Introduction

As we progress further into this digital age, access to computers has evolved from a luxury to a necessity. Digital technologies permeate virtually every aspect of our day-to-day lives, influencing education, employment opportunities, and social interactions. The “digital divide,” the disparity in access to information and communication technologies, is especially pronounced among the economically disadvantaged. Depending on technological, economic, and political factors, the disparity in digital connectivity could potentially facilitate increasingly uneven economic outcomes.

In an attempt to mitigate the digital divide, the Federal Communications Commission has implemented the Affordable Connectivity Program (ACP), where low income households can apply to receive stipends to subsidize broadband internet services. Intuitively we can imagine the many benefits that broadband internet access provides for families, but empirically we see low participation rates. Contemporary analyses of this policy criticize the exceedingly stringent requirements to qualify for the program, noting them as the cause for the lackluster participation rates. However, it could also be the case that broadband does not affect the well-being of those that have access to it. Therefore, in this paper we will explore the extent to which broadband internet access increases the well-being of families on the lower end of the income distribution. We accomplish this by measuring the effect of broadband services on the total personal income of the head of the house as a supplemental measure for household welfare.

The dataset used in this analysis should reflect the contemporary nature of the internet and labor landscape today. As such, only ACS samples from 2016-2021 will be included. The true model we are attempting to estimate is the extent to which broadband internet access affects the earning outcomes of low income households through the proxy of affecting the wages of the head of the household. Our observations of concern are individuals that are their head of household, and are 200% below the federal poverty guidelines. Individuals are classified in this group based on the number of individuals in their direct family unit, as well as their total earned income in the previous year. For context, a family of 4 would have to earn $55,500 or less in total family income in order to be considered 200% below the federal poverty guidelines, and thus qualify for the ACP.

Broadband internet is defined by the Federal Communications Commission as “a minimum of 25Mbps for download and 3Mbps for upload” (fcc.gov). However, these standards are one dimensional in the sense that they only encapsulate the speed at which Internet services can process information. A more holistic definition of broadband internet is that it is a service that provides transportation for “different internet traffic types, allowing multiple data streams to be sent at once” (fcc.gov). This is an important distinction to make as faster upload and download speeds do not imply greater connectivity for the entire family unit.

In order to determine the causal relationship between broadband internet access and total personal income, we will specify a linear regression model:

$$\ln(Y_i) = \boldsymbol{\alpha} + \boldsymbol{\beta} BB_i + \boldsymbol{\rho}\, SEX_i + \boldsymbol{\theta} AGE_i + \boldsymbol{\lambda}\, RACE_i + \boldsymbol{\tau}\, YEAR_i + \boldsymbol{\varepsilon}\, STATE_i + \boldsymbol{\gamma}_1\, EDUC_{1i} + \boldsymbol{\gamma}_2\, EDUC_{2i} + \ldots + \boldsymbol{\gamma}_9\, EDUC_{9i} + e_i$$

In which the dependent variable, Y_i, denotes total personal income of the head of household, and where the treatment, BB_i, denotes whether the observation has access to broadband internet. After controlling for other variables that might determine total personal income, $\boldsymbol{\beta}$ will represent the relationship between the treatment and the dependent variable.

After collecting observations from the 2016 - 2021 ACS samples, and estimating our regression model, we find that broadband internet access increases the total personal income of heads of households that are 200% below the poverty line by 8.5%. This suggests that benefit programs like the ACP should be prioritized as the value that they provide outweighs the costs associated with provisionment.

Literature Review

In his paper, "*Wired and Hired: Employment Effects of Subsidized Broadband Internet for Low-Income Americans*," Dr. Zuo describes the correlation between broadband pricing and labor market outcomes for low-income individuals. His research found that discounted broadband service pricing was positively correlated with employment rates and earning outcomes. Which was spurred by, "greater labor force participation and decreased probability of unemployment" (Zou 1). His research also revealed that regions with reduced broadband prices experienced substantial increases in internet use. This culminates in his finding that the value of broadband to consumers is four times the cost associated with providing the service. In other words, the cost-effectiveness of programs that provide broadband services suggests that additional public and private subsidies should be provided as the value that they create for consumers far outweighs the costs of providing the service.

Low-skill workers, defined as those with a highschool education or less, are most likely to be individuals with low digital competency (Holzer 1996). The prominent focus of my research is the extent to which individuals on the lower end of the income distribution are affected by changes in their ability to utilize digital skills. In her work titled "*The Digital Divide and Economic Opportunity: Does Internet Use Matter for Less-Skilled Workers?*" Dr. Mossberger explores the significance of computer skills concerning earning outcomes among low-income individuals. Her research finds that, "Digital inequality does penalize less educated workers," and that, "increases [in] technology skills among all Americans [would] enable the participation of the least-advantaged in the new economy." (Mossberger 12) That is to say, those with relevant technology skills are compensated much higher than their peers, and may experience compounding advantages over time.

In a 2013 report by the National Telecommunications and Information Administration, the NTIA discusses the three biggest reasons why households report not using broadband internet where they live. The first is that the household does not need it or they are not interested in it. The second is that the cost of connection is too expensive. The third reason is that they lack adequate computer equipment to utilize the technology. This paper was written at a point where 26% of the population was not connected to the internet, this figure currently sits around 7% (Pew Research Center). That is to say, the first reason, why someone wouldn't need an internet connection or be interested in it, has fallen out of practice. That leaves price and availability of technology as the two biggest remaining reasons as to why people haven't adopted broadband services. One of the potential limitations of this study is the fact that an ACP style stipend might not fully cover the cost of broadband services for all families. For the sake of interpretation, we assume that the money provided by the ACP is sufficient to completely compensate for a broadband connection or reduces the cost of broadband enough to entice the family to purchase a plan if they receive the stipend. This is important to note as the average broadband plan is around $45-$60 a month in 2023.

Data

Statistic	N	Mean	St. Dev.	Min	Max
INCTOT	1,664,632	19,443.250	12,247.880	1	102,050
HASBBIA	1,664,632	0.743	0.437	0	1
AGE	1,664,632	52.305	18.691	15	96
SEX	1,664,632	1.571	0.495	1	2
FAMSIZE	1,664,632	2.410	1.517	1	8

This data was obtained from IPUMS USA, more specifically from the American Community Survey from 2016 to 2021. To begin pruning, we first remove any missing, non applicable, or not in universe observations from our dataset. Then we take a subset of our current data so that all individuals under consideration are the head of their household. Because we are only interested in the effects of broadband on those who qualify for the ACP, we should only include individuals that are at or below 200% of the federal poverty level. We achieve this by taking into account the number of people in the family unit, as well as the total family income, and only include observations that qualify based on the federal guidelines outlined by the census bureau (aspe.hhs.gov). It should be noted that Alaska and Hawaii have different criteria for their definition of 200% below the federal poverty level, so we include observations from those two states after accounting for this. Finally, we create a new variable, HASBBIA a simple binary variable, to denote whether the observation has access to broadband internet.

The wording of the question on the ACS survey that probes for whether an observation has a broadband connection or not is imprecise. It provides no internal definition or description of what a broadband connection actually is. Coupled with the evolving speed requirements of broadband, it is completely possible that an individual unknowingly falsely reported the status of their broadband connection. For the sake of this study however, we assume that all questions were answered correctly and truthfully.

Empirical Methodology

Access to broadband affects the earning outcomes of heads of households, and those incomes determine the welfare of the family unit. The internal mechanism of this study will show the causal relationship between broadband internet access and head of household incomes, and we will make the assumption that head of household incomes determine household outcomes.

The intuition behind measuring the returns of broadband in terms of the income of the head of the household is as follows. Firstly, a family's financial well-being is practically entirely determined by the income of the breadwinner (see figure 1). In addition to this fact, broadband access might allow individuals to more effectively allocate their "mental capital" and allow them to work harder/longer on the job, resulting in higher compensation. A broadband network could also allow individuals to work online jobs that they would otherwise not be able to participate in, which in turn would affect their income. Finally, broadband internet could potentially lead to the acquisition of knowledge and skills they otherwise wouldn't have, resulting in higher returns from working in the future. These avenues are some of the most prominent ways that broadband internet access could affect the income of heads of households.

A linear, log-level regression model was constructed to estimate the causal relationship between our dependent variable, total personal income, and our treatment variable, access to broadband internet. The personal income of the head of households has been log transformed so that our regression coefficients would be interpreted in percentage terms. Next, we controlled for age, sex, race, and educational attainment as well as included year and state-level fixed effects.

To address the matter of reverse causality, let's take a look at the distribution of incomes amongst our observations. While there's a valid logical assertion that individuals with higher incomes tend to provide themselves with superior services such as broadband, our empirical observations paint a different picture. Figure 2 illustrates that income distributions closely parallel each other for both groups. Although there is some variability in these distributions, the overarching trends appear to align. This suggests that there is not a substantial difference between those that have broadband and those who do not before they acquire access to the technology.

Results

After estimating our regression model, we find that broadband internet access increases the total personal income of heads of households that are 200% below the poverty line by 8.5%. The results are relatively robust as well, heteroskedasticity robust standard errors show no change in our regression coefficients for our treatment variable. We also observe no change in the treatment regression coefficient for state-wide versus county geographic controls. Meaning that whether an observation is in a metropolitan or rural area, they will still experience the same gains from broadband. Also to justify the usage of our control variables, I ran a short-simple regression where log income only depended on broadband internet access, the sex, and age of the observation. What we found is that broadband access increased personal income by 8.7%. Meaning that, after adding in all of our other control variables, the causal effect of our treatment variable only diminished by 0.2%.

The ACP subsidy for broadband services is $30 a month or $360 a year, this means that individuals that earn more that $4,500 will experience greater gains income from a broadband connection than they would if they were simply given that money instead. In our sample, we find that the gains from an ACP style subsidy provide more value than costs for 90% of our observations.

A quick check we can conduct pertains to gender-based income disparities. According to online sources, women reportedly earn 10-25% less than their male counterparts, a finding that aligns with our own results. It's worth noting that our estimate leans toward the upper end of this range, and one plausible explanation lies in our methodology of comparing heads of households while controlling for gender. In our analysis, the default head of the household is designated as the father when both parents are present. This distinction implies that only single women, separated women, or widows are considered heads of their households, while all categories of men are automatically classified as heads of their households. This aspect of our methodology introduces a potential bias that may influence our results, possibly contributing to the observed skew toward the higher end of the reported gender income gap.

Conclusion

This research embarked on a comprehensive exploration of the impact of broadband internet on low-income American families, centering around the Affordable Connectivity Program. Our investigation delved into both the potential advantages and weaknesses of this policy. What emerged from our analysis is a striking revelation: even without factoring in other positive externalities, a staggering 90% of observations in our sample stand to gain immediate benefits from ACP enrollment. This suggests that the sluggish adoption of the ACP may be more attributable to bureaucratic delays rather than a lack of interest from qualifying households.

Moving forward, future research in this domain should pivot towards employing alternative methodologies to gauge the causal effect of broadband internet access. One promising avenue involves tracking households that have received the ACP stipend over time, enabling the construction of a differences-in-differences model to ascertain the causal relationship between the treatment and the dependent variable. However, the feasibility of this approach hinges on the availability of a longitudinal dataset, a factor that remains uncertain at present.

Tables and Figures

Figure 1: Head of Household Income Correlation with Total Family Income

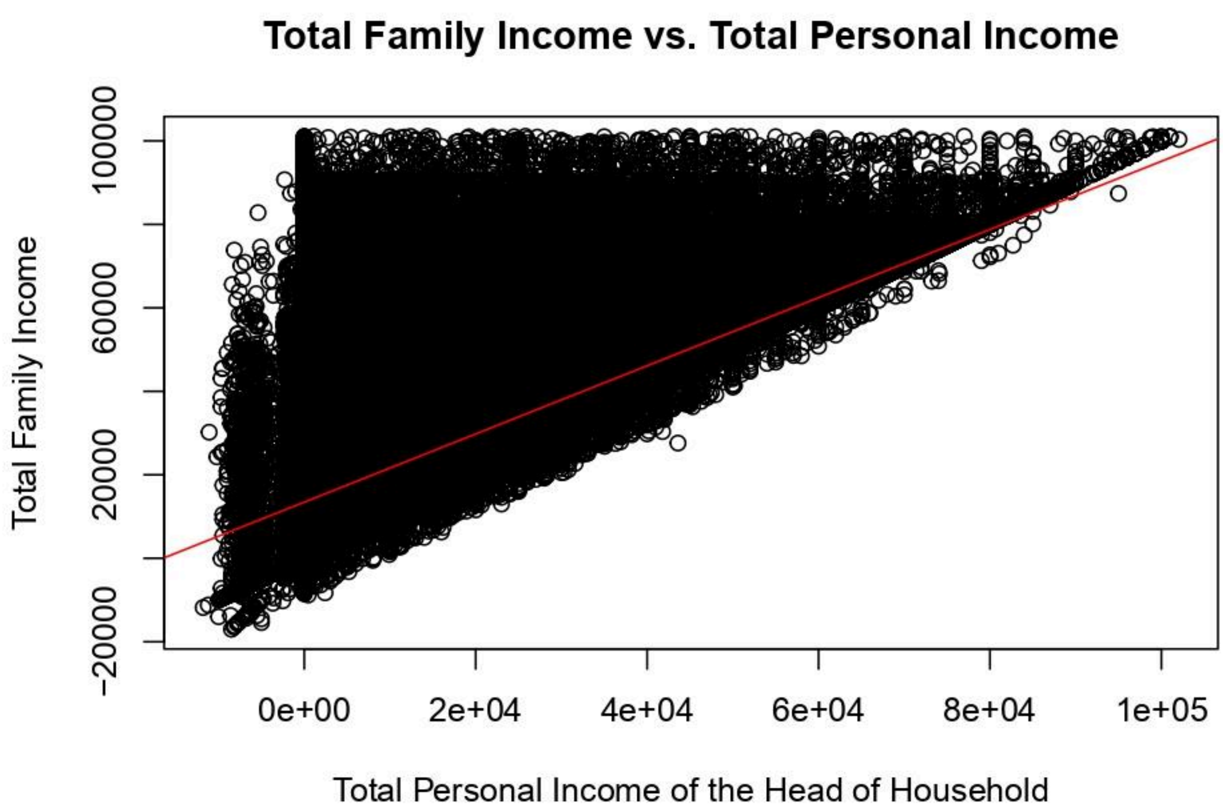

Figure 2: Comparison of Distribution of Incomes Based on Broadband Status

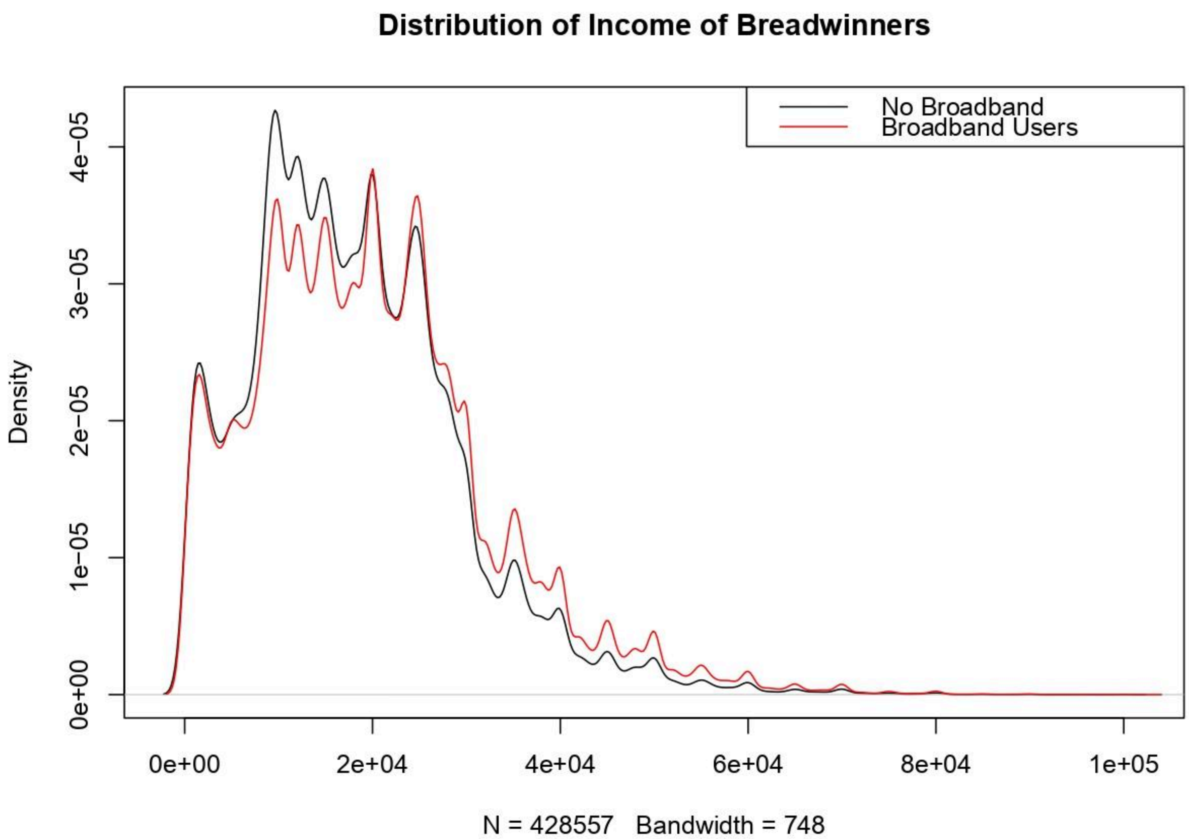

Table 1: Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Max
INCTOT	1,664,632	19,443.250	12,247.880	1	102,050
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Table 2: Regression Results

Regression Results

	Dependent variable:
	LOGINCTOT
HASBBIA	0.085❑¿*¿
	(0.002)
SEX	−0.206❑¿*¿
	(0.002)
AGE	−0.002❑¿*¿
	(0.00004)
as.factor(YEAR)2017	0.011❑¿*¿
	(0.003)
as.factor(YEAR)2018	0.013❑¿*¿
	(0.003)
as.factor(YEAR)2019	0.025❑¿*¿
	(0.003)
as.factor(YEAR)2020	−0.010❑¿*¿
	(0.003)
as.factor(YEAR)2021	−0.049❑¿*¿
	(0.003)
Constant	9.888❑¿*¿
	(0.012)
Observations	1,664,632
R❑²	0.019
Adjusted R❑²	0.019
Residual Std. Error	9.822 (df = 1664556)
F Statistic	431.888❑¿*¿ (df = 75; 1664556)
Note:	❑¿p¿0.1; ❑¿*¿¿p¿0.05; ❑¿*¿p¿0.01

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