.159	15	0.467
Reasons for not previously adopting								
r1-cost	5465	0.710	274	0.339	354	0.209	15	0.267
r2-no need	5435	0.260	274	0.033	354	0.500	15	0.200
r3-didntknowhow	5345	0.115	274	0.066	354	0.056	15	0.200
r4-uncomfortable	5390	0.050	274	0.416	354	0.003	15	0.000
r5-okaywithdialup	5345	0.012	274	0.106	354	0.000	15	0.000
r6-accesselsewhere	5351	0.065	274	0.150	354	0.048	15	0.067

‘Litoffer’ and ‘litaccpt’ in the category of digital literacy are the percentage of subscribers offered and accepting digital literacy training along with their new broadband access. These are typically very low in two of the selected projects (Nexus and NTCA). This is simply a choice made by the companies – in some cases the entity that was supposed to offer the training was later unable to participate. The variables named ‘retain1’, ‘retain 2’, and ‘retain 3’ represent the percentage of subscribers who retained service after the first, second, and third month following the last discount. In case of PRT, the rate of subscribers who retained broadband service after subsidy ended decreased gradually for 3 months (63% → 58%). However, despite the decrease between the first and second month (82% → 73%), NTCA shows no change between the second and third month. No data was collected on these variables for Nexus. In the category of discounts and costs, ‘bbdsct’ and ‘bbcost’ denote the amount of monthly broadband discount and monthly broadband cost to the subscriber after discount. According to the estimates of bbcost, the average monthly cost of PR Telephone is the highest ($33.21), compared to Nexus ($13.17) and NTCA

($17.76). Also, the results indicate that feecost ($88.49) and equipment cost ($172.35) are high in PRT while other projects have less or even zero. This is expected, given PR Telephone's inclusion of a tablet device with each of their plans.

In terms of demographics, the mean age of the household head ranges from 40 – 48 across the 3 projects. As a categorical variable, income is divided into 5 different codes; 1: less than $5,000, 2: $5,000-10,000, 3: $10,000-20,000, 4: $20,000-30,000, and 5: more than $30,000. For example, the income result for NTCA explains that the average total household income in NTCA is between $10,000 and $20,000. This is significantly higher than the values for Nexus and PRT, although the number of observations is quite low. 'Numusingbb' means the number of household members using subsidized broadband. It indicates that the number of people using broadband in the house is higher for these 3 projects than for the rest of the projects. As a dummy variable, 'bbinpast' shows whether the consumer subscribed to broadband in the past or not. If the consumer did not subscribe, bbinpast=0 and otherwise, bbinpast = 1. The rate of subscribers who had previously adopted broadband is 22% for Nexus, 16% for PRT, and 47% for NTCA. Lastly, the variables from r1 to r6 are the reasons for the subscribers not adopting broadband; r1: monthly cost too expensive, r2: didn't use service, r3: don't know how to use computer/Internet, r4: uncomfortable with Internet, r5: happy with dial-up, and r6: could access Internet elsewhere. Interestingly, Nexus and PRT had a higher percentage of subscribers citing "uncomfortable" and "no need", respectively, while for NTCA (and most of the other projects) "cost" is the biggest reason for not previously obtaining broadband.

This research examines how each observation from the 3 projects faces specific choices that will be estimated via a conditional logit model. Then, differences among the attributes of those choices are used to estimate the WTP for specific broadband components. Results from the WTP model can indicate, for example, a low-income household's willingness-to-pay for a higher data allowance (Nexus), a wireless connection (PRT), or higher download speeds (NTCA).

CHAPTER IV

RESULTS

The WTP models of Nexus, NTCA, and PR Telephone provide useful results that can be applied to the Lifeline Program, and should help to design effective policies for encouraging broadband adoption by low-income consumers. The results suggest that, in general, smartphone use is preferred over aircards, and that a wireline connection is preferred to wireless ones (when both are available). Although the speed of the connection and data limits are not always statistically significant, there is evidence that low-income consumers are willing to pay for an extra GB of data each month – but not for higher download speeds. Importantly, the results also demonstrate that some of these outcomes (like the preference for smartphones) are significantly impacted by specific household characteristics such as age or reason for not previously adopting broadband. The findings from each of the three companies are discussed in turn.

Nexus

Results from the Nexus data are shown for 10 distinct models in Table 5. The models all find that the coefficient of *broadband cost* is significant at the 99% level and negative. This unsurprising result demonstrates that the consumer's demand for broadband decreases as the monthly price increases. In model 1, *smartphone* is positive and significant at the 99% level, which implies that the consumer's utility of smartphone use is greater than that for the default option (aircard use). The consumers are willing to pay \$10.38 ($WTP_{smartphone} = -\frac{1.0704}{-0.1031} = 10.3822$) for smartphone access which seems reasonable since most were paying between \$13 and \$40 monthly (with an average of \$13.17). The models also allow us to test for the WTP of increasing data limits. Model 2 implies that *limit* is insignificant (but just barely, $\mathrm{p} = 0.104$): $WTP_{limit} = -\frac{0.0005}{-0.1422} = (\$)\ 0.0035$, which translates to \$3.5/GB per month. However, model 3 (which also controls for smartphone) shows that the coefficient on *limit* is negative at the 90% significance level. This indicates that the consumer's utility decreases as data limit increases which would imply a negative WTP and is counter to economic theory. This result seems to indicate that consumers are mostly driven by preference for smartphones (versus aircards) and that higher data limits are not as important.

Interactions between specific characteristics (such as age or income) and these plan attributes are also included in the model. Model 4 implies that *age* is not significant for consumers when choosing a device between smartphone and aircard. In particular, those over age 60 show no statistical difference from younger households in their WTP for a smartphone. However, model 5 indicates that *income* is a significant factor in determining what device is preferred. The result suggests that lower-income consumers (defined as those making less than \$20,000) are willing to pay approximately \$10 per month more for smartphone access than higher-income consumers:

$$\left(WTP_{incomeless\$20,000smartphone} = -\frac{1.168}{-0.1031} = 11.3288\right)$$

$$-\left(WTP_{incomemore\$20,000smartphone} = -\frac{1.1680 - 0.9793}{-0.1031} = -\frac{0.1887}{-0.1031} = 1.8303\right) = 9.4985.$$

Thus, the preference for smartphones declines dramatically for those with income over \$20,000. This may be because the slightly higher income category of households is more familiar with the use of aircards (and possibly have a device such as a laptop or tablet that can be used with aircards), or because they already have a working smartphone. With respect to *limit*, models 7 and 8 indicate that both age and income are not found to be significant when they are included as interaction terms. However, model 9 shows that the marginal utility of *limit* for the consumer who chose cost as a reason for not previously adopting broadband is slightly lower than for those consumers who chose other reasons (such as a lack of need for Internet service or not being comfortable using the Internet). In fact, the WTP for an additional MB of data for consumers who chose cost as their primary reason for not adopting was actually zero: $WTP_{r1costlimit} = -(\frac{0.0006-0.0006}{-0.1426}) - (\frac{0}{-0.1426}) = 0$. However, it was approximately \$ .004 per MB ($WTP_{otherthanr1costlimit} = -\frac{0.0006}{-0.1426} = 0.0042$) for other consumers. This translates to \$4/GB per month. In other words, consumers choosing some reason other than cost for not adopting had a WTP of \$4/GB of data per month, but those choosing cost as a reason for non-adoption had \$0 WTP. An expansion of model 9 is shown in model 10, which controls for both smartphone and limit but also interacts *r1cost* with limit to estimate the WTP. Although *smartphone* is significantly positive, the coefficient of *limit* is not significant in model 10 to explain the relationship between the reasons and the choice of data limits. Again, this suggests that the preference for smartphones is driving the analysis. The Pseudo R^2 values, with ranges from 0.20 to 0.25 for the 10 models, suggest that they explain roughly ¼ of the variation in the models.

Table 6. Conditional logit results using Nexus Data

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
bbcost	−0.1031*** (0.0105)	−0.1422*** (0.0209)	−0.0715*** (0.0208)	−0.1031*** (0.0105)	−0.1031*** (0.0105)	−0.1031*** (0.0105)	−0.1424*** (0.0209)	−0.1424*** (0.0209)	−0.1426*** (0.0209)	−0.0718*** (0.0208)
smartphone	1.0704*** (0.1617)		1.1911*** (0.18)	1.0727*** (0.167)	1.168*** (0.1736)	0.9597*** (0.1915)				1.1908*** (0.1799)
limit		0.0005 (0.0003)	−0.0005* (0.0003)				0.0004 (0.0003)	0.0005* (0.0003)	0.0006** (0.0003)	−0.0003 (0.0003)
ageover60 *smartphone				−0.0367 (0.6574)						
incomeover4 *smartphone					−0.9793** (0.4939)					
r1cost *smartphone						0.353 (0.3545)				
ageover60 *limit							0.0007 (0.0005)			
incomeover4 *limit								−0.0008 (0.0007)		
r1cost *limit									−0.0006* (0.0003)	−0.0006* (0.0003)
total number of observations	2192	2192	2192	2192	2192	2192	2192	2192	2192	2192
pseudo R^2	0.2443	0.1995	0.2468	0.2443	0.2475	0.2452	0.2013	0.2009	0.2021	0.2494

- *, **, and *** denote statistical significance at the p = .10, .05, and .01 levels, respectively.

Overall, the Nexus data suggest that low-income consumers significantly prefer smartphones over aircard, with a WTP of $10.38 per month for a smartphone. Interestingly, the households with incomes less than $20,000 are willing to pay $10 more for smartphone than the higher income households, perhaps because higher income households already have access to a (lower quality but usable) smartphone. However, age has no impact on the choice of a device. Several models show a WTP for increased data limit of roughly $4/GB per month, although this result disappears when we include the preference for smartphone. Age and income also do not have any significant relationship with data limits. Other variables were also tried as interactions, such as ‘bbinpast’ for limit and ‘numusingbb3’ (the number of households using broadband is over three) for smartphone, and these were also not significant (and not shown in Table 6). Lastly, the consumers who are most susceptible to cost are less willing to pay for a higher data limit compared to other consumers. From a policy perspective, these results suggest that future efforts should be focused on fostering the use of smartphones instead of promoting aircard use among low-income consumers. Furthermore, the Lifeline program should not attempt to differentiate specific subsidy options for various levels of income or age groups, since the WTP does not vary for smartphone or limit across these categories. Finally, households choosing cost as a reason for not adopting should be made aware of the lower data limit plans available, and lower-data limit plans should specifically be included among the wireless options rolled out.

PR Telephone

Table 7 displays model results for 13 specifications associated with the PRT data. Most of the coefficients of *broadband cost* are significant and negative (as expected). Exceptions to this are models 3, 7, and 12. Models 1 and 2 indicate that, as expected, the values of *wired* and *limit* are significantly positive with WTP for *wired* ($WTP_{wired} = -\frac{3.3897}{-0.06} = (\$)\ 56.495$) and comparatively low WTP for *limit* ($WTP_{limit} = -\frac{0.0143}{-0.0601} = (\$)\ 0.2379/GB$). This value for WTP_{wired} seems too high to be realistic, since the average monthly cost for PRT customers was only $33.21. Surprisingly, model 3 and 4 indicate that *speed* is significantly negative which means that the utility of consumers decreases as the download speed of internet increases. However, since model 3 also has a significantly positive value of *broadband cost*, it does not seem that this model is behaving according to economic theory. Models 4, 5, 6, and 7 allow us to test for the WTP by including two or three different broadband attributes listed above in each model. Interestingly, models 4 and 5 imply a negative WTP for both *speed* and *limit*, again counter to economic theory for these attributes: $WTP_{speed} = -\frac{-0.1521}{-0.0381} = -(\$)3.99$ per MBPS and $WTP_{limit} = -\frac{-1.7792}{-0.0105} = -(\$)169.45$ per GB of data. On the other hand, model 6 has a significantly positive value of *limit* and negative value of *speed*. Consumers are willing to pay $0.33/GB for data limit while WTP for speed is less than 0: $WTP_{limit} = -\frac{0.0126}{-0.0382} = (\$)0.33$ per

GB and $WTP_{speed} = -\frac{-0.1512}{-0.0382} = -(\$)3.96$ per MBPS. Model 7 includes all three broadband attributes (wireline, limit, and speed) and it suggests that both *limit* and *speed* are negatively related to consumers' utility, but a choice of *wired* is highly preferred among low-income consumers. However, a significantly positive value of *broadband cost* in model 7 suggests that this model is not behaving as economic theory would suggest.

Interactions between consumers' particular characteristics such as income, digital literacy training, and the period of receiving discounts are also included in the models to see if the impact of broadband attributes still holds along with these independent factors. In particular, model 8 indicates that the level of income shows no statistical difference in the WTP for a wireline connection. In essence, the WTP_{wired} is unchanged at around \$56/month. Model 9 also suggests that the level of income does not affect consumers' choice of data limit. Model 10 indicates that acceptance of digital literacy training among low-income consumers is not found to be a significant factor for consumer's preference for wired connections. However, models 11 and 13 show that consumers who have received discounts more than 10 months are willing to pay more for wired connections and higher data limits than other consumers. The consumers receiving discounts more than 10 months are willing to pay \$10.48 more for *wired:* $(WTP_{dsctmore10wired} = -\frac{2.9842 + 0.6286}{-0.06} = -\frac{3.6128}{-0.06} = 60.2133) - (WTP_{dsctless10wired} = -\frac{2.9842}{-0.06} = 49.7367) = (\$)10.4766$, and are willing to pay an additional \$0.04 per month for an extra GB of data limit: $\left(WTP_{dsctmore10limit} = -\frac{0.0152}{-0.0601} = 0.2529\right) - \left(WTP_{dsctless10limit} = -\frac{0.0126}{-0.0601} = 0.2097\right) = 0.0432$. However, model 12 implies that the period of discounts that consumers received does not significantly affect their choice of *speed*. Again, the parameter on *broadband cost* is positive which is suggesting that this is a poor model.

Table 7. Conditional logit results using PR Telephone Data

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13
bbcost	−0.06*** (0.013)	−0.0601** (0.0129)	0.0877*** (0.0071)	−0.0381** (0.018)	−0.0105 (0.0155)	−0.0382** (0.0181)	0.3175*** (0.0515)	−0.06*** (0.0128)	−0.0601** (0.0129)	−0.0631*** (0.013)	−0.06*** (0.0128)	0.0878*** (0.0071)	−0.0601*** (0.0129)
wired	3.3897*** (0.3757)			2.9842*** (0.4298)	425.0056*** (82.2203)		1197.815*** (141.8758)	3.3967*** (0.3761)		3.4104*** (0.391)	2.9842 (0.4064)		
limit		0.0143*** (0.0016)			−1.7792*** (0.3465)	0.0126*** (0.0018)	−5.0592*** (0.6006)		0.0143*** (0.0016)				0.0126*** (0.0017)
speed			−0.4826** (0.0797)	−0.1521* (0.0899)		−0.1512* (0.0901)	−1.3984*** (0.1913)					−0.5401*** (0.1122)	
income4 *wired								−0.3866 (0.8747)					
income4 *limit									−0.0016 (0.0037)				
litaccpt *wired										0.221 (0.2554)			
dsctmos10 *wired											0.6286** (0.2516)		
dsctmos10 *speed												0.0833 (0.1124)	
dsctmos10 *limit													0.0026*** (0.0011)
total number of observations	2142	2142	2142	2142	2142	2142	2142	2142	2142	2124	2142	2142	2142
pseudo R^2	0.2153	0.2149	0.1720	0.2176	0.2412	0.2171	0.3033	0.2155	0.2150	0.2211	0.2201	0.1725	0.2197

- *, **, and *** denote statistical significance at the p = .10, .05, and .01 levels, respectively.

Overall, the PRT data indicate that low-income consumers are significantly more willing to pay for a wireline connection ($56 WTP) than for wireless. This is a unique finding that was not testable in the other data sets. However, the high numerical value should serve as a caution that the data may not be behaving exactly as expected – in particular, comparing speed and limit across wired/wireless options may be problematic. The main conclusion, however, is that a preference for wired connections exist (without being confident in the resulting point WTP estimate). A higher data limit is also significantly preferred among low-income consumers, with a WTP of $0.24/GB per month. In these models, speed negatively affects the utility of consumers for adopting broadband service which is a counterintuitive finding that could be explained by the high correlation between *speed* and *wired*. With respect to interaction terms, income and acceptance of digital literacy training have no impact on the consumer preference for a wired connection. However, the length of the discount period does impact consumer preference for wireline connection and data limits. These results indicate that consumers receiving more months of discounted service are willing to pay more for a wired connection and for higher data limits.

For wired access, the WTP of consumers receiving at least 10 months of discounts is $60.21 for a wired connection compared to only $50 for those with less than 10 months. For data limits, the WTP of consumers who received discounts more than 10 months is $0.25/GB compared to $0.21/GB for those with discounts less than 10 months. From a policy perspective, the Lifeline Program should recognize this preference for a wireline connection (rather than wireless) among low-income consumers. Specifically, offering long-term discounts for consumers would encourage their choice of a wired connection as well. On the other hand, future efforts should not necessarily be focused on offering faster download speeds, since consumers did not demonstrate a positive WTP for faster speed. Also, no differences across income levels were found for this program, implying that varying options for different income groups is not necessary. Lastly, since accepting digital literacy training does not impact the choices consumers make, the Lifeline Program should consider various ways to assess the adequacy of current training programs.

NTCA

Table 8 shows the results of models using NTCA data. Most of the results of the NTCA data are not significant and are counter to the expected signs. With only 45 observations in each category, it appears that the NTCA data was not robust enough to examine the specific choices and estimate the WTP for each broadband component. First and foremost, the coefficients of *broadband cost* are positive and insignificant, which disagrees with the axiom that the consumer's demand should decrease as the price increases. The rest of broadband factors such as speed, income, and number of households are also not significant to examine the utility of consumers. The poor explanatory power of the model (less than 0.10 in most cases) also suggests that the included variables do not do a good job explaining why consumers acted the way they did. Given these results, the NTCA data is not overly useful for developing WTP estimates for specific broadband attributes. Therefore, the remaining portion of this thesis will only focus on the Nexus and PRT data.

Table 8. Conditional logit results using NTCA Data

	Model 1	Model 2	Model 3	Model 4	Model 5
bbcost	0.0878 (0.0663)	0.0918 (0.0668)	0.0878 (0.0663)	0.0192 (0.1258)	0.0882 (0.0663)
speed	−0.0009* (0.0005)	−0.0012** (0.0006)	−0.0009 (0.0006)	−0.0005 (0.001)	−0.0009* (0.0005)
numusingbb3 *speed		0.0003 (0.0004)			
incomeover4 *speed			2.45e−06 (0.0004)		
r1mcost *speed				−0.0002 (0.0005)	
usedcomp *speed					−0.0001 (0.0003)
total number of observations	225	225	225	225	225
pseudo R^2	0.0779	0.0850	0.0779	0.1253	0.0786

- *, **, and *** denote statistical significance at the p = .10, .05, and .01 levels, respectively.

Lastly, Figure 4 and 5 show the confidence intervals for the WTP estimates for several Nexus and PR Telephone results. Since the parameters from each of the conditional logit models have their own standard errors, the significance of the 'final' WTP estimates cannot be directly estimated (Jeanty, 2007). However, the Krinsky and Robb (1986) procedure helps to establish the upper and lower bound of each WTP estimate. The procedure follows a normal distribution with each of the WTP parameters and estimates the 95% confidence intervals with 10,000 WTP iterations. The Krinsky and Robb procedure was first introduced to examine the non-linear functions (Krinsky and Robb, 1986). Then, Hole (2007) introduced it into Stata with the WTP command as one of the methods to estimate WTP confidence intervals. Since the Krinsky and Robb method does not restrict WTP only to the symmetric distribution, its percentile confidence intervals yield more accurate and better observation than other methods. Figure 4 and 5 indicate that *smartphone* and *limit* have confidence intervals that vary – but that the basic trends of preferences for smartphones (Nexus) and wired connections (PR Telephone) still hold.

Figure 4.Willingness-to-pay and the Estimated Standard Errors for Nexus.

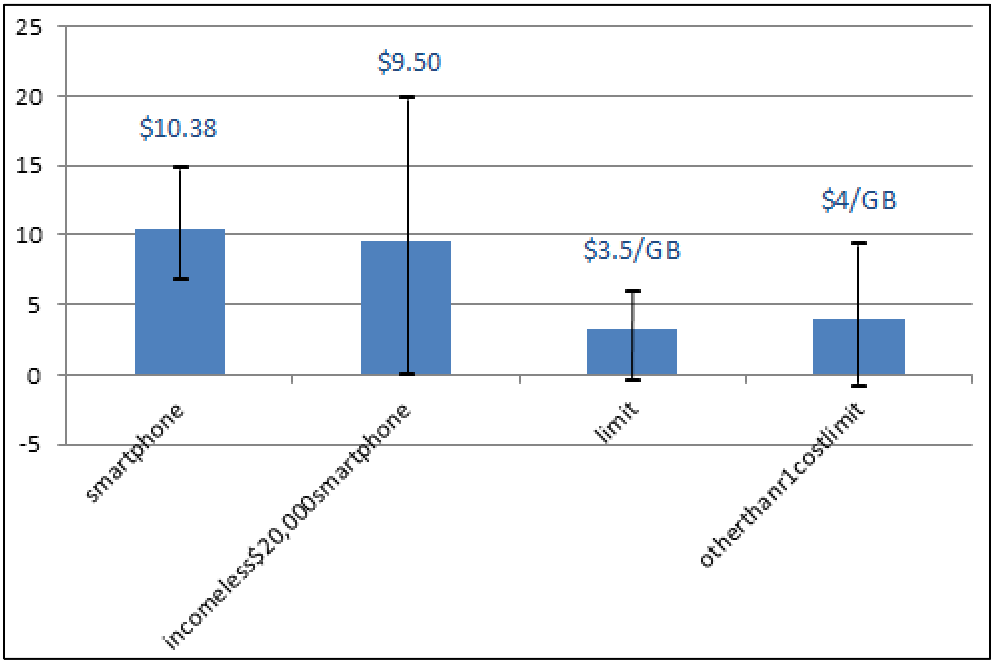
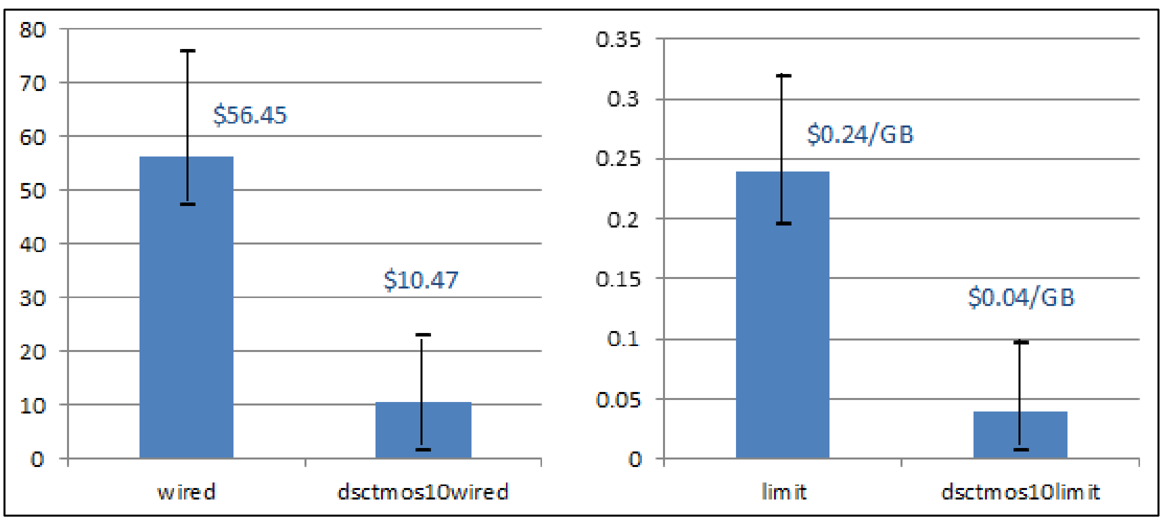


Figure 5.Willingness-to-pay and the Estimated Standard Errors for PR Telephone.



CHAPTER V

CONCLUSION

This paper provides important results associated with the willingness-to-pay for specific broadband attributes by low-income consumers. The Lifeline Pilot Program is focused on encouraging broadband adoption by low-income households, and several specific results can help with future rollouts of the program. The two main findings from the pilot projects are 1) a high preference for smartphones (compared to aircards) and 2) preference for wireline connections (versus wireless) among low-income consumers. Several recent studies support the findings that lower-income consumers prefer smartphones to aircards, and provide additional evidence that Lifeline policy should focus much more heavily on smartphone-oriented options as opposed to options requiring other devices such as laptops or tablets.[2] According to Cox (2015b), the Pew Research Center surveys in 2015 show that the percentage of low-income consumers using a smartphone, but not adopting home broadband service, has increased 8 percentage points between 2013 and 2015. Even more importantly, the report indicates that there is a high proportion of smartphone-only users composed of the young (under age 29) and the poor (income under $20,000) and that this choice of being 'smartphone only' is due primarily to cost issues. Similarly, Martin (2016) indicates that nine out of ten low-income families actually have Internet access at home, but they are only able to connect a tablet or a smartphone to the Internet due to

[2] Note that this finding is specific to wireless-only providers. The results are different when companies can offer either wireless or wireline access (and in fact show a preference for wireline connections).

cost problems. In conjunction with the results from this research, these studies imply that cost is the prominent reason that actually hinders consumers from choosing devices other than smartphones. Specifically, an aircard is a type of mobile broadband modem that allows a laptop, tablet, or a personal computer to get Internet access without a wireline connection. Since it is a device that helps to connect personal computers to the Internet, having an aircard necessarily requires the extra cost associated with additional devices. This suggests that lower-income consumers prefer a single device such as a smartphone, since it can also be used for phone calls (as opposed to tablets). Slightly higher income consumers may be more likely to have another device available to them. This explains why consumers with income over $20,000 are more willing to pay for aircards than smartphones. Thus, for wireless providers, the Lifeline Program should focus on cost-effective smartphone options (as opposed to aircards) for low-income consumers (especially with income less than $20,000).

Second, some companies that will participate in the FCC Lifeline Program can offer either wireless or a wireline connection. The results here suggest a clear preference for wireline connections among low-income consumers[3] when they have a choice between the two. The Federal Communications Commission report (FCC, 2015) indicates that 70 percent of the PR Telephone project participants chose a wired connection rather than wireless. Martin (2016) explains that there are significant drawbacks to having a wireless connection for low-income consumers (in comparison to having a wired connection). The study indicates that one-fifth of low-income families share one smart device together, so individuals have difficulty in utilizing the Internet service efficiently. Furthermore, through only a single mobile connection, the data allowance for a smart device is consumed quickly under a limited data plan. The findings from the PRT portion of the FCC pilot projects suggests that the prospective Lifeline Program should expand options for wired connections instead of promoting wireless access for those who are not familiar with broadband service at all. Moreover, the Lifeline Program should pay close attention

[3] It is worth noting, however, that this result is based on a single provider based in Puerto Rico.

to (and even possibly incentivize) the length of program participation (i.e. the number of months a household receives a discount). The results from the PR Telephone project show that those who had discounts for more than 10 months had a significantly higher preference for a wireline connection.

The latest Census Bureau estimates found that 25 percent of the nation still does not have broadband access at home (Cox, 2015a). Two recent initiatives have sought to address this. ConnectHome focuses on linking public having programs and broadband access, and hopes to enable cost-sensitive low-income households to pay no or very-low broadband cost for their home broadband service. The second initiative is the Lifeline Program, which is the focus of this research. In addition to the findings concerning devices and connections, there are specific results that should be applied to data limits and download speeds. First of all, households choosing cost as a reason for not previously adopting broadband should be made aware of the lower data limit plans available. Those who are sensitive to cost are much more likely to choose plans with lower data limits. As Table 4 shows, broadband costs generally increase with higher levels of data limits. Thus, the Lifeline Program may need to concentrate on providing lower data limit plans to cost-sensitive consumers. Notably, the recent FCC proposal circulating for the new version of Lifeline Program has set a minimum standard of broadband to fulfill consumers' needs (FCC, 2016). This new proposal has established a minimum monthly fixed data allowance of 150GB for wireline, approximately 100GB lower than that used in PR Telephone project. However, FCC (2016) sets a minimum standard of data limits for wireless at 500MB/month of 3G data and plans to increase to 2GB/month until the end of 2018. An inclusion of this new standard would be more effective when it comes to the lower cost or higher discounts, and eventually benefit low-income consumers compared to the latest Lifeline projects varying different levels of data limits. The results from the PR Telephone project show that those who received discounts more than 10 months have a preference for higher data limits. It seems that as the length of the discount increased, consumers began to recognize the need for a higher data limit. This result could be worked into policy in several ways, including automatic shifts to higher data plans (with a slightly higher price) after a pre-specified period of time. Interestingly, the result that consumers do not have a significant WTP for faster download speeds also suggests that the Lifeline Program should not focus on the level of speeds to foster consumers' broadband adoption. Similar to data limits, Table 4 shows that broadband cost increases as download speeds become faster. However, in the case of download speeds, there is no effect of receiving long term discounts on consumers' WTP. Thus, options available as a part of the FCC Lifeline Program should not be overly focused on providing various levels of speeds – often the lower speeds will suffice. In particular, the FCC's new proposal also suggests a fixed speed standard as 10 MB rather than varying the different levels of speeds for wireline. The fact that some minimum has been established – but that varying thresholds are not required – indicates that the program is aware of this lack of WTP for specific speeds. Furthermore, the result about WTP for smartphone not varying across age or income indicates that subsidies should not vary by these different levels of attributes. According to FCC (2016), the Lifeline proposal being circulated is $9.25 per month as a household subsidy for every participant. Future research may want to consider how much varying this amount would increase participation (and the resulting impact on economic output). Lastly, the broadband providers with tax incentives would also foster broadband deployment, especially with regard to the high-cost required services. The new Lifeline proposal has also established budget mechanism in favor of tax payers and freed up the Lifeline marketplace to spur the participation of providers.

In conclusion, these results from the three pilot projects where consumers could choose between different options may suggest opportunities for the new version of the Lifeline Program. The future versions should be more concentrated on the reality of low-income households still in need, as opposed to simply pushing for the growth of broadband adoption throughout the nation. The eventual options made available to low-income households should take into consideration the specific WTP for particular broadband attributes that will lead to long-term, effective broadband adoption, and in particular, broadband *use*.

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