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Impacts of the USDA Broadband Initiatives Program on Employment and Telework: Evidence from Confidential American Community Survey Microdata

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The U.S. Census Bureau has reviewed this data product to ensure appropriate access, use, and disclosure avoidance protection of the confidential source data used to produce this product (Data Management System (DMS) number: **P-7527974**, Disclosure Review Board (DRB) approval numbers: **CBDRB-FY24-SEHSD003-056 and CBDRB-FY25-SEHSD003-026**). The findings and conclusions in this presentation are those of the authors and should not be construed to represent any official USDA or U.S. Government determination or policy.

Introduction (1)

- The digital divide is a continuing policy concern
  - In Nov. 2023, 46% of low income, 38% of nonmetro, and 34% of American Indian or Alaska Native households did not have wired high-speed Internet service in their homes, compared to 26% of all households (NTIA, 2024)
- The Federal Government has invested heavily and increasingly to address the digital divide
  - > $50 billion invested to promote broadband deployment and adoption before 2020
  - > $85 billion in new Federal broadband program investments approved since the start of the COVID-19 pandemic (Pender et al., 2023)
- The Broadband Initiatives Program (BIP) – a $2.5 billion grant & loan program established by the American Recovery and Reinvestment Act of 2009 – is one of the largest USDA broadband programs ever implemented

Introduction (2)

- Few studies have investigated impacts of BIP, and no published studies have investigated impacts of any U.S. broadband program using household or individual level microdata
- We investigate impacts of BIP on individuals' probability of employment and telework (measured by working from home) during 2011-2017 using confidential American Community Survey (ACS) microdata, USDA Rural Utilities Service (RUS) program data, and other data
- We investigate the overall impacts of the program and impacts over time, by rurality, wage level, race, ethnicity, sex, and industry

Introduction (3)

- We find that BIP increased the employment probability in samples of:
  - All working age individuals
  - Whites
  - Males
  - Metro areas
  - High wage workers
  - Workers in service sector overall and in information services, finance & insurance, and professional services
- BIP had a negative impact on employment of:
  - Low and medium wage workers
  - Workers in trade industries
- BIP had a positive impact on probability of telework (working at home) of:
  - Workers in professional services
- Because our results are at the individual level, we interpret these as due more to labor supply than to labor demand effects

Outline of Rest of Presentation

- Relevant literature
- Broadband Initiatives Program (BIP)
- Data
- Analytical methods
- Results: Impacts of BIP on employment and working from home
- Discussion/Conclusions

Relevant Literature (1)

- Large and rapidly growing literature on impacts of broadband
- Less literature on impacts of broadband programs or policies, and no literature on impacts of U.S. broadband programs on individual-level outcomes
- Literature on broadband impacts on labor market outcomes suggest impacts on labor productivity and demand through various mechanisms
  - Direct labor demand for infrastructure construction plus multiplier effects (Atasoy, 2013; Kuttner, 2016)
  - New market opportunities faced by local firms (Atasoy, 2013)
  - Productivity and competition effects on firms' survival and growth (Kolko, 2012; Stephens et al., 2022)
  - Effects on business startups and/or relocations (Atasoy, 2013; Biedny et al.; 2024; Chen et al., 2023; Conroy & Low 2022; Deller et al., 2022; Duvivier, 2019; Kim & Orazem, 2017; Kolko, 2012; Mack, 2014, 2015; Mack et al., 2011; Mack & Rey, 2014; Mack & Wentz, 2017; Shideler & Badaysan, 2012; Stephens et al. 2022; Whitacre et al., 2014a, 2014b)
  - Skill-biased effects on worker productivity, employment, and/or wages (Akerman et al., 2015; Atasoy, 2013; Chen et al., 2020; Falck et al., 2021; Forman et al., 2012; Ivus & Boland, 2015; Jamison & Wang, 2023; Mack & Faggian, 2013; Zuo, 2021)

Relevant Literature (2)

- Broadband can also affect labor supply though various mechanisms
  - Attracting migrants to regions with better access (Mahasuweerachai et al., 2010)), thus affecting house prices (Ahlfeldt et la., 2017; Deller & Whitacre, 2019; Klein, 2022; Molnar et al., 2019; Whitacre, 2024; Wolf & Irwin, 2024)
  - Enabling telework (Barrero et al., 2021; Carvalho et al. 2022; Dettling, 2017; Huang et al., 2020; Pender et al., 2022; Vazquez & Winkler, 2019) and thereby increase labor supply, especially of married women with children (Billari et al., 2019; Dettling, 2017; Hegde & Van Parys 2024)
  - Increasing self-employment possibilities (Han, 2021; Jamison & Wang 2023)
- Broadband can increase the efficiency of the labor market by reducing search costs & increasing effective size of the labor market, but effects are context-dependent
  - Some studies have found that broadband increased the effectiveness of job search (Bagues & Labini, 2009; Choi, 2023; Dettling, 2017; Gürtzgen et al., 2021; Kuhn & Mansour, 2014; Suvankulov et al., 2012)
  - Others found little effect of broadband on unemployed workers' probability of finding a job or on the duration of unemployment (Fountain, 2005; Kroft & Pope, 2014; Kuhn & Skuterud, 2004; Thomsen & Wittich, 2010)
  - Broadband can increase labor mobility (Bagues & Labini, 2009; Hua & Zhang, 2024; Yu et al., 2023)

Relevant Literature (3)

- Most studies of broadband impacts on labor market outcomes are at a national or regional level, limiting their ability to distinguish effects on labor demand, supply, or labor market efficiency
- Some studies are based on firm-level data, which are more likely to reflect productivity and labor-demand effects
- Fifteen studies reviewed used household or individual-level labor market outcome data
  - Most found positive impacts of broadband access on labor force participation or employment probability, or a negative effect on unemployment probability or duration for some populations (Akerman et al., 2015; Beard et al., 2012; Bhuller et al., 2023; Dettling, 2017; Hegde & Van Parys, 2024; Jamison & Wang, 2023; Kolko, 2012; Kuhn & Mansour, 2013; Zuo, 2021)
- These studies demonstrate that labor market impacts of broadband are dependent on context and demographic factors
  - Broadband access increases employment in many but not all contexts, especially for women
  - Broadband access has mixed impacts on telework across studies

Relevant Literature (4)

- Fewer studies have investigated impacts of broadband programs or policies on labor market outcomes
  - Several studies from Europe (Akerman et al., 2015; Briglauer et al., 2019; Canzian et al., 2019)
  - U.S. studies have focused on impacts of
    - USDA Rural Broadband Loan Program (GAO, 2014; Kandilov & Renkow, 2010; Kandilov & Renkow, 2020)
    - BIP (Pender et al., 2022; Rupasingha et al., 2023; Rupasingha et al., 2024)
- Only one study investigated labor market impacts of a broadband policy or program at the individual level (Akerman et al., 2015) – they investigated impacts of Norway's National Broadband Policy at individual and firm level
- Our contributions to the literature:
  - Only study of impacts of a U.S. broadband program on labor market impacts at individual level, using confidential ACS and RUS data
  - One of few studies of impacts of broadband or a broadband program on telework

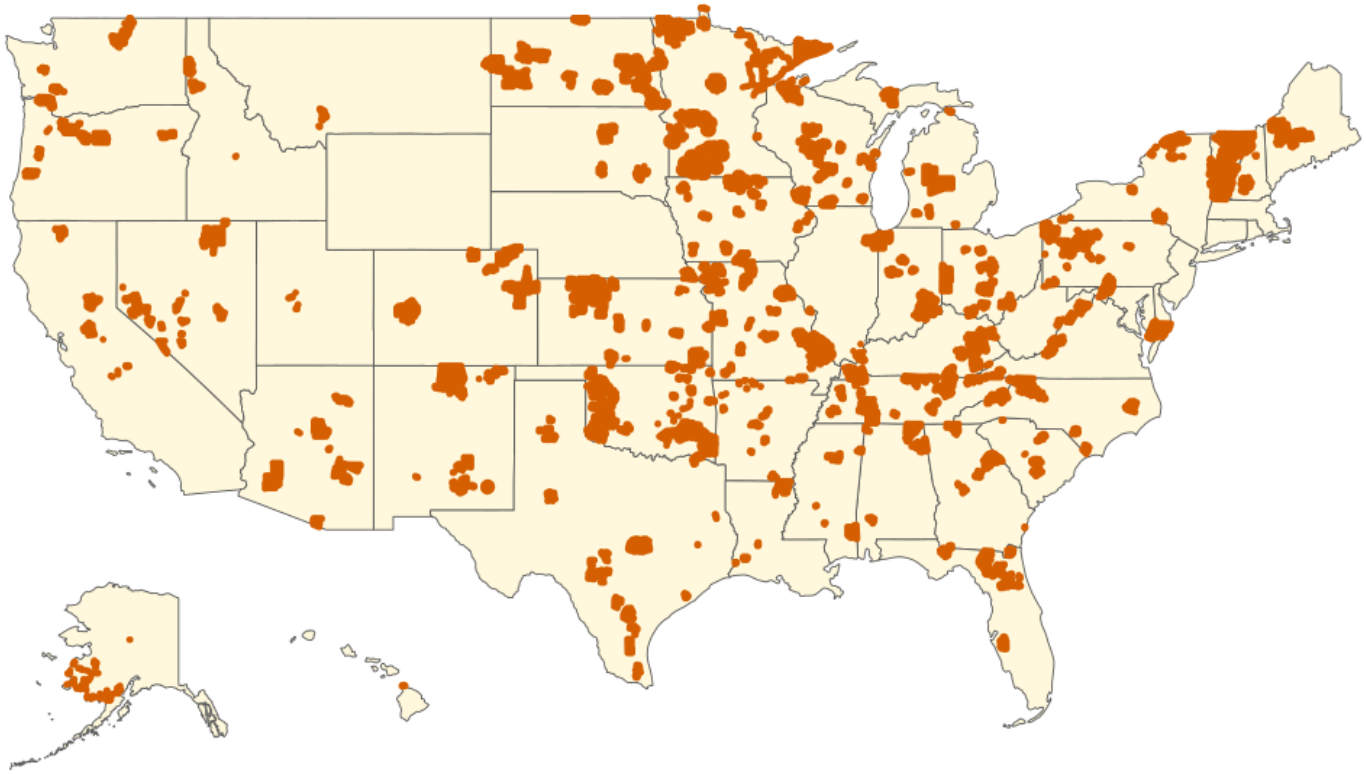
Broadband Initiatives Program (1)

- BIP provided grants and loans to support broadband deployment in rural areas
  - Two rounds of funding in FY 2009 and 2010
  - All projects approved in FY 2010 and completed by FY 2015
- Eligible areas
  - ≥ 75% of project area must be a rural area with insufficient access to high-speed broadband to facilitate economic development
  - "Rural area" = an area not in a town or city with > 20,000 people and not a smaller urbanized area adjacent to a city with > 50,000
  - Insufficient "high-speed broadband" access defined as
    - First round: < 768 kbps downstream/200 kbps upstream to at least 50% of households
    - Second round: as < 5 mbps (upstream + downstream) to at least 50% of households

Broadband Initiatives Program (2)

- Eligible projects
  - Last mile and middle mile infrastructure projects; some second-round projects also supported satellite broadband, rural libraries, and technical assistance
  - Standard 75% grant/25% loan used in second round
- BIP infrastructure projects
  - 299 loan and/or grant projects approved; 260 completed/39 rescinded
  - 95% of projects last mile projects
  - 65% of completed projects provided fiber optic to the premises
  - About 1.3% of the 2010 U.S. population lived in project service areas of completed BIP projects

Service Areas of Completed BIP Infrastructure Projects



Source: Authors' analysis of RUS data

Data

- ACS confidential individual data for 2006-2017
  - Dependent variables – whether working age individual (age 18-64 years, excluding military) was employed in survey reference period, whether working from home
  - Control variables – educational attainment (high school diploma, some college, BS or higher), race (black, other), whether Hispanic, whether married, whether female, whether U.S. citizen, age, age^2
- RUS program data for BIP and other RUS broadband programs
  - "Treated" BIP census blocks – at least 99% BIP area
  - "Control" non-BIP blocks – at most 1% BIP area
  - Households in blocks served by other RUS broadband programs were excluded
- NTIA National Broadband Map data on broadband availability in Dec. 2011
  - Number of broadband providers that offered service at ≥ 768 kbps downstream/200 kbps upstream (threshold for broadband speed in first round of BIP) – used in robustness checks
- ERS Rural Urban Commuting Area (RUCA) codes for 2010
  - Used to classify census tracts as metropolitan (RUCA = 1,2,3), micropolitan (RUCA = 4,5,6), or small town/rural (RUCA = 7,8,9,10)

Analytical Methods

- Two-way fixed effects OLS regressions with census tract and year fixed effects, with ACS individual survey weights and robust standard errors clustered at the census tract level
- Difference-in-difference regression (DID) model:

$$Y_{ijt} = \alpha_j + \lambda_t + \beta Post_t + \gamma BIP_i + \delta BIP_i * Post_t + \theta X_{it} + u_{ijt}$$

- Event study regression model:

$$Y_{ijt} = \alpha_j + \lambda_t + \sum_{k=2006}^{2017} \delta_k \, (BIP_i * Year_t) + \theta X_{it} + u_{ijt}$$

- Y_{ijt} = whether individual i in census tract j was employed or not, whether individual worked from home or not in survey reference period in year t
- BIP_i = 1 if individual i resided in a treated BIP census block, = 0 otherwise
- $Post_t$ = 1 if year of observation > 2010, = 0 otherwise
- $Year_t$ is a vector of dummy variables representing the year of observation ($Year_{2010}$ excluded)
- X_{it} is the vector of control variables
- α_j and λ_t are census tract and year fixed effects
- δ is the coefficient of BIP impact in the DID model, δ_k are the coefficients of interest in the event study

DID Regression Results for Employment – Full Sample

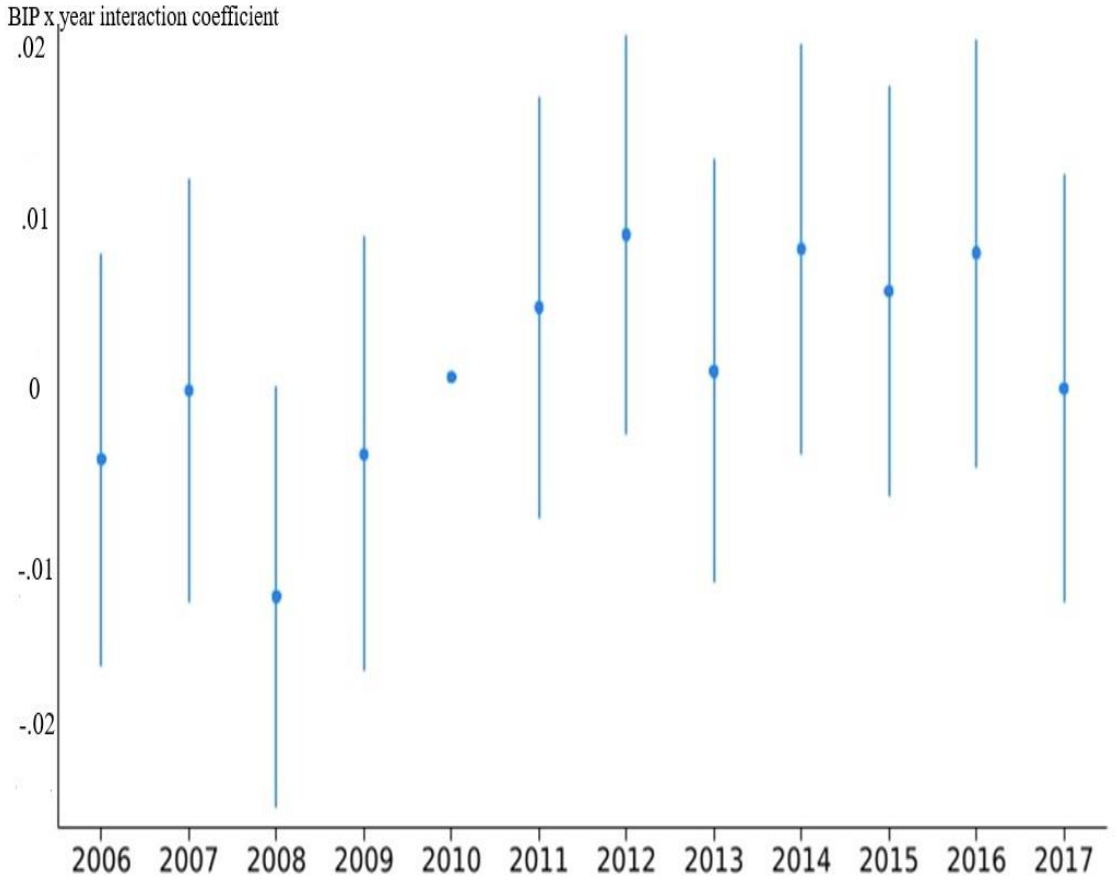
- BIP increased probability of employment by 0.85%
- Control variables have expected signs:
  - Greater likelihood of employment among more educated people, married people, Hispanics, citizens
  - Lower likelihood of employment among women, Blacks/African Americans, other races
  - Inverted U shaped relationship of employment with age
- Results are robust to
  - Including number of broadband providers in the census block in 12/2011 as a covariate
  - Restricting control observations to being within 25 miles of a BIP project area

Variable	Coefficient	Std. error
BIP_i x $Post_t$	0.0085***	0.0026
High school diploma	0.1316***	0.0007
Some college	0.1890***	0.0007
B.S. degree or higher	0.2665***	0.0008
Married	0.0378***	0.0004
Female	-0.0947***	0.0004
Age (years)	0.0412***	0.0001
Age^2 ($years^2$)	-0.0005***	0.0000
Black/African American	-0.0455***	0.0007
Other race	-0.0231***	0.0006
Hispanic	0.0367***	0.0006
Citizen	0.0353***	0.0007
Number of observations	35,380,000	
R-squared	0.131	

*** signifies statistically significant coefficients at 1% level.

Event Study Results for Employment – Full Sample

- The event study results for the employment regressions support the parallel trends assumption of the DID model
  - The pre-2010 coefficients of interactions between BIP_i and $Year_t$ are jointly statistically insignificant in the full sample and in almost all subsamples investigated (except the low and high wage worker samples)
- We also find jointly statistically insignificant pre-program interaction terms in the event study for working from home



Employment Impacts – Subsamples

- The employment impacts of BIP were heterogeneous:
  - Increased employment among Whites but not among Blacks, American Indian/Alaska Natives (AIAN), or Hispanics (positive but insignificant coeffs. for Blacks & Hispanics)
  - Increased employment for men more than for women
  - Increased employment in metro areas but not micropolitan or rural areas
  - Increased employment of high wage workers but reduced employment of low and medium wage workers
  - Increased employment in the services sector but reduced in trade sector

By race/ethnicity	White	Black	AIAN	Hispanic
BIP_i x $Post_t$	0.0105*** (0.0025)	0.0181 (0.0113)	-0.0017 (0.0201)	0.0151 (0.0105)
By sex	Male	Female		
BIP_i x $Post_t$	0.0106*** (0.0032)	0.0055* (0.0034)		
By rurality	Metro	Micro	Rural	
BIP_i x $Post_t$	0.0086** (0.0038)	-0.0018 (0.0065)	-0.0041 (0.0041)	
By wage group	Low	Medium	High	
BIP_i x $Post_t$	-0.0154*** (0.0021)	-0.0121*** (0.0023)	0.0360*** (0.0021)	
By industry sector	Agriculture	Manuf.	Trade	Services
BIP_i x $Post_t$	-0.0002 (0.0009)	-0.0028* (0.0015)	-0.0053*** (0.0017)	0.0240*** (0.0025)

*, **, and *** signify statistically significant coefficients at 10%, 5%, and 1% level, respectively..

Employment & Telework Impacts in Selected Industries

- BIP increased employment probability in information services, finance/insurance, and professional services
- BIP had no impact on probability of working from home in most industries, but a positive impact in professional services

	All industries	Information services	Finance/ Insurance	Professional services
Employment				
BIP_i x $Post_t$	0.0085*** (0.0026)	0.0016*** (0.0006)	0.0049*** (0.0008)	0.0072*** (0.0009)
Work from home				
BIP_i x $Post_t$	0.0000 (0.0008)	0.0002* (0.0001)	0.0001 (0.0002)	0.0006** (0.0003)

*, **, *** signify statistically significant coefficients at 10%, 5%, and 1% level, respectively.

Discussion/Conclusions (1)

- Using confidential ACS microdata and DID estimation, we find positive impacts of BIP on the probability of employment for all individuals and for several subpopulations, including Whites, males, metro areas, high wage workers, workers in services overall and in information services, finance & insurance, and professional services
- We find negative impacts of BIP on the probability of employment of low and medium wage workers and workers in trade industries
- We find significant impact of BIP on probability of working from home only for workers in professional services
- Our findings are robust to controlling for initial broadband availability and restricting control observations to nearby areas, and event study supports parallel pre-trends
- In additional analysis (not reported), we find that the BIP impact on employment was due to both an increase in labor force participation and increased employment among individuals in the labor force

Discussion/Conclusions (2)

- These findings are generally consistent with the literature regarding context- and demography-dependent employment effects of broadband and broadband programs on labor market outcomes
  - The positive impact on employment in metro areas but not in rural areas is consistent with some previous literature (e.g., Forman et al. 2012; GAO, 2014; Kandilov & Renkow, 2010)
  - The positive impact on employment in knowledge-intensive industries is consistent with previous literature (Atasoy, 2013; Chen et al., 2020; Hjort & Poulsen, 2019; Ivus & Boland, 2015; Stockinger, 2019)
  - The positive impact on employment of high wage workers but negative impact on medium and low wage workers is consistent with findings of skill-biased impacts of broadband in previous literature (Akerman et al., 2015; Falck et al., 2021; Hjort & Poulsen, 2019; Mack & Faggian, 2013)
- The smaller impact of BIP on female labor supply is surprising
- Overall, this study shows that BIP increased employment but that the impacts were not distributed evenly across the population, with less impact in rural areas, despite the intent of the program to promote employment in rural areas

Discussion/Conclusions (3)

- Since our data are at the individual level and we control for regional and temporal effects that reflect labor demand conditions, we believe our results reflect impacts of BIP on individual labor supply decisions more than impacts on labor demand
- Some study limitations should be mentioned:
  - RUS data do not indicate whether all BIP project areas were actually served by broadband.
  - Effects of BIP are based on residence in an area with a BIP project, not effects of having broadband service due to BIP projects → impact estimates are intent-to-treat estimates.
  - Pre-program trends were evident for some groups (low and high wage workers), indicating violation of DID parallel trends assumption for those groups.
  - Although we used tract-level fixed effects and year fixed effects, changes in local economic conditions might affect the results. For example, recovery from the Great Recession of 2007-09 may have happened differently in places served by BIP, but not because of BIP. (We plan to investigate using tract x year fixed effects in follow-up work).
  - As an observational study, this study cannot conclusively prove program impacts.

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