A Data-Driven Digital Inclusion Strategy for Gigabit Cities

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EXECUTIVE SUMMARY

While the word "gigabit" has yet to enter the daily vocabulary of most Americans, city governments have grown acquainted with it. In 2010, over 1,100 municipalities applied to be the first Google Fiber city.[1] Kansas City was eventually chosen, meaning it would receive fiber-to-the-home connections with up to a gigabit in speed – roughly 100x faster than the average Internet download speed in the U.S. in 2015. Of course, with any infrastructure project – whether it's roads, rail, or increasingly essential 21st-century information networks – equity is an important consideration. While cities have increased speeds by partnering with private companies or building gigabit networks themselves, they struggle to be digitally *inclusive*. Getting high speed is one thing, but getting everyone online regardless of racial, income, or educational background is another.

Through a mix of data analysis and expert interviews, this study unpacks the barriers to digital inclusion. The primary focus of this study is on developing a set of recommendations to combat the digital divide in gigabit cities and aspiring gigabit cities. The most important findings being:

Finding #1	Gigabit connectivity weakens the usual effect that poverty has on reducing at-home Internet adoption. Specifically, when it comes to both citywide broadband adoption and tract-level broadband adoption in gigabit cities, there is significant interaction between poverty and gigabit access.
Finding #2	The data reveal groups that are particularly vulnerable in the gigabit city digital divide: concentrated, high minority or non-English speaking populations and populations with low educational attainment. The fact that these populations are at risk points to a potential gigabit city-specific "intimidation barrier" for potential broadband adopters.
Finding #3	Low-income census tracts in gigabit cities can beat the odds through proximity to public services, community anchor institutions, and digital inclusion programing.
Finding #4	In general, there is uncertainty and a lack of institutionalized, city support to combat the digital divide sustainably. Only a few cities like Austin, TX and Seattle, WA dedicate a government office or

	annual public funds specifically to digital inclusion.
Finding #5	The interview process uncovered that the relevancy barrier ("I don't know why I need the Internet") is often underestimated.

Based on the findings above, I propose the following targeted recommendations for actors who operate within gigabit cities or aspiring gigabit cities and whose work relates to broadband adoption:

City Governments of Current & Aspiring Gigabit Cities	❖ Designate a digital inclusion point of authority in your city by either partnering with a proven nonprofit or designating a city employee or office to own the issue. ❖ Map your city's "digital deserts," or places where socioeconomic barriers to broadband adoption meet low access to public services and existing digital inclusion programs. ❖ City governments of current gigabit cities should use the "digital desert" information to target programming (whether city-led or through a nonprofit partner), paying special attention to geographically concentrated non-English speakers and communities with low educational attainment. ❖ City government of aspiring gigabit cities should use the "digital desert" information to inform programming *and* inform targeted community "asks" when forming public-private partnership agreements with Internet service providers.
For Internet Service Providers in Gigabit Cities	❖ Give support to trusted, local digital inclusion programs rather than creating and running new digital inclusion programs. ❖ Leverage your branding and marketing capabilities to assist the city government in tackling the underestimated relevancy barrier and added "intimidation barrier" in gigabit cities.

INTRODUCTION

Gigabit cities have a buzz and excitement about them – not just in the headlines, but also in person. Chattanooga's Public Library, nested in the city's Innovation District, has a "giglab" featuring 3D printing that any citizen with a library card can access. There's also a civic lab with an open data portal. This public space in America's first gigabit city has hosted small business pitch competitions as well as "Makers" Day Fairs.[2] Several states away in Kansas City, the Google Fiber headquarters sits as a sleek, welcoming space filled with devices ready for speed tests and staff ready to answer questions.[3] Across town is a start-up village filled with aspiring tech entrepreneurs.[4]

Beyond the buzz, however, hides the question of whether the people walking through these cutting-edge, innovative spaces are representative of the communities they are located in. Does the presence of super fast Internet in a city spillover and positively impact the connectivity of the entire city, of all parts of the city? The "digital divide" – or, the gap between those that have the Internet and know how to use it and those that do not – is not a challenge unique to gigabit cities, but it may be one that looks different in gigabit cities.

TERMS

broadband adoption –the decision to subscribe to broadband Internet services in the home.

digital divide – the gap that exists between those that have the Internet and know how to use it and those that don't.

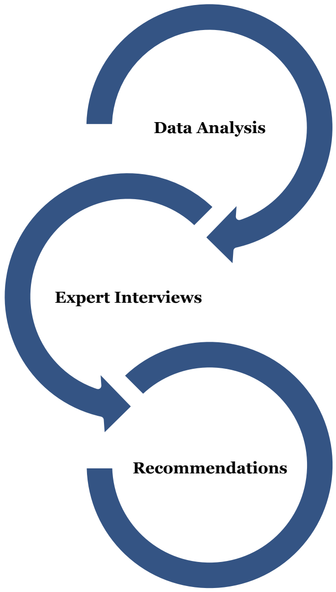
digital inclusion – the goal of decreasing or eliminating the digital divide.

gigabit – gigabit Internet speeds are roughly 100x the average download speeds most Americans have today (10 Mbps).

gigabit city – a metropolitan statistical area (MSA) designated by the National Broadband Map where over 50% of households have access to gigabit speeds as of December 2013.

For more terms, see the glossary in the Appendix.

This study will research effective digital inclusion strategies in gigabit cities and produce a collection of recommendations for city government officials and partnered Internet service providers. To do this, the study will draw from several parts:



- First, the ***data analysis*** will reveal what the digital divide looks like in gigabit cities and whether it differs systematically from the digital divide in non-gigabit cities.

- Second, the ***expert interviews*** will reveal best practices for broadband adoption and digital inclusion.

The recommendations will come from synthesizing trends from the data analysis and expert interview to address the questions of interest:

How do current digital inclusion best practices need to be adapted to accommodate the strengths and weaknesses of gigabit cities? How can we get more citizens in these cities online?

BACKGROUND

This section will summarize the main literature on broadband adoption and gigabit cities in general, setting a foundation for the quantitative and qualitative data analysis to follow.

ON BROADBAND ADOPTION AND THE DIGITAL DIVIDE

***The* digital divide is associated with certain demographic groups and socioeconomic characteristics – mostly aligning with existing inequities.**

Survey work has found overlap between people who do not adopt the Internet in the home and other socioeconomic groups. For instance, the Pew Internet & American Life Project has investigated who in the U.S. are non-adopters and why. According to Pew, in 2013 70% of Americans had a broadband connection in their home. Also, 70% of Americans in urban areas had a broadband connection in the home.[5] Certain groups such as African Americans, people in poverty, people over the age of 65, and people with low educational attainment had lower than average home broadband adoption rates, according to the 2013 *Broadband in the Home Report*.[6]

BROADBAND ADOPTION IN AMERICA

According the Pew Internet & American Life, in 2013, 70% of Americans had broadband in the home, but that average changes when broken down by subcategory:

- Black – 64% adoption
- Hispanic – 53% adoption
- 65+ - 43% adoption
- No diploma – 37% adoption
- <$30,000/year – 54% adoption

In another 2013 survey, Pew investigated what they call "offline adults," or adults who might know about the Internet, benefit from it, or even live in a household where it exists, but still opt not to use it. They found that 15% of American adults fall into this category. These people are often senior, they tend to make under $30,000 and they didn't graduate from high school.[7]

The digital divide is not just about getting people on today's broadband speeds – it's an evolving problem that might require constant redefinition.

Fixing the digital divide can be seen not just as facilitating home adoption, but also as having users reach a certain level of skill and fluency.[8] For instance, if we see broadband adoption not just as binary (determined by the question, “Are they subscribed or not?”), but as also including a spectrum of comfort and skill, it becomes more complex and perhaps more relevant to the opportunity gaps policymakers care about. For instance, should we think about bridging the digital divide in terms of getting low-income neighborhoods online? Or is bridging the digital divide also about making sure that a low-income neighborhood has enough digital fluency to compete and thrive in the digital age?

According to a recent “Digital Readiness Report” conducted by John Horrigan, nearly a third of Americans have trouble navigating the Internet – whether they have access to it or not.[9] The concept of digital readiness implies that equity is not just about ensuring everyone is online, but about making sure everyone is online and capable – whatever “capable” might mean in 2015, 2020, or beyond. Digital readiness implies that the digital divide challenge might be ever evolving and ever-changing as new technologies are introduced and adopted by society. This idea is reinforced by empirical studies. Martin Hilbert work, for instance, supports the idea of technological inequity as an inherently moving target.[10]

Like digital readiness, the goal of “digital citizenship” is another step beyond the more binary question of getting at-home access. Digital citizenship, or the ability to fully participate in society online, requires both individual ability and reducing communitywide digital disparities.[11]

The literature is in agreement about the definition of barriers to broadband adoption.

Why don’t people subscribe to Internet in their homes? Whether from academic studies, think tanks, nonprofits or government agencies, literature on broadband adoption is in agreement about the major barriers to Internet subscriptions in the home. Early survey research from Pew Internet & American Life asked respondents the main reasons why they do not use the Internet. “Just no interested,” “Don’t have a computer,” “Too expensive,” and “Too difficult” were the most common reasons given. [12] In a similar pattern, the Broadband Adoption Toolkit by the National Telecommunications and Information Association (NTIA) groups barriers as cost, perception, relevance, and skill.[13] Cost, digital literacy, and relevance were the three main barriers discussed in the National Broadband Plan.[14]

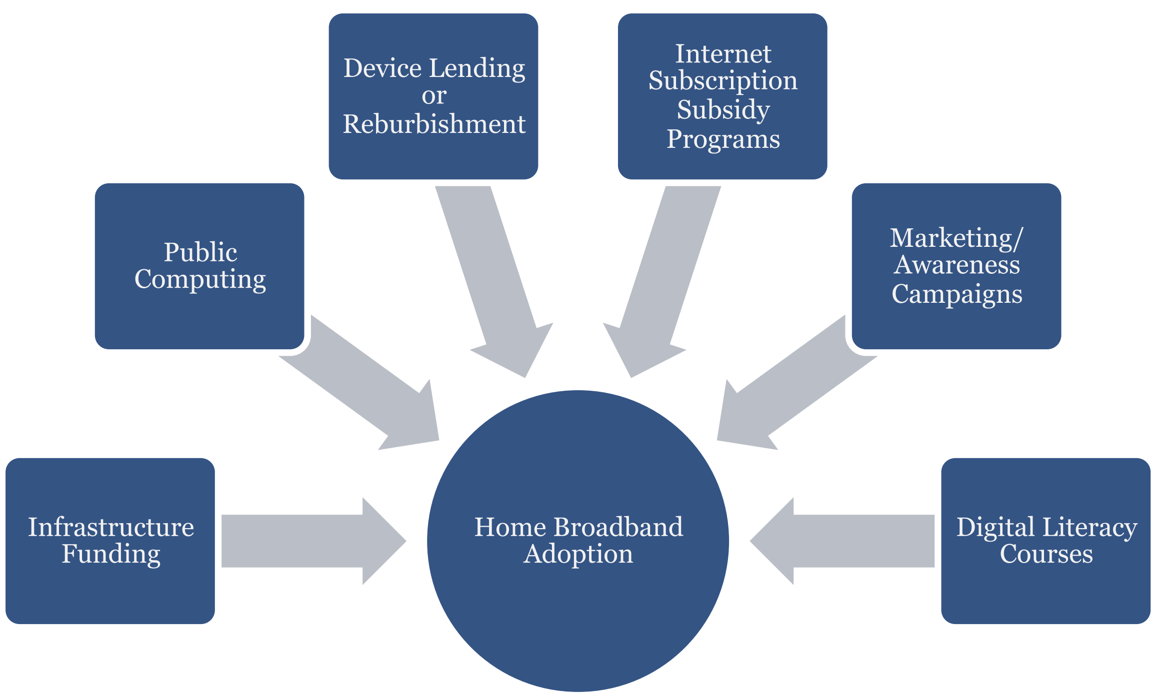
Taking inventory of agreed upon obstacles to adoption in the literature leaves us with the following major categories:

Cost	• "It's too expensive"
Relevance	• "I don't see why I need it."
Skill	• "I don't know how to use it."
Access to a Connection	• "I can't get a connection in my home."
Access to Hardware	• "I don't have a device to get online."

These barriers commonly work together, creating complex, multi-layered obstacles to at-home adoption. In surveys, non-adopters usually cited two or three of the barriers above when asked why they did not invest in a subscription. [15]

The literature is in agreement about the categories of intervention.

In the literature, several popular approaches to combating the digital divide have surfaced.[16] These include:



Each type of approach addresses one or more of the common barriers to broadband adoption.

Hardware programs	These address the portion of the **cost** barrier associated with purchasing **hardware** (a computer, netbook, etc.).
Public Computing Centers	Public computing centers can address the **skill** barrier as well as **cost** barriers associated with **hardware** and monthly at-home broadband subscriptions.
Marketing/awareness campaigns	These address **relevancy** barriers that exist when people do not know what the Internet is important for or do not know how the Internet can be useful in the context of their lives.
Subsidy programs	These address the portion of the **cost** barrier associated with monthly access subscriptions.
Digital literacy courses	These address the **skill** and **relevancy** barriers to broadband adoption.
Infrastructure funding/development	These address the **access** barriers – typically in rural areas.

It is important to note that these interventions are often used in combination. For instance the non-profits Tech Goes Home (founded in Boston) and Connecting for Good (founded in Kansas City) provide training and reduced-cost laptops – sometimes also offering reduced-cost Internet access in the home. This choice to combine interventions seems appropriate given the fact that non-adopters usually cite multiple reasons they cannot get online.

There are networked, social effects that influence an individual or household's decision to adopt Internet in the home.

There are neighborhood effects that impact the strength of certain broadband adoption barriers in cities. For instance, Karen Mossberger's research in Chicago indicates that cost barriers are reported as more significant (and relevancy barriers less significant) the more concentrated and segregated an urban minority population gets.[17] Larose looked at broadband adoption through the lens of Social Cognitive Theory (SCT) – highlighting that social context and outside influences including social interactions, personal experiences, and general self-efficacy accounted for 36% of an inner city resident's intention to adopt broadband. [18]

Though academic literature and government literature study the problem of broadband adoption differently, both point to the importance of (1) individual-level and (2) contextual factors, and the interaction between the two.

While policy papers and federal government studies concentrate on defining the problem of broadband adoption by focusing on individual-level survey data, academic and statistical studies examine neighborhood-level effects and the context in which individuals make decisions about investing in the Internet. Moreover, neither body of research looks at how individual-level characteristics and contextual factors interact to shape a person or household's decision to adoption broadband.

By "interact," I mean to say that context (politics, amenities, culture, etc.) can strengthen or negate individual characteristics that go into decision-making - whether those individual characteristics are someone's poverty, education, or race. For instance, the income threshold at which a family might invest in private schooling might be conditioned by their context. Maybe the quality of the surrounding school system or the cost of living in their area is a factor that "interacts" with their income, a household characteristic. So, applying this logic to the policy question at hand, larger forces within someone's city might strengthen or weaken the impact his or her personal income, education, or age would have on that person's decision to adopt broadband in the home.

ON THE EFFECTS OF GIGABIT CONNECTIVITY

Gigabit cities are under the microscope in terms of equity of access and adoption.

Between the growing need for connectivity in people's everyday lives as well as the high-profile introduction of projects from Google, AT&T, and other providers, "gigabit cities" have become a mainstream news topic. As such, cities seeking increases in speed (either because they are building a faster network themselves or they are attracting a private partner to build one for them) are also under pressure to pay heed to equity. New stories and op-eds have surfaced throughout the past few years expressing the concern that gigabit connectivity could widen existing opportunity gaps and increase the digital divides that already exist in urban areas.[19]

In particular, eyes have been on Google Fiber's deployment in Kansas City. Google split the city up into "fiberhoods" and created a sign-up process to measure demand. Of the 20 fiberhoods with the lowest median incomes, 19 met the sign-up threshold to get the first round of Google Fiber.[20] Despite that initial interest, in late 2014, survey data from the research firm Haynes & Co. were released about lower than expected Google Fiber subscriptions in low-income Kansas City neighborhoods.[21] Researchers went door to door in six neighborhoods. The study revealed that about 33% of low-income households in fiberhoods had signed up for some tier of service compared to 75% in higher-income (over $100,000) households.[22] However, of the those low-income households that subscribed, 24% had only mobile access before subscribing and 9% previously had no Internet at all. This means a third of the low-income up-take in Kansas City stemmed from new at-home broadband adopters.[23]

Despite potential threats to economic inequalities, the literature also shows that when higher speeds are offered and/or the overall Internet use is up in a city, the city still benefits as a whole.

Karen Mossberger's book *Digital Cities* points to this argument. In her analysis, she studied how and why the percentage of citizens online varies across cities. Measuring "people online" in terms of people with Internet in their home and people who use the Internet in general, Mossberger paid special attention to how many low-income and minority residents were users of the Internet. Her main finding was that "a rising tide lifts up all boats," or cities with the highest Internet use had higher percentages of minority and low-income populations online. The reverse was also true; cities that had a lower percentage of their overall population online had smaller portions of their low-income and minority populations online as well.[24]

Gigabit connectivity has also been linked to citywide economic growth. Looking at cities where gigabit speeds are accessible to over 50% of households, the Fiber to the Home (FTTH) Council found that, on average, those cities had higher GDPs than comparable cities in the same states.[25]

ON RECENT EFFORTS TO CLOSE THE DIGITAL DIVIDE

This section will summarize what has been accomplished in the public and private sectors to increase digital inclusion in the U.S.

The American Reinvestment and Recovery Act designated $4.7 billion to establish the Broadband Technology and Opportunity Project (BTOP). Run out of the Department of Commerce's National Telecommunications and information Association (NTIA), BTOP was a grant program that funded broadband adoption and infrastructure initiatives around the country. Part of this funding ($350 million) also went into the development of the National Broadband Map.[26] There were grant winners all across the country – some of which attempted to understand and measure the digital inclusion interventions that took place with the grant money. For instance, a study was done on the BTOP-funded Smart Communities in Chicago that aimed to decrease skill and relevancy barriers to Internet adoption. According to the study, Chicago's Smart Communities had a 15 percentage point higher rate of change in broadband adoption from 2008 to 2011 than communities without the BTOP program.[27]

The National Broadband Plan published in 2010 had an entire chapter on broadband adoption and included suggestions for specific programs like the Digital Literacy Corps program that were never enacted.[28] One of the recommendations was "Federal support should be expanded for regional capacity-building efforts aimed at improving broadband deployment and adoption." While efforts have been made, ownership of the issue (in terms of the accountable level of government) and sustainable funding (beyond a multi-year grant program) has yet to be figured out.

There have also been initiatives from the private sector to bridge the digital divide. Some of the most high profile initiatives have been Comcast's Internet Essential Program.[29] Google Fiber has also engaged in digital inclusion work in the communities they have entered. In Kansas City, they assisted in the development of a Digital Inclusion Fund and in Austin, they committed to connecting public housing developments to their basic Internet tier (5 Mbps download speeds) for free.[30] In each city, Google Fiber offers that free tier of service for a one-time installation fee of $300 that can also be paid over 12 months.[31] As mentioned previously, according Haynes & Co., fewer low-income residents ended up taking advantage of that service. Just 5% of residents in the six low-income, renter-heavy neighborhoods bought that package.[32]

This issue is a moving target. Recent advancements are worth noting, though they do not impact the approach of this study due to data availability and timing. For instance, the definition of "broadband" is being changed to be 25 Mbps download speeds rather than just 4 Mbps.[33] Also, the NTIA is continuing previous BTOP work through the new BroadbandUSA program.[34]

DATA ANALYSIS OF THE DIGITAL DIVIDE IN GIGABIT CITIES

The purpose of this data analysis section is to uncover what is different about broadband adoption in these high-speed, gigabit cities compared to non-gigabit cities. In addition, the analyses that follow will use the latest available data to shed light on what the digital divides look like in these cities.

DATA SOURCES AND DEFINITIONS

Data from two primary sources were merged:

- **The Federal Communication Commission**
  a. Form 477 data on broadband subscriptions, June 2013 by census tract.
  b. Form 477 data on broadband subscriptions, December 2013 by census tract.

- **The Census Bureau**
  c. 5-year 2013 American Community Survey for census tract-level data.
  d. 1-year 2013 American Community Survey for metropolitan statistical area-level (MSA) data.

For the purposes of this study, a hardline definition for "gigabit city" was created. Any MSA that the National Broadband Map designated as having over 50% of households with access to gigabit speeds was deemed a "gigabit city."[35] As of the most recent National Broadband Map (December 2013), there were 21 such MSAs. It should be noted that a similar definition was used in the Fiber to the Home Council's recent study on the effects of gigabit connectivity on GDP.[36]

Established Gigabit MSAs (21)		
Allentown, PA	Fort Wayne, IN	Provo, UT
Bend, OR	Grand Forks, ND-MN	Rapid City, SD
Bismark, ND	Indianapolis, IN	Salem, OR
Chattanooga, TN	Kennewick, WA	Sioux Falls, SD
Corvallis, OR	Kokomo, IN	Springfield, IL
Eugene, OR	Medford, OR	St. George, UT
Fargo, ND	Providence, RI	Yakima, WA

These gigabit MSAs are already slightly different from the country's other MSAs. See the averages below:

Average	Gigabit MSA	Non-gigabit MSA
Total Households	159,170	264, 634
% Households with broadband	75.26%	71.66%
% Households in poverty	14.97%	15.56%
% White alone	85.91%	79.10%

% High school degree or better	89.46%	87.19%
% non-English in the home	14.83%	17.17%
% Disability	13.02%	13.81%
% of Households with under 18-year-olds	32.29%	31.27%

This study's definition of "gigabit city" is reliant on the National Broadband Map – a project that prioritizes the measurement of access, not adoption. Several of the cities studied have different degrees of utilizing gigabit potential though all technically have the infrastructure. For example, in Chattanooga, residential gigabit speeds are available. In Providence, however, the fiber and potential for speed exists, but according to the Program Director of Broadband Rhode Island Stuart Freiman, "Gigabit service is not widely advertised or affordable in Providence – particularly for residents."[37]

DATA LIMITATIONS

While merging the census data and broadband adoption data can allow us to understand the relationship between socioeconomic characteristics and adoption in gigabit cities and non-gigabit cities, the data are not ideal as they stand. This section takes inventory of the limitations that this dataset and methodology have encountered.

First, because the Census Bureau just began measuring the existence of computers in the home and broadband subscriptions in the home in the 2013 American Community Survey (ACS), data on city-level change over time are not yet available.[38] Also these data from the ACS are only available on the MSA level, not the tract level.

Second, data on the number of providers (assumed to indicate competition) were only available on the tract level from the FCC. The tract-level regressions were therefore the only ones where competition could be a control.

Third, the FCC tract-level broadband adoption data are partially closed to the public. The percentage of broadband adoption by census tract is measured and submitted to the FCC from private providers every six months. Unfortunately, the public version of these data (called Form 477 data), do not come in

FCC FORM 477 BROADBAND ADOPTION RATING

5 = 80 – 100% adoption

4 = 60 – 80% adoption

3 = 40 – 60% adoption

2 = 20 – 40% adoption

1 = 0 – 20% adoption

a continuous format.[39] Instead, each tract is assigned a rating.[40]

Fourth, the FCC form 477 data also just recently began measuring "broadband" adoption in terms of the National Broadband Plan standards (4 Mbps download speeds) in the 2013 data. As a result, change overtime data are limited to 2013. Previously, the adoption standard for measurement was set at the "BTOP/BIPS definition" meaning advertised speeds of at least 768 kbps downstream and just 200 kbps upstream.

Fifth, all of the variables used in the analysis are measured at an aggregate level – either at the level of a tract or MSA. However, the goal of this study is to understand the relationship between individual characteristics and context when it comes to adopting broadband. This means assumptions are being made about the aggregate data corresponding to individuals. Essentially, I'm assuming that being a high poverty census tract reflects on the individuals in that tract. As such, ecological fallacy is another important critique to acknowledge in this study. Technically, assumptions about individual decisions surrounding broadband adoption are being made based on the characteristics of groups to which the individuals belong, rather than the individuals themselves.

THE MODELS & VARIABLES OF INTEREST

To understand the quantitative framework, we can see the data analysis as falling into two models or hypothesized equations describing broadband adoption: a direct model of broadband adoption and an interactive model of broadband adoption.

THE DIRECT MODEL OF BROADBAND ADOPTION

The direct model assumes the at-home broadband adoption is a function of someone's personal or household characteristics (as indicated by aggregate statistics) and their context. The analysis from this model aims to uncover how broadband adoption is different in gigabit cities and census tracts in gigabit cities.

Defining "Context"

The context, in this model, is defined as the presence of gigabit residential connectivity. Other contextual factors at play are cost and competition, which, at the tract-level, is measured by the number of broadband providers per tract.

Defining "Personal/Household Characteristic Variables"

The variables tested in this model can be divided into two main categories that also correspond to the way we think about broadband adoption barriers – socioeconomic variables and relevancy variables. These variables can be analyzed at both the city and the tract level.

These variables have been categorized in this way to correspond to the main categories of broadband adoption barriers discussed in the background section of this study:

Cost	• "It's too expensive" **(Socioeconomic)**
Relevance	• "I don't see why I need it." **(Relevancy)**
Skill	• "I don't know how to use it." **(Relevancy)**
Access to a Connection	• "I can't get a connection in my home."
Access to Hardware	• "I don't have a device to get online." **(Socioeconomic)**

Grouping the barriers into these two larger categories, then assigning American Community Survey variables to those two categories means we can draw conclusions about the digital divide in cities and census tracts.

The six variables in this analysis used to capture the digital divide are:

Socioeconomic Variables	**Relevancy Variables**
% households in poverty (in the last 12 months)	% people over the age of 5 who speak a non-English language in the home
% population white alone	% population with disability status
% people over 25 years of age with a high school degree or better	% households with someone under the 18 years of age

By categorizing my variables of analysis in this way, I am making several assumptions. First, that barriers to hardware and at-home subscriptions can both be attributed to cost. Second, that lack of skill is an extension, or at least highly related to, the relevancy barrier. Third, since the *urban* digital divide is the subject at hand, having physical access to a connection is not a significant concern. Fourth, that the city and tract-level aggregated variables are representative of the individuals in that city or tract. This connects again to the concept of *ecological fallacy*; I'm assuming a strong connection between tract-level characteristics and individual characteristics since I only have the variables in the table above aggregated to the tract and city level.

THE INTERACTIVE MODEL OF BROADBAND ADOPTION

In the interactive model, at-home broadband adoption is a function of someone's personal or household characteristics (as indicated by aggregate statistics), their context, and the interaction between their context and personal or household characteristics. The analysis from this model aims to uncover whether patterns of digital exclusion differ systematically in gigabit cities compared to non-gigabit cities. If we take *being* a gigabit city *or not being* a gigabit city to be an important piece of the "context," then we can identify whether this "gigabit" context *conditions* the effects of poverty, education, and language. Put differently, how do these attributes impact adoption in gigabit cities and is this impact different from in non-gigabit cities? Are there comparatively stronger or weaker barriers to broadband adoption in the context of gigabit infrastructure?

THE RESULTS

This section lists the results of the data analysis, organized by major research questions of interest:

- What does citywide broadband adoption look like in gigabit cities compared to non-gigabit cities?
- What does broadband adoption look like across census tracts in gigabit cities versus non-gigabit cities?
- Are the predictors of city-level broadband adoption different in gigabit cities compared to non-gigabit cities?
- Are the predictors of tract-level broadband adoption different in gigabit cities compared to non-gigabit cities?
- Which gigabit city census tracts are "over-performing" when it comes to broadband adoption? Which have higher adoption levels than we would expect given the predictors of adoption in gigabit cities and the U.S. more generally? What can we learn from these pockets of over-performance?

WHAT DOES BROADBAND ADOPTION LOOK LIKE IN GIGABIT CITIES COMPARED TO NON-GIGABIT CITIES?

With 21 gigabit MSAs in the U.S., what can we say about them aside from the existence of infrastructure allowing for faster-than-average Internet speeds? Does the presence of or process of attaining high-speed infrastructure actually increase overall rates of adoption and digital inclusion in a city, holding other factors constant?

Though small advantages are observed in stages of the analysis, the data are mostly inconclusive on whether gigabit cities have higher citywide broadband adoption than similar non-gigabit cities. After controlling for either socioeconomic or relevancy characteristics of the close to four hundred metropolitan areas in my sample, gigabit cities are found to have slightly more households online. When socioeconomic variables like poverty, education, and race are controlled for, I find a statistically significant 2.5 percentage point gap between broadband adoption in gigabit cities compared to non-gigabit cities. **(See Table 4 in Appendix).** When relevancy variables like language, disability, and age are held constant, gigabit cities are associated with 2.3 percentage points more broadband adoption – also statistically significant. **(See Table 5 in Appendix).** However, when all of those variables are controlled for at the same time, gigabit cities see just 1.3 percentage points more broadband adoption and that difference isn't statistically significant. **(See Table 10 in Appendix).**

WHAT DOES BROADBAND ADOPTION LOOK LIKE ACROSS CENSUS TRACTS IN GIGABIT CITIES COMPARED TO NON-GIGABIT CITIES?

Interestingly, the data reveal a slightly different story when we examine broadband adoption at the census tract level.

On average, broadband adoption is not significantly higher in gigabit city census tracts versus similar non-gigabit city census tracts. While stages of the citywide analysis uncovered points where gigabit connectivity boosted citywide broadband adoption, the same cannot be said at the tract level. When either socioeconomic or relevancy variables were controlled, there was no statistical significance. **(See Table 6 & 7 in Appendix).** When we control for both socioeconomic and relevancy variables, there is also no statistical significance. **(See Table 11 in Appendix).**

Why is this?

One reason for this slightly different story between MSAs and census tracts could simply stem from the way tract-level broadband adoption data are recorded. As mentioned before, the FCC doesn't release percentages of broadband adoption by census tract. Instead, they release ratings (5 for 80-100% adoption, 4 for 60-10% adoption, etc.). As a result of this less precise broadband adoption measure the burden of proof is potentially increased to such an extent that it becomes much more difficult to register change. For example, a one-unit change in rating, say from 4 to 5, could result from adoption levels changing by just one percentage point, from 79% to 80%, or from a 20-percentage-point increase, from 60% to 80%.

Another very plausible explanation for this difference is that, though citywide gigabit access (defined as any MSA where over 50% of households have *access* to gigabit speeds) can "move the needle" on citywide broadband adoption, it cannot do so in every small tract or neighborhood within a city.

ARE THE PREDICTORS OF CITY-LEVEL BROADBAND ADOPTION DIFFERENT IN GIGABIT CITIES COMPARED TO NON-GIGABIT CITIES?

To understand how the digital divide might be different in gigabit cities compared to non-gigabit cities, I modified the models used to estimate the results above by interacting socioeconomic and relevancy variables with the gigabit city dummy. These interactive models enable a test of whether the effects of poverty, non-English language use, age, and other factors differ systematically in gigabit cities compared to non-gigabit cities. Another way to ask the question: which barriers to broadband adoption are stronger or weaker in the presence of gigabit connectivity?

The data reveal that a city's poverty level is closely linked to the projected impact a gigabit network can have on citywide broadband adoption. The strength of the negative relationship between poverty and broadband adoption is observably weaker in gigabit cities compared to non-gigabit cities. In cities without access to gigabit broadband, a one-percentage point increase in poverty reduces broadband adoption by almost one percentage point - 0.94 to be precise. **(See Table 13 in Appendix).** In gigabit cities, poverty actually turns out to be positively related to broadband adoption, though the size of the effect is small – namely, a percentage point increase in the city's poverty rate is associated with a little over one-tenth of a percentage point increase in broadband adoption in the city as a whole.

The real-world impact is easier to understand if we illustrate it by way of predicted probabilities. If we take the original regression and think about gigabit and non-gigabit cities with comparable levels of poverty, we get the following expected values of broadband adoption:

	Gigabit City(1)	Non-Gigabit City(0)
Poverty = 5%	73.8114	81.611
Poverty = 15%	75.2604	72.203
Poverty = 30%	77.4339	58.091

To put these hypothetical poverty rates in perspective, in 2013 the U.S. poverty rate was 14.5% - down from 15% in 2012.[41] Of course, cities can also see much higher rates of poverty. For example, the 2009-2013 poverty rates in Detroit and New York City were 39.3% and 20.3%, respectively.[42]

The city-level data also reveal a statistically significant interaction between racial make-up of a city and broadband adoption in a gigabit and non-gigabit context. As seen in the hypothetical cities below, gigabit cities with fewer minorities have a higher percentage of households online. Non-gigabit cities, on the other hand, see only a minor change in broadband adoption when a city's minority population decreases. To see the original regression which the numbers below are based on, see **Table 13** in the Appendix.

	Gigabit City(1)	Non-Gigabit City(0)
White Only = 70%	67.1127	71.6084
White Only = 80%	72.2327	71.7244
White Only = 90%	77.3527	71.8404

ARE THE PREDICTORS OF TRACT-LEVEL BROADBAND ADOPTION DIFFERENT IN GIGABIT CITIES COMPARED TO NON-GIGABIT CITIES?

The more granular, tract-level analysis reveals additional significant interactions between gigabit access and socioeconomic and relevancy variables. These point to some comparative advantages and disadvantages of being in a gigabit city census tract.

First, let's talk about some comparative advantages of being in a gigabit city census tract. As seen in the charts on the next page (all of which represent statistically significant interactions), a very young gigabit city census tract (where over 50% of households have a child) has slightly higher broadband adoption ratings than a similar tract in a non-gigabit city. Of course, the reverse is also true. Gigabit city census tracts with very low percentages of households with children are worse off than non-gigabit city counterparts. Also, average and high levels of disability, gigabit city census tracts have slightly higher broadband adoption ratings – showing that the presence of high-speed connectivity curbs the dramatic effect disability appears to have on the broadband adoption rating. Like the MSA-level analysis, the tract-level analysis also revealed significant interactions with poverty. Very poor census tracts

(40% household poverty) in gigabit cities are projected to have slightly higher broadband adoption ratings than similar, very poor tracts elsewhere.

	Gigabit City(1)	Non-Gigabit City(0)
Households with under 18-year-olds = 10%	3.5933	3.7935
Households with under 18-year-olds = 30%	3.6053	3.6775
Households with under 18-year-olds = 50%	3.6172	3.5615

	Gigabit City(1)	Non-Gigabit City(0)
Disabled = 5%	4.0875	4.1654
Disabled = 20%	3.1755	3.0614
Disabled = 40%	1.9595	1.5894

	Gigabit City(1)	Non-Gigabit City(0)
Poverty = 5%	3.9558	4.0895
Poverty = 15%	3.6138	3.6605
Poverty = 40%	2.7588	2.588

Again, the measurements above are in the FCC's ordinal rating categories. Given this fact, the advantages seen above are relatively small. The changes most of interest are *between* 1, 2, 3, 4, and 5, rather than minor differences between 3.5 and 3.75. We can see such changes in the interaction between a tract's white alone population and gigabit connectivity. Not only do gigabit cities have higher connectivity in every hypothetical, but gigabit cities seem to fare better the less racially diverse they are. This predicted set of values, therefore, might be considered *both* good and bad news:

	Gigabit City(1)	Non-Gigabit City(0)
White Only = 50%	3.7382	3.4736
White Only = 75%	4.1357	3.7036
White Only = 90%	4.3742	3.8416

Because the FCC collects data every 6 months, we can also see how significant interactions between variables and gigabit connectivity impact the *change* in broadband adoption throughout 2013.

The tables below display predicted change in FCC broadband adoption ratings during 2013 and reveal some comparative disadvantages of being in a gigabit city census tract (See Tables 17 & 18 in the Appendix). While both gigabit city census tracts see larger 2013 broadband adoption rating changes the more educated they are, non-gigabit cities have overall higher projected increases in ratings no matter their education level. In fact, non-gigabit cities see larger 2013 boosts in broadband adoption – over half a rating – the lower the educational attainment in the tract.

	Gigabit City(1)	Non-Gigabit City(0)
HS grad or better = 50%	0.0939	0.5098
HS grad or better = 70%	0.1599	0.4338
HS grad or better = 90%	0.2259	0.3578

Also, in terms of non-English speaking residents, the higher the population, the lower the projected increase in the gigabit city census tract's broadband adoption rating. Interestingly, the opposite trend is true for census tracts in non-gigabit cities. A non-gigabit city census tract with 50% non-English speakers in the home is predicted to improve by half a rating while a similar census tract in a gigabit city is projected to have negligible improvement.

	Gigabit City(1)	Non-Gigabit City(0)
Non-English = 5%	0.2377	0.2701
Non-English = 25%	0.1697	0.3841
Non-English = 50%	0.0847	0.5266

WHICH GIGABIT CITY CENSUS TRACTS SEEM TO BE OVER-PERFORMING AND WHY?

When broken down by city, the data reveal "over-performing" census tracts in gigabit cities that, despite having high poverty, have high broadband adoption ratings. Bivariate scatter plots for each gigabit city plotting tract-level household poverty against tract-level Form 477 broadband subscribership ratings revealed the following dozen or so outliers:

Gigabit City	"Over-Performing" Tract	Dec 2013 Rating	#HHs	Poverty
Allentown, PA-NJ	Census Tract 110, Northampton County	5	1351	37.7
Chattanooga, TN	Census Tract 20, Hamilton County	5	641	46.6
Corvallis, OR	Census Tract 106, Benton County	5	1815	48.7
Eugene, OR	Census Tract 39, Lane County	4	1537	44.6
Eugene, OR	Census Tract 37, Lane County	4	461	48.8
Fargo, ND-MN	Census Tract 204, Clay County MN	5	891	34.2
Fort Wayne, IN	Census Tract 12, Allen County	4	583	46.8
Fort Wayne, IN	Census Tract 9800.01 Allen County	5	102	63.7
Providence, RI	Census Tract 2, Providence County	4	1953	45.8
Providence, RI	Census Tract 8, Providence County	4	1666	46.9
Provo, UT	Census Tract 16.02, Utah County	5	146	96.6

Why are these tracts special?

By digging deeper into a few of these tracts we can see that some might very well be random anomalies, but others' good fortune might stem from non-random factors like programs or people or another set of advantageous circumstances. If those circumstances can be identified and replicated elsewhere, that is worth knowing.

For example, take **Hamilton County's Census Tract 20 in Chattanooga**. Just east of the Tennessee River and straddling US Highway 27, this tract exists in a diversely zoned urban area containing restaurants, schools, businesses, and a little over 600 households. One very notable feature of this census tract is the concentration of community institutions – especially communities of faith. Within a few blocks of each other are four churches: New Vernon Grove Baptist Church, St. Phillip Lutheran Church, Historic St. Paul AME Church, and Hamlett Chapel Christian Methodist. Just east of those faith institutions is Howard High School and Harris-Johnson Park. With a mixture of public and faith-based support systems, community anchor institutions, and general walkability, is it possible that these "over performing" low-income census tracts are advantageously placed?

> With a mixture of public and faith-based support systems, community anchor institutions, and general walkability, is it possible that these "over performing" low-income census tracts are advantageously placed?

"If I had to guess one area [in Chattanooga] that was over-performing, it would be that one." said Kelly McCarthy of Chattanooga's newly launched Tech Goes Home digital inclusion nonprofit. According to McCarthy, Howard High School has been the home of a 1:1 laptop program and it is also the source of great history and pride in Chattanooga.[43]

Take **Providence County's tract 2 and tract 8.** Both have almost 50% household poverty, but have 60-80% broadband adoption – much higher than other tracts with similar poverty rates in the city. If we dig deeper into these cases, we see a similar result that we did in Chattanooga - that proximity to support matters. Tract 8 is home to the Providence Public Library as well Grace Episcopal Church, Beneficent Congregational Church, and the Cathedral of Peter & Paul. Tract 2 adjacent to the South Providence Library and contains Lillian Feinstein Elementary and Highlander Charter School.

During both the background research and expert interview phase of this study, the importance of community anchor institutions was understandably reinforced. Often, broadband adoption programs and digital literacy trainings were purposefully built on top of existing institutions or infrastructures in the city – whether that meant the local churches, schools, or community centers.[44] These places were often the sites of nonprofit work or winners of federal or state-level grants after the American Recovery and Reinvestment Act. Considering this, the fact that "over-performing" tracts in urban areas tend to be close to institutions offering community support – whether through education or faith – is unsurprising.

It is important to note that this advantage is relevant to other cities, not just those with gigabit capable infrastructure. Chicago, for instance, has a strong outlier with the same proximity advantages as the outliers in Chattanooga and Providence. **Cook County Census Tract 3504** is on a single northeastern section of Chicago's Douglas neighborhood. It has a modest 665 housing units, but a large 71.1% household poverty. The FCC has given this tract a "5" - meaning it has at least 80% at-home broadband adoption despite having such high poverty. In and just around this tract are Drake Elementary School, Mount Carmel Missionary Baptist Church, and St. James Church. Just south of tract 3504 is the Illinois Institute of Technology.

Other evidence from expert interviewing confirms the effect that walkability and easy access to public computing, community anchor institutions, and amenities can have on the digital inclusion of low-income communities. Kirby Aull, an AmeriCorps VISTA digital inclusion worker in Austin, TX discussed how she witnessed uneven distributions of digital services and support across low-income geographies influence their broadband adoption rates. Part of her job was identifying those neglected areas that were *both* impoverished and did not have easy access to existing resources.[45]

This interview evidence, along with the results from the quantitative data analysis, seem to confirm what we might suspect; that low-income areas do better than expected when they are home to particular types of services and resources – whether that's existing digital inclusion programing or existing community institutions like schools and churches.

IMPORTANT IMPLICATIONS FROM THE DATA ANALYSIS

To summarize, the data analysis has left us with several new pieces of knowledge:

Broadband adoption data from gigabit cities and gigabit city census tracts tell different stories. Why is this? This could be a result of the way the FCC shares tract-level broadband adoption data (a ranking system versus a percentage). This difference might also be explained by the fact that, when gigabit speeds are widely available (to >50% of households), a city as a whole might have more people online, but not all parts of the city.

The positive association of gigabit access on citywide and tract level broadband adoption interacts significantly with poverty. This means that, under this model, the normally negative effect high poverty rates can have on broadband adoption is curbed by the gigabit access. In other words, a gigabit city with high household poverty (say, 40-50%) will have higher broadband adoption than a similar city without gigabit access. This strong relationship is seen citywide in gigabit MSAs and also in the census tracts within gigabit MSAs.

In gigabit cities, particular problem areas for the digital divide include high or concentrated populations of non-English speakers and high or concentrated populations of less educated individuals. While poorer, non-white, young, and high disability census tracts fare better for broadband adoption in gigabit cities versus non-gigabit cities, language and education standout as weaknesses.

Low-income census tracts – whether in gigabit cities or non-gigabit cities – can have higher than expected broadband adoption if they have easy access to community institutions and existing digital inclusion programming. The analysis of quantitative data, reinforced by anecdotal evidence from expert interviews, indicate that broadband adoption is not just predicted by the socio-demographic characteristics of the people who live in a census tract, but also what local amenities exist in and around the tract.

LESSONS FROM EXPERT INTERVIEWS

Digital inclusion in gigabit cities is a complex issue that requires more than numbers to produce fully-fledged recommendations and policy implications. As I witnessed in the data analysis, it was only when I coupled the "over-performing tract" data with relevant expert interviews that I truly understood and confirmed why those areas had such high broadband adoption.

Expert knowledge on this topic was gathered from a mixture of national and local digital inclusion programming experts to round out and inform what was learned in both the literature review and the data analysis.

For the full interview log and questionnaire, see the Appendix.

THEMES THAT UNDERSCORED MULTIPLE INTERVIEWS

BEST PRACTICES FOR DIGITAL INCLUSION PROGRAMMING

Effective interventions should battle the digital divide on multiple fronts. They should acknowledge the complexity of adoption by tackling several adoption "barriers" at once - cost, relevancy, access, and digital literacy.[46]

Interventions should be accompanied with effective, targeted outreach. Programs should be marketed well and marketed specifically to truly reach low-income groups or neighborhoods and lower any "intimidation" factors.[47]

Effective interventions include "carrots." For instance, if you complete a certain number of training hours you can get a free or reduced netbook or tablet.[48]

Effective interventions have feedback loops.[49] These might come in the form of surveys evaluating trainers or follow-up communication. For example, Boston's Tech Goes Home calls training graduates 6, 12, and 18 months after they leave the program to gauge progress.

To reach non-adopters and combat intimidation and relevancy barriers, effective programs often partner with existing, trusted institutions – even ones that do not obviously relate to digital inclusion.[50] Depending on the community, these trusted community partners could be churches, community colleges, or senior centers. It might vary. Alisson Walsh from Mobile Beacon also highlighted the importance of what she called "hybrid programs."[51] These might be workforce development programs of ESL programs where computer skills or digital literacy is a secondary, complimentary component. Creating these programs can be extremely efficient when it comes to reaching the intended audience. Also, if a "why" is built in, the relevancy barrier to broadband adoption dissipates. Another example of such a "hybrid" approach can be seen in Broadband Rhode Island's (BBRI) work. Given the state's high unemployment, several years ago BBRI made the strategic decision to merge digital literacy training with adult education and workforce development.[52]

There is a social, personal aspect of digital inclusion work that should be recognized in program design.[53] For instance, "train-the-trainer" models are cited as being successful in the context of digital literacy because people are tasked with training their family and neighborhood network. A grandparent might have a skill and relevancy barrier to adopting the Internet, but if their grandchild is trained to train them, then the medium becomes the message. They might see the relevancy of online connections through the personal connection in front of them.

In general, experts believe there is no single "tipping point" that results in broadband adoption. Experts have very different, but strong opinions about what the up-take "tipping point" is. For instance, Deb Socia of Boston said it was relevancy – specifically overcoming fear.[54] Michael Liimatta of Kansas City said the "tipping point" was hardware.[55] This might imply that, depending on local barriers and culture, "tipping points" could vary from city to city (or be different for gigabit cities in general). The Austin Digital Inclusion Team echoed the idea that every new or prospective adopter had a unique, personalized "tipping point" – usually when they grasped or witnessed what connectivity could transform their own lives.[56]

> BBRI brought an educational expert to apply Universal Design Learning (UDL) principles to digital inclusion – transforming text heavy, set curriculum into nimble instruction to meet the learning styles and motivations of diverse audiences.

Formal digital training and literacy programs involve a trade-off between structure and flexibility.[57] While structured curriculum means more uniform lessons, ease of training, and predictable performance metrics for funders or evaluators, there is a cost. As mentioned above, adoption "tipping" points can be personalized. The Internet means something different to each new user and you don't want a cookie-cutter structure to get in the way of that. Programs that are too prescriptive (say, with a structured curriculum, goal, or learning tool) lack the flexibility to "reach the person in the room" and address the unique relevancy challenges of the non-adopter being trained. The Broadband Rhode Island (BBRI) initiative actually considered this need for flexibility while constructing their curriculum and training their digital literacy instructors. BBRI brought an educational expert to apply Universal Design Learning (UDL) principles to digital inclusion – transforming text heavy, set curriculum into nimble instruction to meet the learning styles and motivations of diverse audiences.[58]

CAUTIONARY POINTS

Many well-intentioned interventions and programs failed because they didn't meet non-adopters where they were in terms of cost, lifestyle, and knowledge. Effective programs are structured in such a way that they fit into the lives and challenges of low-income and marginalized communities. For example, avoid interventions where credit cards or online sign-up are required, avoid interventions only in English, avoid interventions where there is no complimentary hardware program, or interventions where the transiency of low-income families is not recognized or easily addressed.[59] Having low barriers to entry can be powerful. For instance, the new NYC library hotspot program doesn't require anything but a library card to get a free Internet connection. [60]

At present, digital literacy programming tends to be run by nonprofits and grassroots organizations rather than the government.[61] These organizations have "grassroots power," volunteer coordination experience, and connections with neighborhoods which might give them an advantage when it comes to this work. The downside, however, is that digital inclusion stems from the nonprofit sector where funding can be unstable. Another related point made by Alisson Walsh of Mobile Beacon was that digital inclusion support tends to stem from either neighborhood-level or federal-level actors, but there is a lack of institutionalized support at the city level. [62] City grant programs and digital inclusion offices like the ones seen in Austin, Texas seem to be exceptions to this rule.[63]

The relevancy barrier is underestimated.[64] Several expert interviewees specifically mentioned that the impact of the relevancy barrier ("I don't understand why I need the Internet") is underestimated when it comes to designing effective programs, training, and digital inclusion strategies.

COMMON CHARACTERISTICS OF DIGITALLY INCLUSIVE CITIES

Digitally inclusive cities contain a network of champions.[65] These people are either formally connected by a taskforce or informally connected by professional and personal ties.

These cities also recognize that digital inclusion is an evolving problem.[66] This means cities need to have smart/flexible people and programs that tackle the problem that exists today, but are also adaptable to address what the "digital divide" might look like tomorrow. For instance, policies don't define success as getting a certain percentage online or a certain percentage literate in a program or device used today and only today.

There is often a point of accountability when it comes to digital inclusion. Someone "owns the issue" or it is institutionalized. This could manifest itself in several ways. For instance, a city government can create grant programs, designate city workers to focus on digital inclusion, or outsource public goals to a closely partnered local nonprofit.[67]

The prerequisite to being a digitally inclusive city is knowing the unique attributes of the city's or neighborhood's digital divide.[68] This knowledge often comes in the form of data collection. Austin just finished polling residents by mail about their broadband adoption and Internet usage.[69]

UNIQUE, IMPORTANT PERSPECTIVES WORTH HIGHLIGHTING

> "When an average citizen cares about hunger and homelessness, they know what they as an individual can do to help in a small way – go to a soup kitchen, contribute to a canned food drive, and so forth. We should have a call to action when it comes to the digital divide."
>
> - Rachel Merlo, Kansas City Google Fiber Community Impact Manager

Not all of the value from the expert interviews stemmed from the recurring themes. Some key insights from the qualitative information came from interviewees saying something new or unique about broadband adoption and digital inclusion programming.

The digital divide needs a "call to action." Rachel Merlo, the Google Fiber Community Impact Manager for Kansas City had an interesting point: "When an average citizen cares about hunger and homelessness, they know what they as an individual can do to help in a small way – go to a soup kitchen, contribute to a canned food drive, and so forth. We should have a call to action when it comes to the digital divide."[70] This is a compelling point that city governments and non-profits can certainly take note of. When average, connected citizens are made aware of the digital divide, a possible next step should be made clear to them. One example could be to emulate what Michael Liimatta has done at Connecting for Good. He sees that "next step" or "call to action" as donating an old computer.[71] Other ideas could include donating volunteer hours, being a volunteer translator at trainings, or donating a monthly Internet subscription to a home that needs it.

Maybe boosting digital skills needs to start in public schools. Geoff Millener works for the Mozilla Community Fund in Chattanooga where they just started piloting a project-based class that operates like a high school in-house IT office. Any teacher at the school might present a problem to the student group (for example, "I need a new website for my class.") and the students will work together to tackle it. While this program doesn't address the issue of access, Millener points out that it tackles the digital divide in the sense of skill gaps. He makes the distinction between digital literacy and digital fluency.[72]

Maybe modest innovations to public computing facilities or libraries can make a difference to lowering intimidation barriers to getting online. Nate Hill of the Chattanooga Public Library is doing some interesting things to encourage people to feel comfortable learning and developing their skills in the library. He hires what he calls "smart people" to do personal research in public spaces and answer questions or help library visitors. Nate also pointed out that there are small, user-focused changes that a public computing center can do to make people – especially new users – feel comfortable. For instance, something as simple as creating open, multi-chair workstations (rather than the traditional mini-cubical, one-chair-to-one-desktop configuration) or lending out more tablets and providing comfortable seating can encourage people to talk and help one another learn.

CONCLUSION & RECOMMENDATIONS

The data analysis of this report illuminated the nature of the digital divide in gigabit and non-gigabit cities while the expert interviews illuminated best practices for digital inclusion programming in general. By synthesizing these pieces, we gain a better understanding of appropriate digital inclusion strategies tailored to the particular needs of gigabit cities and future gigabit cities.

CITY GOVERNMENTS IN GIGABIT CITIES: DESIGNATE AN AUTHORITY FOR DIGITAL INCLUSION

Perhaps one of the largest big-picture take-aways from this report is the need for consistent, institutionalized, city-level support when it comes to bridging the digital divide in gigabit cities. Though the data show that high speeds are associated with slightly higher levels of *citywide* broadband adoption, analyses based on more granular data provide cause for less optimism. Therefore, if the digital divide is an issue the city government wants to address, having a designated authority that is capable of tracking progress on both a citywide *and* the neighborhood or tract level would be key.

Based on precedence, this digital inclusion authority can take several shapes:

- **Lower-effort Investment:** The city government can work with and invest in a proven digital inclusion non-profit or collaborative. This would mean the city government wouldn't need to run programming, but would instead partially "outsource" this work to another organization. This is currently being done in cities like Boston (Tech Goes Home), Chicago (Smart Chicago Collaborative) and Chattanooga (Tech Goes Home – Chattanooga).
- **Higher-effort Investment:** The city government can actually designate an office to tackle this work. This higher-effort approach can bee seen in cities like Austin and Seattle. Austin and Seattle also have grant programs to support grassroots digital inclusion work.[73]

The assumption built in to this recommendation is that it is the city government's job to help in directing digital inclusion strategy, regardless of whether another party is providing funding or running the programming. A city government is capable of grasping local history and unique city strengths or challenges more than an ISP. Likewise, a neighborhood grassroots initiative or nonprofit might not always be incentivized to think in terms of long term, *citywide* strategies and best interests.

CITY GOVERNMENTS IN GIGABIT CITIES & FUTURE GIGABIT CITIES: LOCATE YOUR "DIGITAL DESERTS"

Map where current computer labs, free Wi-Fi hotspots, community anchor institutions, and where digital trainings or resources exist around the city and compare that to tract-level socioeconomic data.

This will do two things. *First*, it will tell you whether your city has a well-rounded approach to the digital divide right now. For instance, are there lots of training programs but no cost programs or device lending programs? *Second*, it will let you identify those areas in your city that are lacking the resources associated with high broadband adoption rates. These "resource maps" should record information related to residents of the area across the socioeconomic and relevancy dimensions outlined above. These maps should also include information related to the institutional and structural resources of neighborhoods.

As seen in this study's data analysis of "over-performing" census tracts in gigabit and non-gigabit cities, proximity to amenities and support networks matters to the digital equity of a neighborhood. For a city aiming to make efficient decisions with scare resources, it's not enough to know which demographics are in need; the city should also know where vulnerable groups intersect with a lack of existing resources.

City governments in existing gigabit cities should use this "digital desert" information to explore investing in targeted programs – especially, concentrated minority or non-English speaking communities as well as communities with low educational attainment. Those groups have been identified as being comparatively worse off in gigabit cities.

City governments in future gigabit cities should use this information to inform potential partnerships with Internet service providers. If you are partnering with a private company or seeking to partner with a private company, understand your community's digital divide and let that inform your development agreement negotiation. Is your community's digital divide mainly a geographic digital divide? If so, then push for more areas to be covered by the network – even if strong demand doesn't exist yet. Is your digital divide centered on income or concentrated in public housing? Then push for a low-cost tier of service. Is there a shared relevancy challenge found in an immigrant community or a large senior population? Then push for targeted corporate social responsibility funding to nonprofits already working with those communities. The better you can answer these questions, the better you will know your "asks."

INTERNET SERVICE PROVIDERS IN GIGABIT CITIES: SUPPORT THE EXISTING LOCAL EXPERTS IN PROGRAMMING

Traditionally, for many private ISPs, there has been no requirement to do anything when it comes to bridging the digital divide. Now that gigabit networks have popped up around the country, city governments and ISPs have begun to include digital inclusion provisions or details in their development agreements. Now, the question is, based on the findings of this report, what are some of the most effective roles that Internet service providers like Google Fiber can play in this space?

First, if an ISP has strong branding or outreach capabilities, they can partner with the city government to address the relevancy barrier through targeted marketing campaigns. The data analysis of this report showed that areas with concentrations of low-educational attainment and people who speak non-English are particularly vulnerable in gigabit cities – possibly because of additional intimidation barriers.

Second, ISPs in gigabit cities should make sure any low-cost tiers or digital inclusion programming they support is compatible with the lives of low-income people and non-adopters in the city. For instance, requiring email addresses or credit card information to sign-up for a low-cost tier of service might act as a barrier to an otherwise useful offering. Not distributing information on promotions or digital inclusion programming in multiple languages might have the same effect.

Third, if an ISP seeks to address the digital divide, it should first consult with and support existing local experts in programming rather than doing it themselves. Google Fiber's Community Impact Manager in Kansas City, Rachel Merlo, echoed this sentiment: "We certainly recognize that we're not programming experts."[74] As discussed in the expert interview analysis, a community's trusted, local institutions are often the home of the most effective programs that reach vulnerable slow-adopting populations in a city. Those grassroots organizations have the experience and expertise to do the programming, but often lack stable support. On a side note, if an ISP chooses to help fund these efforts (through a grant or award, for instance), they should consider tailoring expected performance benchmarks by the type of specific digital inclusion program that is being funded. In other words, a computing center and training program in public housing should be assessed using different criteria from those used to assess a Wi-Fi hotspot lending program out of the city library.[75]

OPPORTUNITIES FOR CONTINUING ANALYSIS

With new Census Bureau and FCC data being released on broadband adoption every year, there is an opportunity to continue this analysis. Analyzing the predictors of change over time in broadband adoption and the impacts of gigabit connectivity will be possible after just a few more years of data become available.

Also, with more and more cities upgrading their speeds, there will be more gigabit cities to observe and extract trends and digital inclusion best practices from. Even now, Google Fiber cities like Kansas City, Provo, and Austin are enjoying gigabit speeds, but, because of timing, were unable to be included in this analysis.

It should also be noted that the datasets created for this study can also produce useful city-specific analyses on local digital divides in all U.S. MSAs. Individual gigabit cities or prospective gigabit cities interested in either accessing the data or receiving an analysis should contact the author of this study.

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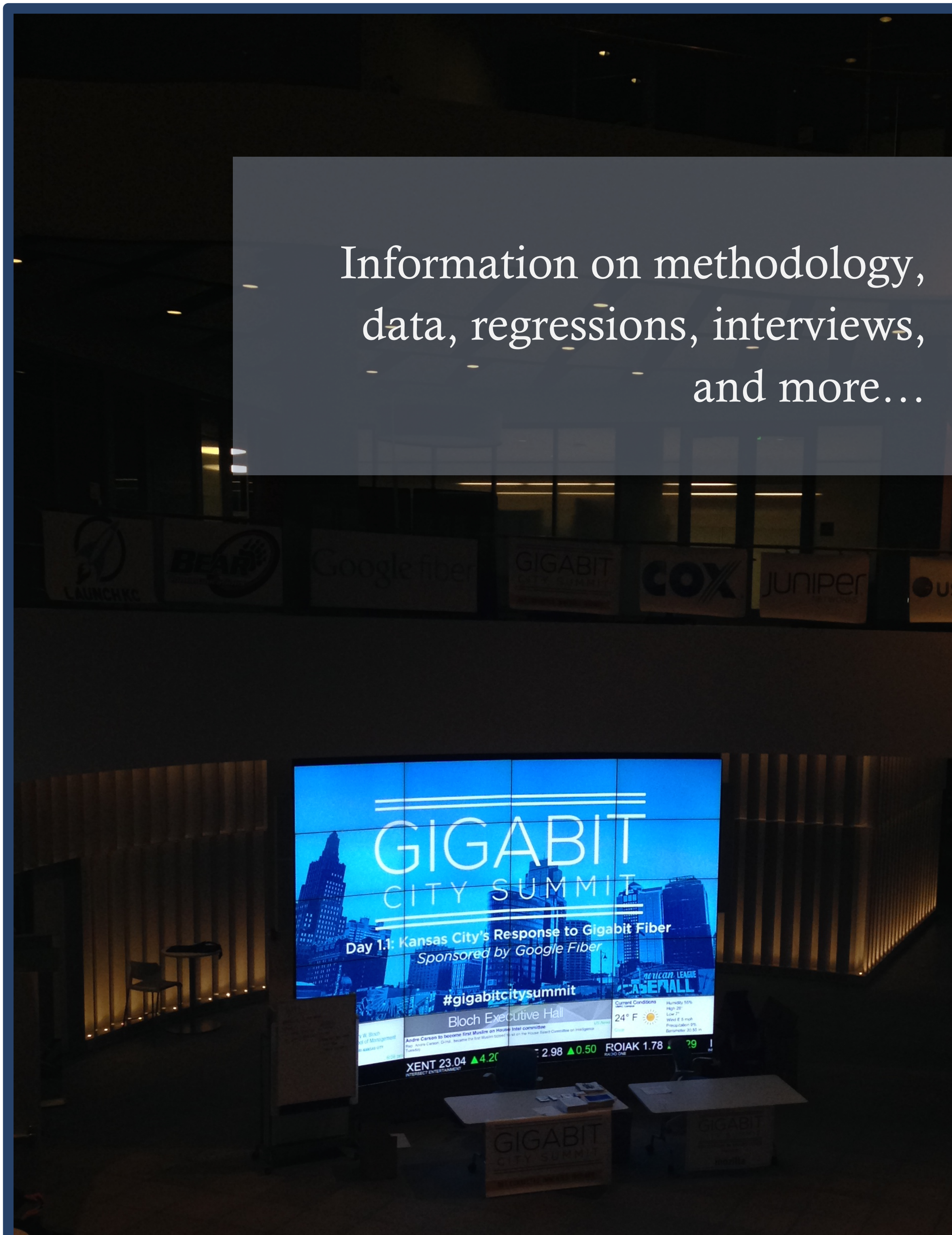
APPENDIX



Information on methodology, data, regressions, interviews, and more…

GLOSSARY

broadband – for the purposes of this report and the dates at which data was measured and surveyed, broadband is defined as an Internet connection of least 4 Mbps download speeds.

broadband adoption – refers to the decision to subscribe to broadband Internet services in the home.

non-adopters – those who do not have broadband in their homes.

the digital divide – refers to the socioeconomic gap that exists between those that have the Internet and know how to use it and those that don't.

digital inclusion – a general term referring to a goal of decreasing or eliminating the digital divide.

digital inclusion programs – programs with the explicit goal of decreasing to eliminating the digital divide.

digital inclusion interventions – a more general term for "digital inclusion programs" that also includes informal interventions (ex: being trained by a non-expert neighbor) and interventions that help bridge the digital divide thought their first goal is not to do so (ex: workforce development workshops with computers).

gigabit – gigabit Internet speeds are roughly 100x the average download speeds most Americans have today (10 Mpbs).

gigabit city – for the purposes of this report, a gigabit city as defined as a city where more than 50% of households had access to gigabit speeds as of the end of 2013 (according to the National Broadband Map).

INTERVIEW LOG

Name	Organization/Affiliation	Date
Deb Socia	Tech Goes Home; Next Century Cities	November 24, 2014
Ken Hays and Chattanooga Digital Inclusion Taskforce	Enterprise Center and the Chattanooga Digital Inclusion Team	December 17, 2014
Michael Liimatta	Connecting for Good, Kansas City	December 8, 2014
Nate Hill	Chattanooga Public Library	January 12. 2015
Parisa Fatehi-Weeks	Google Fiber Community Impact Manager - Austin	January 21, 2015
Geoff Millener	Mozilla Foundation Chattanooga	January 26, 2015
Alisson Walsh	Mobile Beacon	January 22, 2015
Gabe Martinez Cabrera	Digital Promise	January 23, 2015
Rachel Merlo	Google Fiber Community Impact Manager – Kansas City	January 20, 2015
Rondella Hawkins and City Digital Inclusion Team (John Speirs, Sharla Chamberlain, Kirby Aull)	Telecommunications & Regulatory Affairs Office – Austin, TX	January 31, 2015
Kelly McCarthy	Starting New Tech Goes Home Program in Chattanooga	March 3, 2015
Don Gregory	Digital Literacy Coordinator, BBRI & Instructor, Providence Public Library	March 12, 2015
Stuart Freiman	Broadband Program Director, BBRI	March 26, 2015

INTERVIEW QUESTIONS

Note: Depending on the role/expertise of the interviewee, I excluded or focused on certain sections.

Failures, Success, Observations: A National Perspective

- (If interviewee worked with a specific organization or project) What informed your program design? What informed your broadband adoption "theory of change"?

- In your opinion, looking at the broadband adoption efforts made since the National Broadband Plan, what has worked and what hasn't?

- Is there something missing from the conversation about broadband adoption in the U.S. – an effect not accounted for, an observation not talked about, barriers not recognized, an intervention not tried, etc.?

Broadband Adoption in High-Speed Cities

- In your opinion, are there unique broadband inclusion challenges/dangers faced by gigabit or upgrading cities? Is so, what are they?

Context: Broadband Adoption and Place Effects

- Have you witnessed neighborhood effects when it comes to adoption or non-adoption?

- Are there circumstances, strengths or challenges you've found unique to your city?

Broadband Adoption and Institutional Effects

- How does the institutional delivery affect adoption? In other words, who does it best – existing public outlets (ex: libraries, schools), companies (ISP corporate social responsibility), or the non-profit sector?

- What role do/should local policymakers play in the success or failure of a city's broadband adoption approach?

- What role do/should local ISPs play in the success or failure of a city's broadband adoption approach?

Broadband Adoption and Program Design Best Practices

- What types of programs drive adoption? Is it about one type of program? A combination?

- Is there a type of program or intervention that you think has been given enough attention/support? Maybe one that hasn't been tried?

- How does the program design drive adoption?

- Is a good approach to broadband adoption easily transferable? If not, what needs to be changed community by community? User by user?

- From a non-adopter's perspective, what is the tipping point that causes at-home adoption? Is it a certain about of time spent online? A certain skill threshold? A certain cost barrier crossed? Encountering key relevant tools or online content? Or, is it contextual factors? For instance, is it when their child reaches a certain age or when a certain number of their neighbors or friends get online?

Logistics

- Who else do you recommend I speak with?

- Is there something I am not considering? Questions I am not asking?

ON VARIABLE SELECTION

There were many variables in the merged master dataset, but not all could be used in the analysis. This section will describe the process of choosing the final six.

The initial ten variables are in the table below. They were selected based on background research on broadband adoption barriers – the idea being that these variables might correspond to personal characteristics that would correlate to the decision to adopt or not adopt broadband in the home.

Socioeconomic Variables	Relevancy Variables
% households in poverty (in the last 12 months)	% people over the age of 5 who speak a non-English language in the home
% households receiving food stamps	% foreign born
% population white alone	% population with disability status
% people over 25 years of age with a high school degree or better	% households with someone over 65 years of age
% people over the age of 1 years old who live in the same address as last year	% households with someone under the 18 years of age

To narrow down and simplify the final analysis, two things were done: a correlation table analysis and a factor analysis.

The correlation tables show us that a few of the variables of interest overlap or, essentially tell the same story. For instance, “poverty” and “SNAP participation” are highly correlated. So are “% who don’t speak English in the home” and “foreign” born.

A factor analysis was also conducted, which reinforced the conclusions drawn from the correlation tables.

CORRELATIONS

MSA 2013 Broadband Adoption Correlation Table

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Bband Adoption	1.00											
(2) Gigabit City	0.04	1.00										
(3) % HHs in poverty	-0.66	-0.02	1.00									
(4) % SNAP participation	-0.65	0.14	0.65	1.00								
(5) % White alone	0.05	0.13	-0.11	-0.04	1.00							
(6) % HS or better	0.58	0.03	-0.55	-0.49	0.22	1.00						
(7) % Transiency	-0.21	-0.02	-0.22	0.12	0.00	-0.14	1.00					
(8) % non-English at home	-0.06	-0.04	0.26	0.14	-0.27	-0.71	0.04	1.00				
(9) % Foreign born	0.19	-0.05	0.06	-0.06	-0.35	-0.52	0.04	0.90	1.00			
(10) % Disabled	-0.50	-0.01	0.34	0.48	0.15	-0.14	0.07	-0.27	-0.39	1.00		
(11) % HHs >65	-0.13	-0.09	-0.04	0.08	0.22	-0.06	0.28	-0.04	0.01	0.59	1.00	
(12) % HHs <18	-0.20	0.11	0.20	0.22	-0.31	-0.58	0.04	0.57	0.43	-0.34	-0.55	1.00

Census Tract 2013 Broadband Adoption Rating Correlation Table

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Bband Adoption	1.00												
(2) Gigabit City	-0.01	1.00											
(3) % HHs in poverty	-0.52	0.00	1.00										
(4) % SNAP participation	-0.52	0.02	0.81	1.00									
(5) % White alone	0.23	0.00	-0.48	-0.52	1.00								
(6) % HS or better	0.50	0.01	-0.64	-0.65	0.42	1.00							
(7) % Transiency	0.14	-0.02	-0,40	-0.20	0.14	0.08	1.00						
(8) % non-English at home	-0.07	-0.07	0.25	0.18	-0.28	-0.61	-0.02	1.00					
(9) % Foreign born	0.06	0.00	0.14	0.07	-0.33	-0.45	0.00	0.90	1.00				
(10) % Disabled	-0.41	0.03	0.39	0.50	-0.14	-0.29	-0.05	-0.18	-0.25	1.00			
(11) % HHs >65	0.00	-0.01	-0.19	-0.14	0.18	0.09	0.36	-0.15	-0.10	0.40	1.00		
(12) % HHs <18	-0.07	0.00	0.05	0.20	-0.20	-0.34	0.20	0.35	0.22	-0.27	-0.37	1.00	
(13) # Providers	-0.12	0.06	-0.09	-0.06	0.13	0.03	0.07	-0.14	-0.18	0.06	0.01	0.07	1.00

Census Tract 2013 Change in Broadband Adoption Rating Correlation Table

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**
(1) Bband Adoption	1.00												
(2) Gigabit City	-0.06	1.00											
(3) % HHs in poverty	0.02	0.00	1.00										
(4) % SNAP participation	-0.05	0.02	0.81	1.00									
(5) % White alone	-0.04	0.08	-0.48	-0.52	1.00								
(6) % HS or better	-0.07	0.01	-0.64	-0.65	0.42	1.00							
(7) % Transiency	0.00	-0.02	-0.40	-0.20	0.14	0.08	1.00						
(8) % non-English at home	0.20	-0.07	0.25	0.18	-0.28	-0.61	-0.02	1.00					
(9) % Foreign born	0.18	-0.08	0.14	0.07	-0.33	-0.45	0.00	0.90	1.00				
(10) % Disabled	-0.04	0.03	0.39	0.50	-0.14	-0.29	-0.05	-0.18	-0.25	1.00			
(11) % HHs >65	0.02	-0.01	-0.19	-0.14	0.18	0.09	0.36	-0.15	-0.10	0.40	1.00		
(12) % HHs <18	-0.02	0.00	0.85	0.20	-0.20	-0.34	0.20	0.35	0.22	-0.27	-0.37	1.00	
(13) # Providers	0.02	0.06	-0.09	-0.06	0.13	0.03	0.07	-0.14	-0.18	0.06	0.01	0.07	1.00

Highly positively correlated variable relationships can be seen between:

- % Household Poverty and % SNAP participation (MSA-level)
- % Non-English spoken at home and % Foreign Born (MSA-level)
- % Households with an <18-year-old and % Non-English spoken at home (MSA-level)
- % Disability and % Households with >65-year-old (MSA-level)
- %Poverty and % SNAP participation (Tract-level)
- % Non-English spoken at home and % Foreign Born (Tract-level)

Highly negatively correlated variable relationship can be seen between:

- % Poverty and % High School Degree or Better
- % High School Degree or Better and % Non-English spoken at home
- % High School Degree or Better and % Disability
- % Households with >65-year-old and % Households with an <18-year-old
- % Poverty and % High School Degree or Better
- % SNAP participation and % White
- % SNAP participation and % High School Degree or Better
- % High School Degree or Better and % Non-English spoken at home
- # Broadband providers and % Poverty
- # Broadband providers and % SNAP

MSA Variable Factor Analysis:

Rotating Factor Loadings (Pattern Matrix) and Unique Variances (blanks represent absolute values < 0.3)

Variable	Factor 1	Factor 2	Factor 3	Uniqueness
% HHs in poverty		0.8814		0.1947
% SNAP participation		0.8730		0.2315
% White alone	-0.4351			0.7526
% HS or better	-0.7031	-0.5291		0.1487
% Transiency			0.6395	0.5942
% non-English at home	0.9463			0.1125
% Foreign born	0.9343			0.1480
% Disabled	-0.4142	0.6467	0.3967	0.1718
% HHs >65			0.8985	0.1342
% HHs <18	0.6717		-0.3963	0.2815

Variable	Kasier-Meyer-Olkin measure of sampling adequacy
% HHs in poverty	0.5812
% SNAP participation	0.6799
% White alone	0.5635
% HS or better	0.7541
% Transiency	0.2754
% non-English at home	0.6645
% Foreign born	0.5905
% Disabled	0.6095
% HHs >65	0.4322
% HHs <18	0.6633
Overall	**0.6118**

Tract Variable Factor Analysis

Rotating Factor Loadings (Pattern Matrix) and Unique Variances (blanks represent absolute values < 0.3)

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Uniqueness
% HHs in poverty	0.8828				0.1531
% SNAP participation	0.9344				0.1373
% White alone	-0.5737				0.5362
% HS or better	-0.7195	-0.4372			0.1852
% Transiency			0.5903	0.5299	0.2531
% non-English at home		0.9390			0.1058
% Foreign born		0.9837			0.1147
% Disabled	0.6677		0.5472		0.1762
% HHs >65			0.9189		0.1509
% HHs <18			-0.3149	0.7077	0.2378
# Providers		-0.4661		0.6761	0.5103

Variable	Kasier-Meyer-Olkin measure of sampling adequacy
% HHs in poverty	0.7465
% SNAP participation	0.7359
% White alone	0.7737
% HS or better	0.8199
% Transiency	0.5344
% non-English at home	0.6067
% Foreign born	0.5776
% Disabled	0.6475
% HHs >65	0.5561
% HHs <18	0.5513
# Providers	0.6901
Overall	**0.6731**

RESULTING VARIABLES

Eliminated:

- Foreign Born
- SNAP
- Trans
- >65 HHs

Remaining Socioeconomic Variables for Analysis:

- % Poverty
- % HS degree or better
- % White

Remaining Relevancy Variables for Analysis:

- % Non-English spoken in the home
- % Disability
- % Households with <18-year-olds

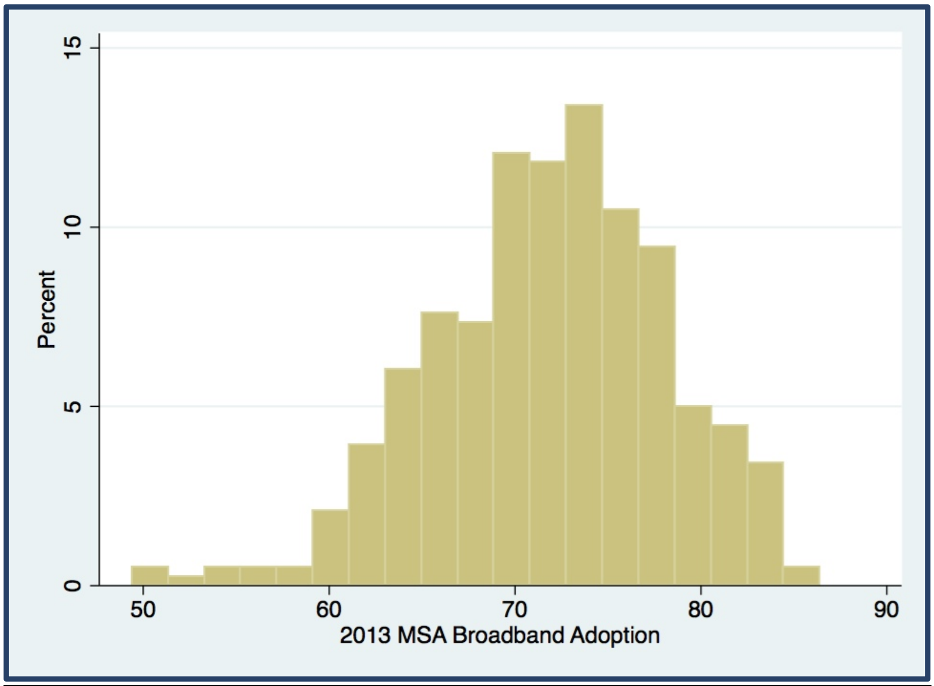
MORE ON METHODOLOGY

ON THE DIRECT MODEL

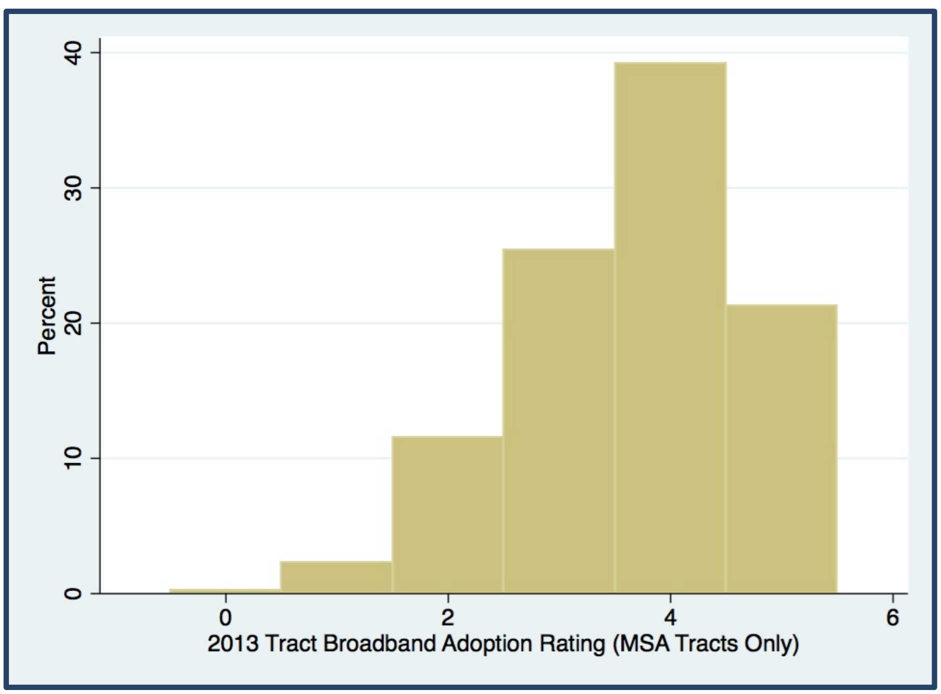
ON THE INTERACTIVE MODEL

BROADBAND ADOPTION HISTOGRAMS

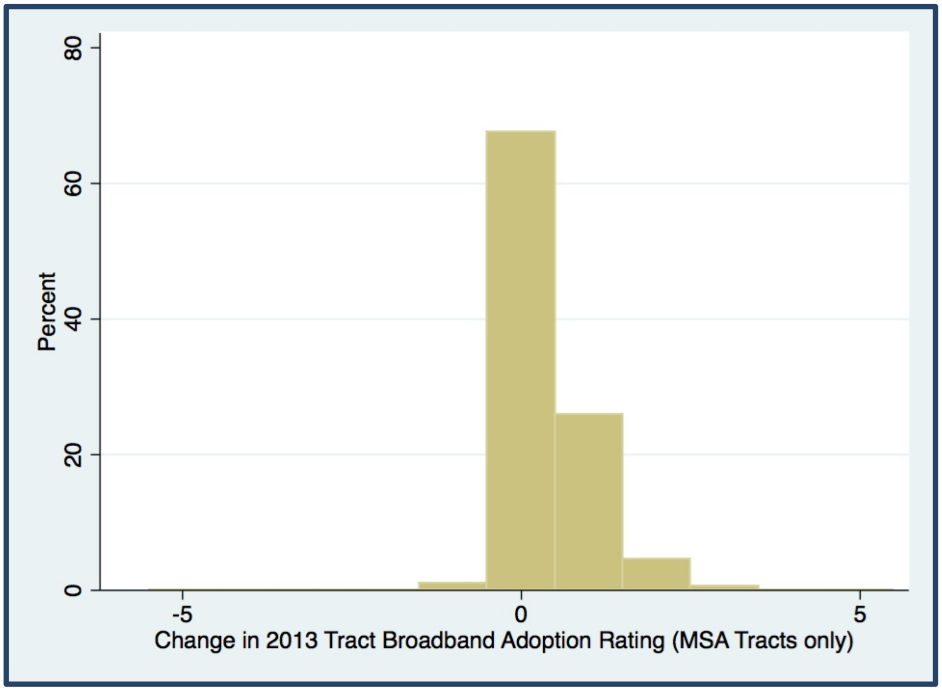
Histogram: 2013 Broadband Adoption in MSAs (%)



Histogram: 2013 Broadband Adoption in Census Tracts in MSAs (1-5 rating)



Histogram: June 2013 – December 2013 Change in Broadband Adoption Rating (1-5) in Census Tracts in MSAs



FULL REGRESSION RESULTS

PRELIMINARY REGRESSIONS

Table 1: Individual Variable Regressions (No Controls)
Dependent Variable: 2013 MSA-Level Broadband Adoption %

	Gigabit (1)	Poverty (2)	White (3)	HS Grad (4)	NonEng (5)	Disable (6)	<18 HH (7)
Intercept	71.662*** (0.3314)	85.9322*** (1.0566)	69.8736*** (2.1757)	13.4454*** (4.4591)	73.8877*** (0.6121)	86.6520*** (1.2838)	77.2986*** (1.8733)
Coeff.	3.5946** (1.4116)	-0.9054*** (0.0658)	0.0256 (0.271)	0.6690*** (0.0510)	-0.0259 (0.0281)	-1.0746*** (0.0911)	-0.1736*** (0.0589)
Observations	381	381	377	381	237	381	381

****** = at 1% level   ** = at 5% level   * = at 10% level***

Table 2: Individual Variable Regressions (No Controls)
Dependent Variable: 2013 Tract-Level Broadband Adoption Rating

	#Providers (1)
Intercept	3.8189*** (0.1117)
Coeff.	-0.0595** (0.01872)
Observations	56705

	Gigabit (2)	Poverty (3)	White (4)	HS Grad (5)	NonEng (6)	Disable (7)	<18 HH (8)
Intercept	3.5946** (1.4116)	4.2985*** (0.0563)	3.0065*** (0.2101)	0.1198 (0.3121)	3.7268*** (0.0640)	4.5288*** (0.0763)	3.8440*** (0.0834)
Coeff.	-0.0487 (0.1694	-0.0426*** (0.0014)	0.0092*** (0.0020)	0.04129*** (0.0030)	-0.0032 (0.0021)	-0.0731*** (0.0034)	-0.006*** (0.0020)
Observations	56705	56555	56629	56623	56629	56600	56555

****** = at 1% level   ** = at 5% level   * = at 10% level***

Table 3: Individual Variable Regressions (No Controls)
Dependent Variable: Change in Tract-Level Broadband Adoption Rating (June 2013 – December 2013)

	#Providers (1)
Intercept	0.3480*** (0.0407)
IV Coeff.	0.0065 (0.0052)
Observations	56705

	Gigabit (2)	Poverty (3)	White (4)	HS Grad (5)	NonEng (6)	Disable (7)	<18 HH (8)
Intercept	0.3718*** (1.4116)	0.3535*** (0.0483)	0.4342*** (0.0967)	0.6819*** (0.1452)	0.2392*** (0.0205)	0.4235*** (0.0847)	0.3778*** (0.0554)
Coeff.	-0.1646** (0.0705)	0.0009 (0.0006)	-0.0010 (0.0008)	-0.0037*** (0.0013)	0.0056*** (0.0015)	-0.0047 (0.0036)	-0.0003 (0.0014)
Observations	56705	56555	56629	56623	56629	56600	56555

****** = at 1% level   ** = at 5% level   * = at 10% level***

DIRECT MODEL REGRESSIONS

Table 4
Dependent Variable: 2013 MSA-Level Broadband Adoption %

	(1)	**(2)**	**(3)**	**(4)**
Intercept	71.6625*** (0.3314)	85.6722*** (1.0529)	87.7602*** (2.1883)	46.2898*** (5.2978)
Gigabit City	3.5946** (1.4116)	3.0517*** (1.1542)	3.1922*** (1.1676)	2.5127** (1.0737)
% HH poverty		-0.8995*** (0.0653)	-0.9046*** (0.0664)	-0.6316*** (0.0689)
% White alone			-0.0250 (0.0224)	-0.0534** (0.0208)
% HS degree or better				0.4527*** (0.0535)
Observations	381	381	377	377

****** = at 1% level   ** = at 5% level   * = at 10% level***

Table 5
Dependent Variable: 2013 MSA-Level Broadband Adoption %

	(1)	(2)	(3)	(4)
Intercept	71.6625*** (0.3314)	73.8164*** (0.6228)	91.463*** (1.8953)	107.1835*** (2.8605)
Gigabit City	3.5946** (1.4116)	1.0806 (1.6811)	0.8300 (1.4224)	2.3047* (1.3159)
% non-English in the home		-0.0252 (0.0281)	-0.0905*** (0.0247)	0.0095 (0.0268)
% Disabled			-1.2720*** (0.1312)	-1.4720*** (0.1232)
% HHs with <18				-0.4685*** (0.0679)
Observations	381	237	237	237

****** = at 1% level** ***** = at 5% level*** **** = at 10% level***

Table 6
Dependent Variable: 2013 Tract-Level Broadband Adoption Rating

	(1)	(2)	(3)	(4)
Intercept	3.8191*** (0.1125)	4.5777*** (0.08334)	4.5839*** (0.2008)	2.4587*** (0.4031)
Gigabit City	-0.0128 (0.1538)	0.0099 (0.01353)	0.0108 (0.1321)	0.0031 (0.1448)
% HH poverty		-0.04382*** (0.00142)	-0.0439*** (0.0016)	-0.0304*** (0.0022)
% White alone			-0.0001 (0.0016)	-0.0017 (0.0016)
% HS degree or better				0.0236*** (0.0025)
# Providers	-0.0594*** (0.01852)	-0.0916*** (0.0150)	-0.0915*** (0.0139)	-0.0848*** (0.0150)
Observations	56705	56555	56555	56554

****** = at 1% level** ***** = at 5% level*** **** = at 10% level***

Table 7
Dependent Variable: 2013 Tract-Level Broadband Adoption Rating

	(1)	(2)	(3)	(4)
Intercept	3.8191*** (0.1125)	3.9455*** (0.1028)	4.9359*** (0.0711)	5.3654*** (0.0789)
Gigabit City	-0.0128 (0.1538)	-0.0456 (0.1580)	-0.0029 (0.1611)	0.0172 (0.1568)
% non-English in the home		-0.0041** (0.0019)	-0.0076*** (0.0019)	-0.0055*** (0.0017)
% Disabled			-0.0774*** (0.0031)	-0.0853*** (0.0028)
% HHs with <18				-0.0122*** (0.0011)
# Providers	-0.0594*** (0.0185)	-0.0696*** (0.0184)	-0.0640*** (0.0158)	-0.0541*** (0.0160)
Observations	56705	56629	56600	56555

****** = at 1% level** ***** = at 5% level*** **** = at 10% level***

Table 8
Dependent Variable: Change in Tract-Level Broadband Adoption Rating (June 2013 – December 2013)

	(1)	(2)	(3)	(4)
Intercept	0.3507*** (0.0411)	0.3355*** (0.0465)	0.4125*** (0.1259)	0.8578*** (0.2582)
Gigabit City	-0.1691** (0.0707)	-0.1696** (0.0704)	-0.1589** (0.0628)	-0.1573** (0.0645)
% HH poverty		0.0010 (0.0006)	0.0001 (0.0013)	-0.0028 (0.0021)
% White alone			-0.0009 (0.0011)	-0.0006 (0.0010)
% HS degree or better				-0.0049*** (0.0018)
# Providers	0.0075 (0.0053)	0.0077 (0.0054)	0.0087 (0.0061)	0.0073 (0.0056)
Observations	56705	56555	56555	56554

****** = at 1% level   ** = at 5% level   * = at 10% level***

Table 9
Dependent Variable: Change in Tract-Level Broadband Adoption Rating (June 2013 – December 2013)

	(1)	(2)	(3)	(4)
Intercept	0.3507*** (0.0411)	0.1919*** (0.0324)	0.2029*** (0.0402)	0.3714*** (0.0786)
Gigabit City	-0.1691** (0.0707)	-0.1224* (0.0676)	-0.1220* (0.0671)	-0.1151* (0.0688)
% non-English in the home		0.0057*** (0.0015)	0.0057*** (0.0015)	0.0066*** (0.0017)
% Disabled			-0.0008 (0.0023)	-0.0034 (0.0031)
% HHs with <18				-0.0051*** (0.0018)
# Providers	0.0075 (0.0053)	0.0170** (0.0068)	0.0170** (0.0069)	0.0213*** (0.0078)
Observations	56705	56629	56600	56555

****** = at 1% level   ** = at 5% level   * = at 10% level***

Table 10
Dependent Variable: 2013 MSA-Level Broadband Adoption %

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept	71.6625*** (0.3314)	85.6722*** (1.0529)	87.760*** (2.1883)	46.290*** (5.2978)	1.6290 (7.1019)	11.7991 (7.6513)	24.389** (9.6060)
Gigabit City	3.5946** (1.4116)	3.0517*** (1.1542)	3.1922*** (1.1676)	2.5127** (1.0737)	0.9662 (0.9709)	0.8592 (0.9525)	1.2826 (0.9657)
% HH poverty		-0.8995*** (0.0653)	-0.905*** (0.0664)	-0.6316*** (0.0689)	-0.6010*** (0.0728)	-0.5419*** (0.0737)	-0.5440*** (0.0731)
% White alone			-0.025 (0.0224)	-0.0534** (0.0208)	-0.0048 (0.0200)	0.0040 (0.0198)	-0.0035 (0.0200)
% HS degree or better				0.4527*** (0.0535)	0.8794*** (0.0692)	0.8024*** (0.0720)	0.7250*** (0.0801)
% non-English in the home					0.2604*** (0.0236)	0.2197*** (0.0264)	0.22001*** (0.0262)
% Disabled						-0.3328*** (0.1038)	-0.4379*** (0.1141)
% HHs with <18							-0.1222** (0.0571)
Observations	381	381	377	377	237	237	237

****** = at 1% level***   ***** = at 5% level***   **** = at 10% level***

Table 11
Dependent Variable: 2013 Tract-Level Broadband Adoption Rating

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept	3.8191*** (0.1125)	4.5778*** (0.0833)	4.5839*** (0.2008)	2.4587*** (0.4031)	0.4200 (0.3457)	1.2685*** (0.3337)	1.4712*** (0.3651)
Gigabit City	-0.0128 (0.1538)	0.0099 (0.1353)	0.0108 (0.1321)	0.0031 (0.1448)	0.0807 (0.1329)	0.0792 (0.1383)	0.0819 (0.1376)
% HH poverty		-0.0438*** (0.0014)	-0.0439*** (0.0016)	-0.0304*** (0.0022)	-0.0237*** (0.0020)	-0.0208*** (0.0019)	-0.0213*** (0.0019)
% White alone			-0.0001*** (0.0016)	-0.0017 (0.0016)	-0.0008 (0.0015)	-0.0007 (0.0014)	-0.0008 (0.0014)
% HS degree or better				0.0236*** (0.0025)	0.0413*** (0.0022)	0.0355*** (0.0020)	0.0343*** (0.0021)
% non-English in the home					0.0129*** (0.0012)	0.0093*** (0.0012)	0.0093*** (0.0012)
% Disabled						-0.0272*** (0.0020)	-0.0289*** (0.0021)
% HHs with <18							-0.0021** (0.0009)
# Providers	-0.0594*** (0.0185)	-0.0916*** (0.0150)	-0.0915*** (0.0139)	-0.0848*** (0.0150)	-0.0636*** (0.0116)	-0.0625*** (0.0115)	-0.0611*** (0.0113)
Observations				56554	56554	56554	56554

****** = at 1% level***   ***** = at 5% level***   **** = at 10% level***

Table 12
Dependent Variable: Change in Tract-Level Broadband Adoption Rating (June 2013 – December 2013)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept	0.3507*** (0.0411)	0.3355*** (0.0465)	0.4125*** (0.1259)	0.8578*** (0.2582)	-0.3026* (0.1776)	-0.4162** (0.1765)	0.0101 (0.2283)
Gigabit City	-0.1691** (0.0707)	-0.1696** (0.0704)	-0.1589** (0.0628)	-0.1573** (0.0645)	-0.1131* (0.0659)	-0.1129* (0.0665)	-0.1072 (0.0002)
% HH poverty		0.0010 (0.0006)	0.0001 (0.0013)	-0.0028 (0.0021)	0.0011 (0.0010)	0.0007 (0.0010)	-0.0002 (0.0013)
% White alone			-0.0009 (0.0011)	-0.0006 (0.0010)	-0.0001 (0.0007)	-0.0001 (0.0007)	-0.0004 (0.0008)
% HS degree or better				-0.0049*** (0.0018)	0.0052*** (0.0020)	0.0059*** (0.0019)	0.0035** (0.0017)
% non-English in the home					0.0073*** (0.0021)	0.0078*** (0.0021)	0.0077*** (0.0020)
% Disabled						0.0036** (0.0017)	-0.0001 (0.0027)
% HHs with <18							-0.0043** (0.0020)
# Providers	0.0075 (0.0053)	0.0077 (0.0465)	0.0087 (0.0061)	0.0073 (0.0056)	0.0194** (0.0077)	0.0193** (0.0076)	0.0221*** (0.0083)
Observations		56555	56555	56554	56554	56554	56554

****** = at 1% level   ** = at 5% level   * = at 10% level***

INTERACTIVE MODEL REGRESSIONS

Table 13
Dependent Variable: 2013 MSA-Level Broadband Adoption %

	(1)	(2)	(3)
Intercept	86.3150*** (1.0592)	70.7964*** (2.1751)	13.9322*** (4.5824)
Gigabit City	-13.2281** (5.1876)	-39.5237* (22.1091)	5.6618 (21.0887)
% HH Poverty	-0.9408*** (0.0658)		
Gigabit City*HH poverty	1.0857*** (0.3375)		
% white alone		0.0116 (0.0272)	
Gigabit City*white alone		0.5004* (0.2570)	
% HS degree or better			0.6621*** (0.0525)
Gigabit City*HS degree			-0.0399 (0.2357)
Observations	381	377	381

****** = at 1% level   ** = at 5% level   * = at 10% level***

Table 14
Dependent Variable: 2013 MSA-Level Broadband Adoption %

	(1)	(2)	(3)
Intercept	73.7112*** (0.6281)	86.5407*** (1.3115)	77.6600*** 1.9283
Gigabit City	4.0129 (2.9374)	-1.9583 (6.0484)	-1.3362 (7.4006)
% NonEnglish at home	-0.0191 (0.0285)		
Gigabit City *Non English at home	-0.1967 (0.1617)		
% Disability status		-1.0775*** (0.0927)	
Gigabit City*Disability Status		0.3612 (0.4540)	
% HH with <18			-0.1918*** (0.0608)
Gigabit City*HHs with <18			0.1587 (0.2256)
Observations	237	381	381

****** = at 1% level**   ***** = at 5% level***   **** = at 10% level***

Table 15
Dependent Variable: 2013 Tract-Level Broadband Adoption Rating

	(1)	(2)	(3)
Intercept	4.3040*** (0.0059)	3.0136*** (0.0121)	0.1161*** (0.0267)
Gigabit City	-0.1772*** (0.0333)	-0.07042*** (0.1028)	0.1142 (0.1686)
% HH Poverty	-0.0429*** (0.0003)		
Gigabit City*HH poverty	0.0087*** (0.0017)		
% white alone		0.0092*** (0.0002)	
Gigabit City*white alone		0.0067*** (0.0012)	
% HS degree or better			0.0414*** (0.0003)
Gigabit City*HS degree			-0.00232 (0.0019)
Observations	56555	56629	56623

****** = at 1% level**   ***** = at 5% level***   **** = at 10% level***

Table 16
Dependent Variable: 2013 Tract-Level Broadband Adoption Rating

	(1)	(2)	(3)
Intercept	3.7293*** (0.0062)	4.5334*** (0.0094)	3.8515*** (0.0125)
Gigabit City	-0.0301 (0.0339)	-0.1419*** (0.0543)	-0.2642*** (0.0749)
% NonEnglish at home	-0.0032** (0.0002)		
Gigabit City *Non English at home	-0.0036 (0.0017)		
% Disability status		-0.0736*** (0.0007)	
Gigabit City*Disability Status		0.0128** (0.0038)	
% HH with <18			-0.0058*** (0.0003)
Gigabit City*HHs with <18			0.0064*** (0.0021)
Observations	56629	56600	56555

****** = at 1% level   ** = at 5% level   * = at 10% level***

Table 17
Dependent Variable: Change in Tract-Level Broadband Adoption Rating (June 2013 – December 2013)

	(1)	(2)	(3)
Intercept	0.3580*** (0.0050)	0.4335** (0.0972)	0.6998*** (0.1452)
Gigabit City	-0.1422 (0.0874)	-0.1783 (0.1345)	-0.7709*** (0.1620)
% HH Poverty	0.0009 (0.0006)		
Gigabit City*HH poverty	-0.0015 (0.0016)		
% white alone		-0.0009 (0.0008)	
Gigabit City*white alone		-0.0003 (0.0011)	
% HS degree or better			-0.0038*** (0.0013)
Gigabit City*HS degree			0.0071*** (0.0014)
Observations	56555	56629	56623

****** = at 1% level   ** = at 5% level   * = at 10% level***

Table 18
Dependent Variable: Change in Tract-Level Broadband Adoption Rating (June 2013 – December 2013)

	(1)	(2)	(3)
Intercept	0.2416*** (0.0213)	0.4276*** (0.0864)	0.3821*** (0.0569)
Gigabit City	0.0131 (0.0626)	-0.1883** (0.1091)	-0.1142 (0.0946)
% NonEnglish at home	0.0057*** (0.0015)		
Gigabit City *Non English at home	-0.0091*** (0.0018)		
% Disability status		-0.0046 (0.0037)	
Gigabit City*Disability Status		0.0022 (0.0040)	
% HH with <18			-0.0003 (0.0014)
Gigabit City*HHs with <18			-0.0015 (0.0017)
Observations	56629	56600	56555

****** = at 1% level**   ***** = at 5% level**   **** = at 10% level***

ABOUT THE STUDENT

Denise Linn is a Master in Public Policy Candidate at the Harvard Kennedy School. Her professional experience thus far has revolved around closing the digital divide, increasing broadband competition, and implementing city-level Internet access projects. Throughout 2014 as an Ash Fellow with the Gig.U project and as a member of the Berkman Center Fiber Team, she assisted local leaders seeking to build or extend next generation fiber- optic networks to spur economic development. Before attending graduate school, she was an Economics Research Assistant for the Auctions and Spectrum Access Division of the Federal Communications Commission (FCC). She is also an alumna of the AmeriCorps*VISTA program and spent a year of service working on broadband access and digital literacy projects with One Economy in North Carolina. Denise graduated from the University of Virginia in 2010 with highest honors.

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