Online Appendix:

Wired and Hired: Employment Effects of Subsidized Broadband Internet for Low-Income Americans

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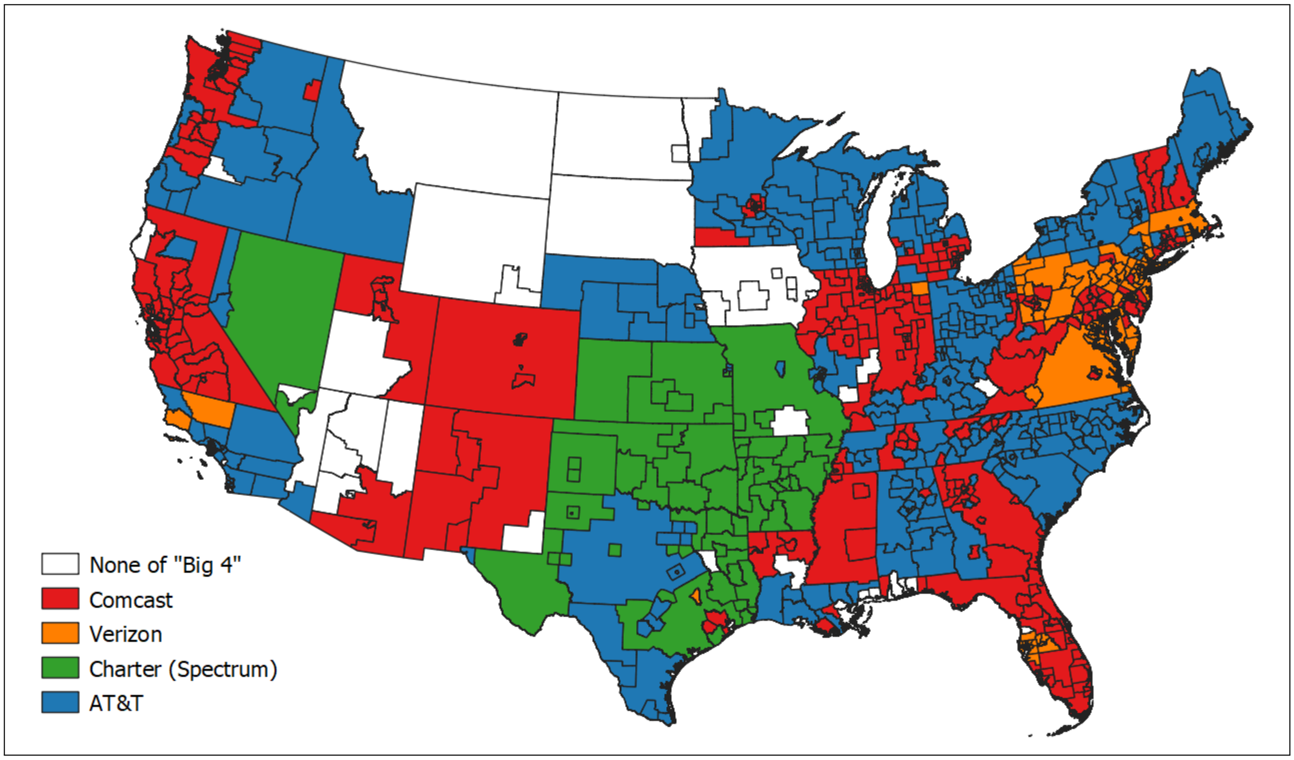
Appendix A: Appendix Tables and Figures

Figure A1: Major Comcast Cable M&A Events: 1990-2018

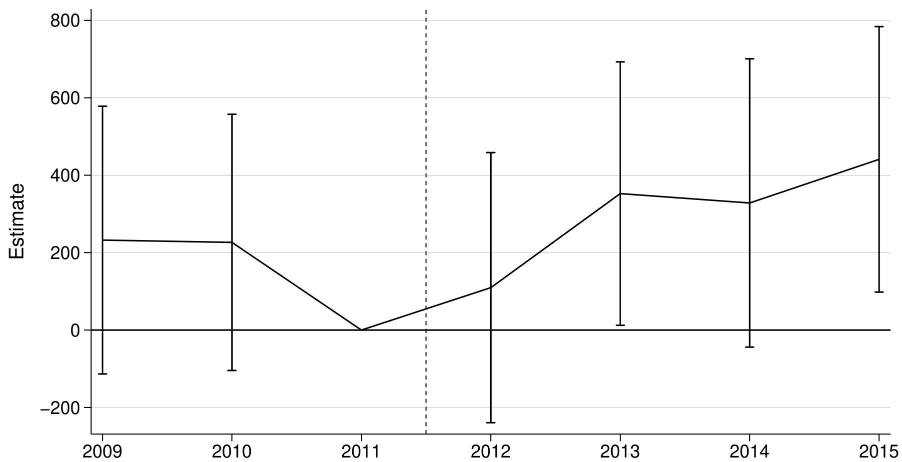
1994	Comcast acquires Canadian based Maclean Hunter's U.S. cable operation based in New Jersey, Michigan, and Florida, adding 550,000 subscribers
1995	Comcast acquires E.W. Scripps cable systems based in California, Tennessee, Georgia, West Virginia, Florida, and Kentucky, adding 800,000 subscribers
1998	Comcast acquires Jones Intercable, Inc in the Mid-Atlantic adding 1 million subscribers
1998	Comcast acquires Prime Communications in Maryland, Virginia, adding 430,000 subscribers
1999	Comcast acquires Greater Philadelphia Cablevision, Inc in Philadelphia, adding 79,000 subscribers
1999	Comcast and AT&T enter agreement to exchange cable communications systems, gaining cable communications systems serving 1.5 million subscribers
2000	Comcast acquires Lenfest Communications in Pennsylvania, Delaware and New Jersey adding 1.3 millions subscribers
2000	Comcast completes cable swaps with Adelphia and AT&T broadband, gaining customers in Florida, Indiana, Michigan, New Jersey, New Mexico, Pennsylvania and Washington D.C.
2001	Comcast acquires select AT&T Broadband cable systems in New Mexico, Maryland, Delaware, New Jersey, Pennsylvania and Tennessee adding 585,000 subscribers
2001	Comcast acquires AT&T Broadband cable systems in Baltimore adding 112,000 subscribers
2001	Comcast and A&T Broadband merge forming the largest cable provider in the US with nearly 22 million subscribers
2005	Comcast and Time Warner jointly acquire Adelphia communications, gaining 1.7 millions video subscribers
2005	Comcast acquires cable systems of Susquehanna Communctions in Pennsylvania, Mississippi, Maine, Illinois, Indiana and New York, gaining 225,000 subscribers
2005	Comcast and Time Warner jointly acquire the assets of Adelphia Communications, with Comcast gaining 1.7 million subscribers
2006	Comcast and Time Warner announce that Comcast will take over holdings in Texas gaining 700,000 subscribers
2007	Comcast acquires Patriot Media in New Jersey, gaining 81,000 subscribers
2008	Comcast complete the acquisition of Insight cable systems in Illinois and Indiana, gaining 696,000 subscribers
2011	Comcast completes its purchase of NBCUniversal with a 51% stake
2013	Comcast purchases the remaining 49% in NBCUniversal
	Cable-related M&A activities conclude

Figure A2: Largest ISP in each PUMA



Note: This figure shows which of the four largest ISPs (Comcast, Charter, AT&T, Verizon) serves the greatest percentage of population for each consistent PUMA. PUMAs with no shading were served primarily by ISPs other than AT&T, Charter, Verizon, and Comcast.

Figure A3: Earnings Event Study, with Additional Control Group Restriction



Note: This figure plots time-varying labor market effects of PUMA-wide Internet Essentials availability, allowing the triple interaction term in Equation (1) to vary each year. The interaction term on the final pre-treatment year 2011 is omitted. The control group is the set of all low-income ineligibles living with children, but whose ages are outside the traditional K-12 range. 95% confidence intervals are provided for non-omitted years. All estimates are weighted using ACS person weights, and standard errors are clustered at the PUMA level.

Table A1: Frequency and Effectiveness of Job Search Methods

	Has Broadband	No Broadband
Used in job search		
Connections	83.4%	67.1%
Online search	81.3%	67.0%
Employment agency	33.0%	27.9%
Print ads	31.1%	34.8%
Job fairs	26.6%	30.3%
Other	10.1%	11.8%
Most effective resource		
Connections	49.8%	42.3%
Online search	30.9%	32.2%
Employment agency	6.5%	2.4%
Print ads	2.7%	5.2%
Job fairs	5.5%	7.2%
Other	3.6%	4.1%
N	478	116

Note: This table presents mean response rates from a sample of individuals who searched for a job within the last two years. Data comes from the 2015 Pew Research Center survey on gaming, jobs, and broadband. The top panel contains means indicating whether a specific job search method was ever used in the most recent job search. Respondents were allowed to select multiple methods. "Connections" is an aggregation of connections from close friends/family members, connections from acquaintances/friends of friends, and connections from professional or work settings. In the bottom panel, respondents were asked: "Thinking of the resources that you used in your last job search, which of them was the MOST important?" Columns in this panel add to less than 100 percent due to non-response. All means are weighted by Pew survey sample weights.

Table A2: Summary Statistics, by Broadband Usage and Income

	Whole Population		Poor ($\leq$185% FPL)	
	Has Broadband	No Broadband	Has Broadband	No Broadband
Male	0.48	0.46	0.43	0.42
Age	48.32	54.60	44.25	53.31
Black	0.08	0.13	0.12	0.18
Hispanic	0.11	0.15	0.19	0.20
Married	0.61	0.46	0.38	0.31
Years Education	13.89	12.21	12.56	11.27
Number of Children	0.71	0.52	0.86	0.62
Employed	0.65	0.47	0.46	0.32
In Labor Force	0.68	0.51	0.53	0.38
HH Income, % FPL	353.16	257.20	104.08	100.10
N	8,304,338	3,069,847	1,568,972	1,241,417

Note: This table presents summary statistics computed separately for individuals with and without in-home broadband. Results are also shown for a subsample of low-income adults with family incomes below 185% FPL. Broadband data in the ACS are only available 2013 and later. The sample used to construct this table includes all non-institutionalized adults living in counties that are identified in the ACS from 2013-2015. Means are weighted by ACS person-level weights.

Table A3: Top Five ISPs, by Subscriber Count

Rank	Broadband Provider	Subscribers (as of 2Q 2018)
1	Comcast	26,509,000
2	Charter	24,622,000
3	AT&T	15,772,000
4	Verizon	6,956,000
5	CenturyLink	5,506,000

Source: Leichtman Research Group, August 2018. https://www.leichtmanresearch.com/455000-added-broadband-in-2q-2018/.

Table A4: Correlation between County Coverage Rates of Top 4 Internet Service Providers

	Comcast	Charter	AT&T	Verizon
Comcast	1.000			
Charter	-0.247	1.000		
AT&T	-0.207	0.153	1.000	
Verizon	0.011	-0.209	-0.173	1.000

Note: This table presents the correlation between county-level coverage rates of the four largest Internet Service Providers in the US.

Table A5: Placebo Test: Effects of Exposure to Non-Comcast ISPs

	(1)	(2)	(3)	(4)	(5)
A. Labor Force Participation					
Comcast × Post × Eligible	0.004				0.005
	(0.003)				(0.003)
Charter × Post × Eligible		0.003			0.004
		(0.007)			(0.007)
AT&T × Post × Eligible			0.005		0.006
			(0.005)		(0.005)
Verizon × Post × Eligible				-0.002	-0.001
				(0.004)	(0.004)
B. Unemployed					
Comcast × Post × Eligible	-0.005*				-0.004
	(0.002)				(0.003)
Charter × Post × Eligible		0.005			0.002
		(0.005)			(0.005)
AT&T × Post × Eligible			0.008**		0.007*
			(0.004)		(0.004)
Verizon × Post × Eligible				-0.003	-0.002
				(0.003)	(0.003)
C. Income					
Comcast × Post × Eligible	147**				175**
	(71)				(73)
Charter × Post × Eligible		-27			28
		(140)			(142)
AT&T × Post × Eligible			199**		236**
			(91)		(95)
Verizon × Post × Eligible				-64	-36
				(89)	(88)
N			4,656,835		

Note: This table presents results from a placebo test replacing Comcast coverage rates with coverage rates of the three next largest ISPs: Charter (Time Warner Cable), AT&T, and Verizon. Panel A contains triple differences results from Equation (1), using labor force participation as the outcome variable. Panels B and C display estimates for unemployment and income. The analysis uses the group of low-income ineligibles as the control group (see Panel C of Table 3). These regressions are weighted by ACS person-level sample weights, and standard errors are adjusted for clustering at the PUMA level. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A6: Changes in Comcast Coverage Rates Across Time

	Δ PUMA Comcast Coverage Rates		
	2012-2013	2013-2014	2014-2015
Min	-0.164	-0.197	-0.022
P1	-0.091	-0.056	-0.010
P10	-0.016	-0.013	0.000
P25	-0.001	-0.002	0.000
P50	0.000	0.000	0.000
Mean	-0.005	-0.001	0.001
P75	0.000	0.000	0.000
P90	0.001	0.009	0.002
P99	0.016	0.053	0.013
Max	0.065	0.100	0.097

Note: This table shows the distribution of how PUMA-level Comcast coverage rates change from year to year. A value of zero means no change, whereas a value of $+0.100$ implies that coverage increased by 10 percentage points. Coverage rates are calculated via Equation (2), and represent the percentage of a PUMA's population living in a census block where Comcast provides broadband service. Census block population counts are taken from the 2010 decennial census, and indicators for Comcast coverage within a given block come from the NTIA in 2012 and 2013, and from the FCC Form 477 in 2014 and 2015.

Table A7: Event Study of Internet Essentials and Labor Market Outcomes

	Employed	In Labor Force	Unemployed	Income
(% Comcast)×(IE-Eligible)×(Year=2009)	0.003	0.009	0.006	297**
	(0.006)	(0.005)	(0.005)	(129)
(% Comcast)×(IE-Eligible)×(Year=2010)	0.007	0.007	0.000	165
	(0.007)	(0.006)	(0.005)	(134)
(% Comcast)×(IE-Eligible)×(Year=2012)	0.005	-0.000	-0.005	162
	(0.006)	(0.006)	(0.005)	(123)
(% Comcast)×(IE-Eligible)×(Year=2013)	0.010	0.006	-0.004	237*
	(0.006)	(0.006)	(0.004)	(126)
(% Comcast)×(IE-Eligible)×(Year=2014)	0.015**	0.015***	0.001	379***
	(0.006)	(0.006)	(0.005)	(131)
(% Comcast)×(IE-Eligible)×(Year=2015)	0.018***	0.015**	-0.003	412***
	(0.006)	(0.006)	(0.004)	(133)
N	4,656,835	4,656,835	4,656,835	4,656,835

Note: This table shows the labor effects of PUMA-wide Internet Essentials availability, allowing the triple interaction term in Equation (1) to vary each year. The interaction term on the final pre-treatment year 2011 is omitted. The analysis is otherwise identical to the main analysis presented in Panel C of Table 3. All estimates are weighted using ACS person weights, and standard errors are clustered at the PUMA level. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A8: Testing for Control-Driven Effects in Triple Differences

Outcome	Employed	In Labor Force	Unemployed	Income
Treatment group mean (2011)	0.567	0.710	0.143	11,173
Panel A: Eligibles				
(% Comcast Coverage)×(Year≥2012)	0.013***	0.004	-0.009***	186***
	(0.003)	(0.003)	(0.003)	(67)
N	1,014,881	1,014,881	1,014,881	1,014,881
Group Mean	0.581	0.702	0.120	11,351
Panel B: Ineligibles with Low Income				
(% Comcast Coverage)×(Year≥2012)	0.006***	0.003	-0.003*	47
	(0.002)	(0.002)	(0.002)	(30)
N	3,641,954	3,641,954	3,641,954	3,641,954
Group Mean	0.360	0.467	0.107	4,803
Panel C: Ineligibles with Low Income + Children				
(% Comcast Coverage)×(Year≥2012)	-0.001	-0.005	-0.005	18
	(0.004)	(0.004)	(0.003)	(70)
N	591,054	591,054	591,054	591,054
Group Mean	0.413	0.519	0.106	6,778

Note: This table presents differences-in-differences results for three separate sub-samples: 1) the treatment group (those eligible for the program), 2) the control group restricted to low-income ineligibles, and 3) the control group restricted to low-income ineligibles with children. The DD treament variable is Comcast coverage rates. Conceptually, the triple differences estimator is the difference between the differences-in-differences estimates of the treatment and control group, so it is important to verify whether significant effects in triple differences are driven by changes in the treatment group, or less desirably, the control group. Control variables include gender, age, age-squared, race, marital status, and number of children. All regressions are weighted by ACS person-level sample weights; standard errors are clustered at the PUMA level and are reported in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A9: Alternative Income Specifications

	(1)	(2)	(3)	(4)
Outcome: Income (Different Specifications)				
(% Comcast Coverage)×(Year≥2012)	147**	0.058**	0.065**	0.022**
×(IE-Eligible)	(71)	(0.029)	(0.031)	(0.010)
N	4,656,835	4,648,861	4,656,835	4,656,835
Treatment Mean	11,173	6.208	6.645	8.448
Specification	Income	ln(Income+1)	IHS(Income)	ln(Income)
Data Modification	None	None	None	p5 Bottom Code

Note: This table provides triple differences estimates from Equation (1) using different transformations of income as the outcome variable. Column (1) provides the main estimate in levels. Column (2) uses the natural log transformation, adding $1 to all incomes. Column (3) uses the inverse hyperbolic sine transformation. Column (4) uses the natural log transformation, bottom-coding the lowest 5% of incomes to the 5th percentile of non-zero incomes. All regressions are weighted by ACS person-level sample weights; standard errors are clustered at the PUMA level and are reported in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A10: Effects of Metro/Statewide Availability of Internet Essentials on Internet Use

	(1)	(2)	(3)	(4)
Outcome: Uses Internet at Home				
(% Comcast Coverage)×(Yr≥2012)	0.049**	0.039**	0.078***	0.065***
	(0.022)	(0.017)	(0.016)	(0.013)
N	21,232	29,613	37,976	53,245
Untreated mean	0.650	0.681	0.635	0.670
Low-income threshold (% of FPL)	185	250	185	250
Geographic Aggregation	Metro	Metro	State	State

Note: This table provides differences-in-differences estimates from Equation (5) of the effect of metro/state-wide Internet Essentials availability on home internet use. Data on internet use come from an aggregation of internet use supplements from the Current Population Survey in 2007, 2009, 2010, 2011, 2012, 2013, and 2015. The sample is restricted to individuals eligible for Internet Essentials. Approximately 73 percent of the sample lives in a metro area that is identified in the CPS. Results are also presented using state-level aggregation, which is identified for all respondents. "% Comcast Coverage" is calculated using Equation (2) using metro/state as the respective level of geographic aggregation. The table presents results for two different income eligibility thresholds to account for noisy reports of family income in the CPS. All regressions are weighted by CPS supplement weights; standard errors are clustered at the respective metro/state level and are reported in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A11: Labor Market Effects of Internet Essentials Availability, Urban vs. Non-Urban

	Employed	In Labor Force	Unemployed	Income
A. Urban: 95% Pop. in Urban Cluster				
DDD Estimate - Urban PUMAs	0.014***	0.008*	-0.006*	184*
	(0.005)	(0.005)	(0.003)	(98)
N	1,736,027	1,736,027	1,736,027	1,736,027
Treatment group mean (2011)	0.566	0.716	0.150	11,153
DDD Estimate: Non-Urban PUMAs	-0.000	-0.003	-0.002	143
	(0.005)	(0.005)	(0.004)	(109)
N	2,920,808	2,920,808	2,920,808	2,920,808
Treatment group mean (2011)	0.568	0.704	0.136	11,196
Difference (p-value)	0.030	0.111	0.448	0.780
B. Urban: 99% Pop. in Urban Cluster				
DDD Estimate - Urban PUMAs	0.010*	0.008	-0.002	133
	(0.005)	(0.006)	(0.004)	(121)
N	1,145,717	1,145,717	1,145,717	1,145,717
Treatment group mean (2011)	0.558	0.716	0.158	11,002
DDD Estimate: Non-Urban PUMAs	0.006	0.000	-0.006**	193**
	(0.004)	(0.004)	(0.003)	(87)
N	3,511,118	3,511,118	3,511,118	3,511,118
Treatment group mean (2011)	0.572	0.707	0.135	11,268
Difference (p-value)	0.582	0.280	0.465	0.687
C. Urban: ≥1,000 residents/sq. mile				
DDD Estimate - Urban PUMAs	0.014***	0.009*	-0.005	192*
	(0.005)	(0.005)	(0.004)	(105)
N	1,580,666	1,580,666	1,580,666	1,580,666
Treatment group mean (2011)	0.566	0.715	0.149	11,162
DDD Estimate: Non-Urban PUMAs	0.001	-0.003	-0.004	144
	(0.005)	(0.005)	(0.003)	(102)
N	3,076,169	3,076,169	3,076,169	3,076,169
Treatment group mean (2011)	0.568	0.706	0.138	11,184
Difference (p-value)	0.065	0.077	0.912	0.740

Note: This table replicates the triple differences analysis in Table 3 separately for urban and non-urban PUMAs. Each analysis is conducted using the group of low-income ineligibles as the control group (Panel C of Table 3). Each panel in this table contains a defines "urban" PUMAs differently. The Census classifies census blocks as "urban" if population density exceeds 1,000 people per square mile (Ratcliffe et al., 2016). A census block that touches an urban block and has a population density over 500 people per square mile is considered to be a part of an "urban cluster". Panel A classifies a PUMA as urban if 95% of the population lives within an urban cluster. Panel B increases this threshold to 99%. Panel C classifies a PUMA as urban if population density throughout the PUMA exceeds 1,000 people per square mile. All regressions are weighted by ACS person-level sample weights; standard errors are clustered at the PUMA level and are reported in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A12: Labor Market Effects of Internet Essentials Availability, by Demographic Groups

	Employed	In Labor Force	Unemployed	Income
A. Gender				
DDD Estimate - Male	0.009*	-0.000	-0.009**	225*
	(0.005)	(0.004)	(0.004)	(134)
N	2,016,412	2,016,412	2,016,412	2,016,412
Treatment group mean (2011)	0.691	0.842	0.151	15,884
DDD Estimate - Female	0.009*	0.007	-0.002	101
	(0.004)	(0.005)	(0.003)	(89)
N	2,640,423	2,640,423	2,640,423	2,640,423
Treatment group mean (2011)	0.494	0.633	0.139	8,406
Difference (p-value)	*0.963*	*0.284*	*0.146*	*0.467*
B. Education				
DDD Estimate - HS Grad or Greater	0.012**	0.005	-0.008*	212*
	(0.005)	(0.005)	(0.004)	(121)
N	1,951,528	1,951,528	1,951,528	1,951,528
Treatment group mean (2011)	0.592	0.739	0.147	12,189
DDD Estimate - Less than HS	0.007	0.004	-0.003	120
	(0.005)	(0.004)	(0.003)	(96)
N	2,705,307	2,705,307	2,705,307	2,705,307
Treatment group mean (2011)	0.550	0.692	0.141	10,507
Difference (p-value)	*0.480*	*0.924*	*0.384*	*0.562*
C. Age				
DDD Estimate - Age 38 and Older	0.012**	0.006	-0.006*	184*
	(0.005)	(0.004)	(0.003)	(98)
N	2,748,598	2,748,598	2,748,598	2,748,598
Treatment group mean (2011)	0.569	0.707	0.139	11,403
DDD Estimate - Less than Age 38	0.006	0.002	-0.004	109
	(0.005)	(0.005)	(0.004)	(105)
N	1,908,237	1,908,237	1,908,237	1,908,237
Treatment group mean (2011)	0.565	0.714	0.148	10,941
Difference (p-value)	*0.401*	*0.501*	*0.792*	*0.596*

Note: This table replicates the triple differences analysis in Table 3 separately for gender, education, and age. Each analysis is conducted using the group of low-income ineligibles as the control group (Panel C of Table 3). All regressions are weighted by ACS person-level sample weights; standard errors are clustered at the PUMA level and are reported in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A13: Effects of Internet Essentials Availability on Job Characteristics

Outcome	Part-time	Income	Commute (Mins.)
Treatment group mean (2011)	0.402	18,228	24.00
(% Comcast Coverage)×(Year≥2012)	-0.001	-16	-0.213
×(IE-Eligible)	(0.005)	(102)	(0.226)
N	4,656,835	1,783,238	1,783,238
Control group mean	0.550	11,689	21.13

Note: This table replicates the triple differences analysis in Table 3, using three different outcomes which are all conditional on being employed: the probability of part-time work (defined as working less than 40 hours per week), log wage income (conditional on working), and transit time to work. All regressions are weighted by ACS person-level sample weights; standard errors are clustered at the PUMA level and are reported in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Appendix B: Data and Technical Appendix

B.1. Technical Geographic Appendix

Credits to Danny Kolliner for this write-up: We create a variable that calculates the percentage of the population in a given area that has access to broadband internet. A major challenge in creating this variable is that Internet Essentials launches in 2012, so that data before the program launches is based on the 2000 decennial census geographies and data after the program launches is based around 2010 decennial census geographies. Microdata from the American Community Survey provides very rich data at the individual level, but data on where these individuals live is constrained. When performing studies across census periods, it's typical to use data at the county level, however this significantly limits which geographies are observed to mostly highly populated urban areas.

Census geographies are constructed using very small areas, called census blocks. These areas are "statistical areas bounded by visible features, such as streets, roads, streams, and railroad tracks, and by nonvisible boundaries, such as selected property lines and city, township, school district, and county limits and short line-of-sight extensions of streets and roads."[33] In 2010 census blocks on average contained roughly 27 people. Each census block is based on a 15 digit code. The first through fifth contain the county fips code, and the first through eleventh digit contain the census tracts. Census block and tract boundaries change every decennial census, but counties typically don't. By construction then counties tend to be a time consistent unit of geography.

The smallest unit of geography that fully covers the United States and is publicly available in the American Community Survey (ACS) is the public use micro area (PUMA). These areas nest within states, contain atleast 100,000 people, and are built on census tracts and counties. There are three possible cases that define the relationship between a PUMA and county. First, a PUMA can be coterminous within a county. Second, highly populated counties can be defined by many PUMAs. Third, multiple low population counties can be defined by a single PUMA. An individuals county is only observed in the ACS in the first and second case. This primarily results in observing counties that contain more than 100,000 people, which are highly urban areas.

The primary challenge is that PUMAs boundaries have changed from the decennial census in 2000 to 2010. Since PUMAs are built around census tracts, which have changing boundaries to reflect physical changes such as new roads and highways as well changes in population trends. Tracts with

[33] Source: See 2010 Census Summary File 1 Urban/Rural Update Technical Documentation prepared by the U.S. Census Bureau, 2012 at A-10, http://www.census.gov/prod/cen2010/doc/sf1.pdf.

high population growth are split and tracts with population decline are combined. In order to use data from the ACS from 2009 to 2015 consistent geographies across time need to be constructed.

The Integrated Public Use Microdata Series (IPUMs) has created a geographic entity, Consistent Public Use Microdata Areas (CPUMAs), which are consistent across time. Each CPUMa is "an aggregation of one or more 2010 PUMA that, in combination, align closely with a corresponding set of 2000 PUMAs." This process essentially creates new geographies where PUMAs in 2000 and 2010 are perfectly mapped into one another. This creates larger geographies than the original PUMAs, where the number of PUMAs in 2010 is 2378 but the number of CPUMAs is 1085.

To create an access to internet variable, we use two main sources. For internet availability from 2012-2013 data are collected from the National Telecommunications and Information Administration. The data come from the State Broadband Initiative, which among other things has worked to assist states in collecting data on availability, speed, and location of broadband services within a state. The result is a dataset that contains data on which internet providers and services are available in each census block. Using this data it is possible to distinguish which blocks are served by different internet service providers, for instance which census blocks have access to Comcast internet services. Data is similarly available from 2014-2015 from Federal Communications Commissions Fixed Broadband Deployment Data in the same format.

We create several access to internet variables by different internet service providers; one for Comcast, Verizon, AT&T, Charter, and Time Warner. To create this variable for Comcast, for instance, we first identify which census blocks Comcast internet is available in. We then merge these census blocks to a census block to PUMA concordance file. Since PUMAs are created along census tracts, each census block is entirely contained by a PUMA. This concordance file, which contains the PUMA and census block population from the 2010 census, is created using the Missouri Census Datacenter's Geocorr 2014 utility. Then, within a puma, we aggregate the census block populations that have access to Comcast and divide this number by the total PUMA population. In all years access to internet service providers are based on 2010 census populations since census block populations are only observed during the decennial census. An example is that PUMA 0100100 which corresponds to Lauderdale, Colbert, Franklin, and Marion counties in Alabama has a total population of 148,972, of which 99,283 live in census blocks which have access to Comcast, so 66.6% of the population has access to Comcast.

Once population data are aggregated to the PUMA level, they are then further aggregated into CPUMAs using the IPUMs 2010 PUMA components list, which gives a listing of the 2010 PUMAs that comprise each CPUMA. The result is a variable which indicates the percentage of people who live in a census block based on 2010 population definitions who have access to Comcast. This process is repeated for each internet service provider and each year.

B.2. Construction of ACS Analysis Data

I took the following steps to construct the analysis data set from the ACS

- I obtained ACS 1-year estimates from IPUMS
- I restricted the sample to individuals age 18 and older and dropped anyone with a RELATE code indicating institutional inmate status
- Construction of key variables (referencing IPUMS variables):
  - I construct employment and unemployment from the EMPSTAT variable in IPUMS
  - I construct labor force participation from the LABFORCE variable
  - Income:
    * I set negative wage income (INCWAGE) to $0, and I replace responses of "999999" to missing.
    * I replace responses for business/farm income (INCBUS00) that are "999999" to missing.
    * I add the two together and top-code the resulting variable to the 95th percentile to mitigate the influence of outliers.
  - Eligibility:
    * I defined "child" status as having at least one child between the ages of 5 and 17. This was done by making sure that the eldest child (ELDCH) was at least 5 and that the youngest child was 17 or younger (YNGCH).
    * Poverty status as a % of FPL is defined via the POVERTY variable in the ACS
- I merged to the NTIA broadband data via consistent-PUMA (CPUMA0010) and state (STATEFIP) in the ACS

See code for details on coding of various control variables (such as years of education).

B.3. Construction of CPS Analysis Data

I took the following steps to construct the analysis data set from the CPS:

- I obtained Computer and Internet Use supplements for the years 2007, 2009, 2010, 2011, 2012, 2013, and 2015 via IPUMS.
- I obtained federal poverty tables for years 2009-15 from: https://aspe.hhs.gov/poverty-guidelines. The tables were compiled in a Excel file in the "Raw Data" directory named "poverty_tables.xlsx".
- I merged this data to family sizes in the CPS.
- I restricted the sample to individuals age 18 and older
- I merged the NTIA broadband data at the county, CBSA (2013 metro FIPS), and state levels

- I defined "child" status as having at least one child between the ages of 5 and 18. This was done by making sure that the eldest child was at least 5 and that the youngest child 18 years old or younger
- For poverty status, we first use the income brackets provided in the CPS, then took the upper bound of each bracket. I then merged this onto the aforementioned poverty tables.

B.3. CPS Internet Use Survey Questions

The following are the exact questionnaires used to derive the IPUMS internet use indicators in the CPS Computer and Internet Supplements.

July 2015 Computer and Internet Use Supplement

- Universe: all Supplement respondents
- Question Number/Text: INHOME / [Do you/Does anyone in this household] use the Internet at home? *(Yes: 70.0%)*

July 2013 Computer and Internet Use Supplement

- Universe: All respondents
- Question Number/Text: NET3 / Does anyone in this household use the Internet from home? *(Yes: 78.6%)*

October 2012 School Enrollment and Internet Use Supplement

- Universe: All respondents
- Question Number/Text: NET3 / People can connect to the Internet in multiple ways, including using mobile devices such as laptops or smartphones, as well as on desktop computers. Does anyone in this household use the Internet from home? *(Yes: 79.2%)*

July 2011 Computer and Internet Use Supplement

- Universe: Universe: All households where respondent accesses the internet from any location
- Question Number/Text: PUHOME / Does Name1 access the Internet from home? How about Name 2? (Does Name2 access the Internet from home?) Etc. *(Yes: 98.8%)*

October 2010 School Enrollment and Internet Use Supplement

- Universe: All households where respondent uses some sort of computer
- Question Number/Text: NET2a / At home, [do you / do you or any member of this household] access the Internet? *(Yes: 93.5%)*

October 2009 School Enrollment and Internet Use Supplement

- Universe: All households where respondent accesses the internet from any location
- Question Number/Text: NET3 / (Do you/Does anyone in this household) connect to the Internet from home? *(Yes: 91.0%)*

October 2007 School Enrollment and Internet Use Supplement

- Universe: All households where respondent accesses the internet from any location
- Question Number/Text: NET3 / (Do you/Does anyone in this household) connect to the Internet from home? *(Yes: 88.5%)*

Appendix C: Broadband Production and Regulation

This content is directly adapted and summarized from Figure A1 in Tomer, Kneebone and Shivaram (2017), which I highly recommend for further reading on this subject.

How Does Broadband Ultimate Reach Consumers?

Broadly speaking, broadband infrastructure is comprised of the backbone, the middle mile, and the last mile.

- The backbone is the physical stock of large capacity trunks that is capable of transmitting large amounts of data, and is where "broadband" originates.
- Between the backbone and middle mile, internet traffic across ISPs is processed through physical locations called Internet eXchange Points (IXPs), which require mutual peering agreements. At Points of Presence (POPs), long-distance carrier cables transfer into a regional or city network.
- In the last mile, broadband is delivered to homes and end users through telephone/utility poles through cable companies or telephone exchanges.

Federal Regulations

- Right-of-Way Permits: ISPs must secure permits to build and operate on federal lands, buildings, highways, and roadways.
- Franchise Agreements: The Cable Communications Act of 1984 requires ISPs to reach a contract with local governments.
- Pole Permits: ISPs must secure agreements to access telephone/utility poles that are owned by investor-owned utilities in states without pole regulations prior to the Pole Attachment Act.

State Regulations

- Right-of-Way Permits: ISPs must secure permits to build and operate on state lands, buildings, highways, and roadways.
- Franchise Agreements: ISPs must secure state-wide cable and video franchise agreements from the Department of State or Public Utilities Commissions.
- Pole Permits: ISPs must secure agreements to access telephone/utility poles in states that had pole regulations which pre-empted federal regulation.

Local Regulations

- Right-of-Way Permits/Franchise Agreements: The franchise agreements listed above typically include local right-of-way permits, and can also include franchise fees, programming requirements, and customer service standards.
- Pole Permits: ISPs must secure agreements to access telephone/utility poles owned by public electric cooperatives and municipalities in states without any specific pole regulation.
- Last-mile Access: Often, ISPs must contend with exclusive contracts provided by owners/homeowners' associations, who otherwise gate access to customers living in individual/multiple dwelling units.