If You Fund it, Will They Come? The Impact of Broadband Technology Opportunities Program on County Employment*

Abstract

The Broadband Technology Opportunities Program (BTOP) is a 4.7-billion-dollar investment program which supported various projects throughout the U.S. to improve Internet access and broadband services in unserved or underserved areas. Although the most direct goal of the program was to improve Internet access and promote broadband adoption, increasing employment in the places covered by the program is also a central goal of the investment. Using the multivariate OLS regression method, this study examines and compares the effects of the three different types of BTOP projects on the change in the unemployment rate in 390 counties selected from a stratified sampling technique. The results of the analysis show that the presence of Sustainable Broadband Adoption (SBA) projects in a county was associated with a 0.14 – 0.25 percentage point greater decrease in the unemployment rate. Some positive effects of the Comprehensive Community Infrastructure (CCI) projects were also discovered. A county covered by such projects would experience a 0.1 – 0.26 percentage point greater decrease in the unemployment rate. The analysis also reveals that the effect of SBA projects was immediate but tended to be short-lived, whereas the effect of CCI projects tended to last longer. The study does not detect any significant effect of the Public Computer Centers projects on the decrease in county unemployment rate.

*Acknowledgement

The author thanks Karen Perry of National Telecommunications and Information Administration, Bill Callahan and Angela Siefer of National Digital Inclusion Alliance for providing valuable suggestions regarding the design of the study and BTOP-related materials and data.

The power of the Internet as a catalyst for social and economic development has been well studied and recognized (Madon, 2000; Gillett et al., 2006; Koutroumpis, 2009). As part of the efforts to recover the U.S economy from the 2008 recession, the American Recovery and Reinvestment Act of 2009 specified a total of $7.2 billion to promote broadband deployment and adoption throughout the country. 65% of the funds were distributed through the Broadband Technology Opportunities Program (BTOP), administered by the National Telecommunications and Information Administration (NTIA). The main purpose of the program was to improve Internet access in the unserved areas and promote broadband services in the underserved areas (LaRose et al., 2014).

Whether the 4.7-billion-dollar investment served the neediest communities and achieved its intended effects has been studied in the past few years. Mixed evidence has been found regarding the effect of the program. A number of studies evaluates of the distribution of the funds and concludes that not all the funds were invested in neediest communities (Jayakar & Park, 2012; Gimpel et al., 2013; LaRose et al., 2014). Hauge and Prieger (2015) analyzed the impact of BTOP investment on broadband adoption at the county level. Although BTOP investment was found to be positive associated with broadband adoption, the significance of the effect reduces dramatically when the trends in broadband adoption was controlled for. On the other hand, NTIA, in cooperation with ASR analytics, conducted the Broadband Technology Opportunities Program Evaluation Study. In the final report (2014), it claimed that the program increased broadband availability by 2 percent, increased $5.7 billion - $21 billion of GDP and created 6900 – 22000 long-term jobs in areas served by the program.

This study joins the discussion about the effects of BTOP. The main research question is: whether or to what extent did BTOP projects promote employment at the county level? The

contribution of this study is twofold. First, most of the previous studies are focused on the most direct impact of the program, i.e., broadband adoption (Hauge & Prieger, 2015). Nevertheless, BTOP is a much more ambitious program with many other goals such as creating jobs and increasing productivity (NTIA, 2011). This study focuses on the impact of BTOP on employment, which is so far an understudied area in the discussion about BTOP's effect. Moreover, instead of examining the overall employment effect, this research investigates the impact of BTOP on the county level. Second, unlike most of the previous studies which focus on either BTOP program as a whole or specific type of BTOP projects (Jayakar & Park, 2012; Schartman & Krebs, 2017), this study examines all three types of BTOP projects together so that the effect of each type can be compared.

The study is structured as follows. The next section provides a brief introduction to the BTOP program, followed by a review of the existing studies on the effects of BTOP investment. The data and analytical strategies are introduced in the third section. The fourth section presents the results of the analyses. This study ends with a summary of the main finding and a discussion about the policy implications and the limitations of the study.

Literature Review

Overview of BTOP

Mandated by the American Recovery and Reinvestment Act (ARRA), the Broadband Technology Opportunities Program (BTOP) overseen by National Telecommunications and Information Administration (NTIA) is a 4.7 billion-dollar investment in projects throughout the United States to support the deployment of broadband infrastructure, the expansion of public computer centers and facilitate sustainable broadband adoption (NTIA, *n.d.*). By the end of 2010, $3.4 billion federal funds and $1.2 billion non-federal matching funds were invested in 233

projects. According to NTIA (2011), all the states, five territories and the District of Columbia benefited from the program. Three types of projects were funded under BTOP:

Public Computer Centers (PCC) projects constructed new public computer centers or upgraded existing ones. The central goal of PCC projects is to provide broadband access to the public and particularly, the marginalized population groups. Moreover, users of the newly constructed or upgraded facilities also received training on digital and job-related skills. In total, $201 million was invested in 66 PCC projects.

Sustainable Broadband Adoption (SBA) projects were aimed at providing the necessary support and training to promote broadband usage and adoption among marginalized population groups. A total of 44 SBA projects received $251 million investment from BTOP.

Comprehensive Community Infrastructure (CCI) projects focused on the construction and upgrading of network infrastructure. The CCI projects were mainly aimed at connecting community anchor institutes (CAIs) such as schools and libraries, though households and businesses could also benefit. The 123 CCI project took the largest share of the BTOP funding, receiving approximately $3.5 billion investment in total.

The BTOP funds were distributed to the awardees in two phases. The first phase, which ended in December 2009, focused on funding the SBA and PCC projects. The second phase, which ended in the September of 2010, mainly focused on funding the CCI projects (Kruger, 2010). As summarized by Jayakar and Park (2012), in general, all the BTOP projects are expected to fulfill at least one of the following central purposes: (a) providing or improving Internet access to underserved areas; (b) promoting affordable broadband services in underserved population; (c) connecting community anchor institutions such as schools and public libraries

that serve marginalized population; (d) improving the broadband service quality to public safety agencies; (e) creating employment and stimulating productivity growth.

Evaluation of BTOP

Although the multi-billion- dollar program has drawn much attention in the digital inclusion community and the public policy debate, not many studies have been conducted which examine the program's effectiveness. A number of studies focus on the distribution of funding and examine whether the investment went to the neediest communities. Park and Jayakar (2013) matched the distribution of the PCC investment with the demographics and economic status of the localities of the awardees. Their analysis shows that despite the stated purpose of BTOP to provide access and services to unserved or underserved areas, the majority of the PCC funds were actually distributed to localities with high Internet availability and high service demand. Also, they also found that government agencies received the lion's share of the funding, and government agencies, on average, received larger amounts of funding per awards than non-governmental awardees. LaRose et al. (2014) extended the examination to cover all types of BTOP projects and analyzed the distribution patterns of the funding. Although in general, the BTOP funding fulfilled its states purposes of serving the underserved or unserved communities, several issues were identified. First, according to the projects descriptions published on the BTOP's website, very few projects indicated that the minority populations were the primary target of the program. Second, the funding was roughly equally distributed to metropolitan and non-metropolitan areas. The authors warned that this could in effect lead to the widening of the digital divide because rural areas are largely lagged behind in the Internet infrastructure and services. Therefore, more funding should be assigned to rural areas. Based on ethnographic interviews and observation, Jackson and Gordon (2011) concluded that many grassroots

community-based organizations were in effect excluded from BTOP investment because of the tight application deadline, complicated accounting requirements and the difficulty in aligning the organization's priorities and goals with those of BTOP investment.

A few studies moved beyond the examination of the distribution of funding and investigated whether the program achieved its intended goals. NTIA, in cooperation with ASR analytics, conducted the Broadband Technology Opportunities Program Evaluation Study. According to the study's final report (2014), compared to counties without CCI projects, counties with similar socioeconomic and demographic characteristics but covered by CCI projects had 2 percent higher broadband availability. Based on this 2-percent difference, the study also estimated that the investment in CCI projects could lead to $5.7 billion in increased output and create 6,900 to 22,000 long-term jobs. Based on the budgets of BTOP projects, the study estimated that the program in total directly created 79,000 year-long jobs and approximately $13 billion output. The study also estimated that PCC projects had led to 330,000 weeks reduction in unemployment durations and the SBA projects had resulted in over 6,400 new business subscribers of broadband Internet.

Based on the telephone survey targeted at the participants of a large-scale SBA project in Cleveland, the study conducted by Schartman and Krebs (2017) investigated the effects of the project on the participants. The survey shows that the participants, in general, were benefited from the project. For example, 6 years after their participation in the project, 76% of the respondents reported to have kept their home Internet services. They also found evidence that participation in the project generated employment-related benefits. Specifically, 82% of the respondents revealed that participation in the project had positive job-related impacts, such as the increase in salaries or wages and promotion in the positions. Moreover, among the 54% of the

respondents who were employed, 45% of them started their current jobs after the participation in the project.

Perhaps the closest to the present study is the research conducted by Hauge and Prieger (2015). Focusing on the impact of BTOP at the county-level, the researchers first determined the coverage of BTOP projects at the county level and the amount of funding received by each county and then estimated the effect of BTOP investment on broadband adoption. The initial logistic regression indicates that BTOP investment was positively associated with increased broadband adoption, although the effect was non-linear and, in some cases, even negative. However, after controlling for the time trend in broadband adoption, the effect of BTOP investment on broadband adoption was significantly weakened.

Although all the aforementioned studies provide useful information regarding the effects of the BTOP investment, very few of them directly investigate the employment effect of the program at the local level. Moreover, the studies do not provide much information about which one(s) of the three types of BTOP projects yielded the largest employment effects. This research seeks to fill in the gaps in the literature by conducting an empirical analysis on the effects of SBA, PCC and CCI projects on the county-level employment.

Data and Method

The Sample

In order to obtain a representative sample of counties, a stratified random sampling technique was used. First, all counties in the United States were classified into one of the four groups: urban rich, urban poor, rural rich and rural poor. According to the Census Bureau, in 2010, 80.7% of the U.S population lived in urban areas. Thus, if the percentage of urban residents in a county was higher than 80.7%, that county would be classified as “urban”. Otherwise, it would be classified as “rural”. The national average per capita income in 2010 was

$40, 277 (Bureau of Economic Analysis, 2010). Any county with per capita personal income higher than the national average was categorized as “rich”. Other counties were then categorized as “poor”. Then, 100 counties were randomly selected from each category.

Although several options exist as the potential unit of analysis, such as states and cities, this study focuses on counties for three considerations. First, about 55% of the project descriptions which specify the geographic reach of the project use counties as the main geographic unit. Therefore, it is reasonable to infer that the county is the geographic unit in which many grantees expected to see the impact of the program. Second, although using a larger unit of analysis, for example, the state, could effectively reduce measurement errors, the size of the sample would be much smaller, which significantly lowers the power of the statistical analysis. Moreover, the dependent variable, the change in the unemployment rate, when aggregated at the state level, would lose much of the variation. Third, from a practical perspective, the socioeconomic and demographic data at more granular levels might not be as widely available.

The Treatment Variables

To determine whether a county was covered by BTOP projects, two sources were consulted. First, the descriptions of all the funded projects, which are available at the Broadband USA website, were read. When the project description did not provide clear enough information, the BTOP Map data was examined. The data specifies the cities where the PCC projects were located and where the SBA activities took place. For CCI projects, the data reports the cities where there existed the network points of presence. The counties in which the cities are located are assumed to be impacted by the project. Admittedly, using this method to determine the impacted counties might exaggerate the reach of some projects. However, the BTOP Map data is

the most accurate source available to identify the impacted areas. Therefore, there are inevitably some measurement errors in the treatment variables.

For each type of BTOP projects, a dummy variable was created. If a county was covered by at least one project, the corresponding dummy variable would take a value of 1, otherwise 0. Given that no details have been revealed about how the funding was distributed among different participants of a project, this study does not distinguish the amount of funding distributed to each impacted county. After reading and analyzing the materials, 10 counties were discarded because it is not clear whether they were covered by any BTOP project. The final sample for analysis contains a total of 390 counties.

Determination of the Timeline

Although it is common in policy evaluation studies to compare the outcome before the intervention to the outcome after the completion of the intervention, this strategy is not adopted in this study. In general, almost all the funds were awarded to the grantees by September 2010 (NTIA, 2011). However, according to the quarterly report data submitted by the grantees to NTIA, by the end of 2010, only 2 of the 123 CCI projects had begun deploying the network. Out of the 66 PCC projects, only 20 had started installing computers, and only 2 SBA projects had converted some participants to broadband adopters. Given that few of the BTOP projects started full operation in 2010, the unemployment rate of 2010 was used as the baseline for comparison.

According to the 20th quarterly BTOP report (NTIA, 2014), as of December 2013, only 32 of the 233 BTOP projects were still active, and 85% of the funding was used up. By the end of 2014, the grant recipients drew down 91% of the funding, and 91% of the projects were closed (NTIA, 2015). Therefore, the 2013-2014 period could be seen as the “end” of BTOP. However, the simple comparison between the counties’ employment statistics in 2013 or 2014 and that in

2010 would be problematic. First, as shown in the quarterly progress data, many SBA and PCC projects in fact ended in the year 2011 and 2010. If those projects only had short-term effects on county unemployment, the effects would not be revealed in the 2014-2010 or 2013-2010 comparison. Also, many SBA and PCC projects started full operation in 2011. Therefore, these projects are likely to have already generated some positive effects in 2011, and the effects might not be seen if only the employment statistics in 2013 or 2014 are examined. Third, for projects which ended in 2013 or 2014, its lasting effects, if any, might not be revealed if only the unemployment statistics in 2013 or 2014 are examined. As a result, the changes in the unemployment rate from 2010 to 2011, 2011 to 2012, 2012 to 2013, 2013 to 2014 and 2014 to 2015[1] were all examined so that both the short-term and long-term effects, if there were any, can be revealed. The rationale for the selection of the dependent variables is discussed in the next section.

The Dependent and Control Variables

This study focuses on the effect of BTOP projects on the *change* in the county unemployment rate rather than the level of the unemployment rate. The examination of the locations where the BTOP projects were launched shows that BTOP projects were focused on counties with higher unemployment rates in 2010, the base year in this study. On average, the counties covered by BTOP projects had an unemployment rate of 8.9% in 2010, whereas the average unemployment rate in the uncovered counties was 8.2%. This pattern persisted in the subsequent years from 2011 to 2015.

[1] Admittedly, the effects of BTOP projects, the CCI projects in particular, could possibly extend beyond 2015. Nevertheless, the ANOVA test using a random subsample of 50 counties shows that until 2015, the counties' demographics and socioeconomic status remain relatively close to their 2010 values. Since the demographic and socioeconomic status are potential factors influencing the county employment, the year 2015 was selected as the last period examined so that the influence of the socioeconomic and demographics can be controlled.

Consistent with the finding in other employment studies (Jayakar & Park, 2013), the bivariate correlation test shows that the pattern of unemployment rate tends to persist (Table 1).

Table 1. Correlation between unemployment rates from 2010 to 2015

		unemp2010	unemp2011	unemp2012	unemp2013	unemp2014	unemp2015
unemp2010	Pearson Correlation	1	.975**	.943**	.914**	.896**	.848**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	390	390	389	390	388	390

**. Correlation is significant at the 0.01 level (2-tailed).

Given the short period under study, using the level of unemployment rate would be problematic since the unemployment rates in the counties covered by BTOP projects were likely to be consistently higher than the rates in the non-covered counties. Therefore, using the level of the unemployment rate as the dependent variable would likely to lead to the strange result that counties covered by BTOP projects had higher unemployment rates. However, such results are reflections of the initial difference in the unemployment rate rather than the effect of the BTOP projects. Therefore, this study uses the change in the unemployment rate as the dependent variable, which does show any persistent trend in the correlation test.

Moreover, this study focuses on the year-to-year changes in the unemployment rate, i.e., the change in unemployment rate from 2010 to 2011, 2011 to 2012, 2012 to 2013, 2013 to 2014 and 2014 to 2015 as the key indicators for the effect of BTOP projects. The long-term changes, e.g., from 2010 to 2012, are not used because the short-term effect might be lost in this measurement. For example, if the test shows that counties with BTOP projects experienced a bigger decrease in the unemployment rate from 2010 to 2012, it would be impossible to tell whether the effect mainly took place in the 2010-2011or 2011 or 2012 period.

Data on the county unemployment rate were obtained from the Local Area Unemployment Statistics available at the website of the Bureau of Labor Statistics. Based on previous studies on employment (Gillett et al., 2006; Jayakar & Park, 2013; Lapointe, 2015),

several demographic and economic factors were included in the model as covariates. Data on these control variables were obtained using the American FactFinder tool provided by the U.S Bureau of Census. The definitions and descriptive statistics of the variables used in the study are summarized in Table 2. All the control variables were collected for 2010, the base year for the analysis.

Table 2. Descriptions of variables

Dependent Variables	**Definition**	**N**	**Mean**	**Std. Deviation**
Unemp1110	Unemployment rate 2011 - Unemployment rate 2010	390	-0.57	0.68
Unemp1211	Unemployment rate 2012 - Unemployment rate 2011	390	-0.84	0.95
Unemp1312	Unemployment rate 2013 - Unemployment rate 2012	390	-0.46	0.92
Unemp1413	Unemployment rate 2014 - Unemployment rate 2013	390	-1.11	0.89
Unemp1514	Unemployment rate 2015 - Unemployment rate 2014	390	-0.66	0.78
Independent Variables				
PCC	1 if the county was covered by at least one PCC project; otherwise 0	390	n/a	n/a
SBA	1 if the county was covered by at least one SBA project; otherwise 0	390	n/a	n/a
CCI	1 if the county was covered by at least one CCI project; otherwise 0	390	n/a	n/a
Ln (pop)	Natural log of county population	390	11.24	1.86
Ln (working age)	Natural log of % of population aged 18 - 59	389	6.97	0.005
High school	% of the population with at least a high school diploma	390	85.88	7.43
Minority	% of minority population	390	16.02	15.78
Stateunemp	The unemployment rate in the same state in 2010	390	8.81	2.15
Stateexppc	State expenditure per capita in 2010	390	5.09	1.05
Unemp $_{t-1}$	County unemployment rate in the previous year. For example, for *Unemp1110*, this variable would be the unemployment rate of the county in 2010.	390	8.64	3.08

Note: Two variables, *working age* and *pop* are natural-log transformed to ensure normality.

Empirical Approach

The coverage of BTOP projects and the general trend in the unemployment rate change during the studied periods were examined using descriptive statistics. Then, to further analyze the potentially differentiated impact of each individual type of BTOP projects and specify the size of their effects, multivariate regression analyses were conducted using the Ordinary Least Square estimator. Given the short period under study, the slow evolvement in demographics and

the inclusion of the county unemployment rate immediately prior to the examined period, time-specific demographic and socioeconomic covariates are not controlled in this study. Instead, for each dependent variable, the unemployment rate in the immediate prior year is included as a regressor. Since the level of (un)employment rate is a strong predictor of the change in the (un)employment rate in the subsequent year (Anghelache et al., 2018), the time effects are not controlled.

In order to test whether the effect of BTOP projects in the rural counties was different from that in urban counties, further analyses were conducted with interaction terms between the three BTOP-related variables and a location dummy variable (1 if the county is classified as an urban region, otherwise 0) added to the model[2]. If any of the BTOP projects had different effects in urban and rural counties, the coefficient on the corresponding interaction terms should be statistically significant.

Analyses and Results

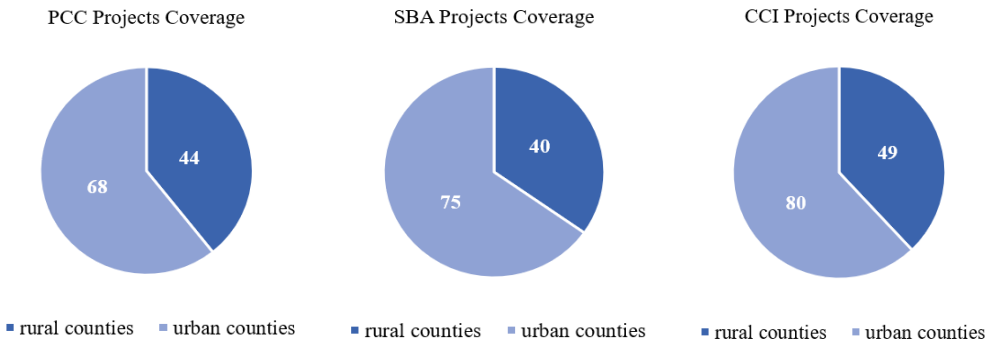
BTOP Coverage

Among all the 390 counties included in the analysis, 59.2% (231) were served by at least one type of BTOP project. The PCC and SBA projects both reached about 29% of the counties. The CCI projects had a wider coverage and reached 33% of the counties. Most of the counties were covered by one type of BTOP projects. Among the 231 counties covered by BTOP-funded programs, only 22 (9.5%) were covered by both PCC and SBA projects. 24 (10.4%) were served

[2] The three integration terms added are: *urban*pcc*, *urban*sba* and *urban*cci*. The regression coefficients of these three terms show the interaction effects between the location type of the county and the presence of BTOP projects. For example, the coefficient of *urban*pcc* shows the difference between the effect of PCC projects in an urban county and the effect in a rural county. See detailed discussion on the interpretation of interaction terms in OLS regression in Woodridge (2016).

by both PCC and CCI projects. 27 were covered by both SBA and CCI projects. In total, 26 (11.3%) of the impacted counties were covered by all three types of projects.

Figure 1. BTOP projects coverage, urban/rural



In general, the BTOP program had a well-balanced presence in affluent and low-income communities. Specifically, 114 (49.4%) of the covered counties had a per capita income lower than the 2010 national average. Nevertheless, the analysis shows that more projects were present in urban areas than in rural areas, with 58.9% (136) of the covered counties having a larger urban population than the national average in 2010. Similar patterns exist in the coverage of each individual type of BTOP projects. As shown in Figure 1, among the 112 counties covered by PCC projects, 68 (60.7%) were classified as urban areas. 75 of the 115 counties served by SBA projects were in urban areas. 80 of the 129 counties with CCI project presence were urban areas. As a comparison, no significant differences between projects presence in affluent and low-income counties were discovered for any individual type of BTOP projects.

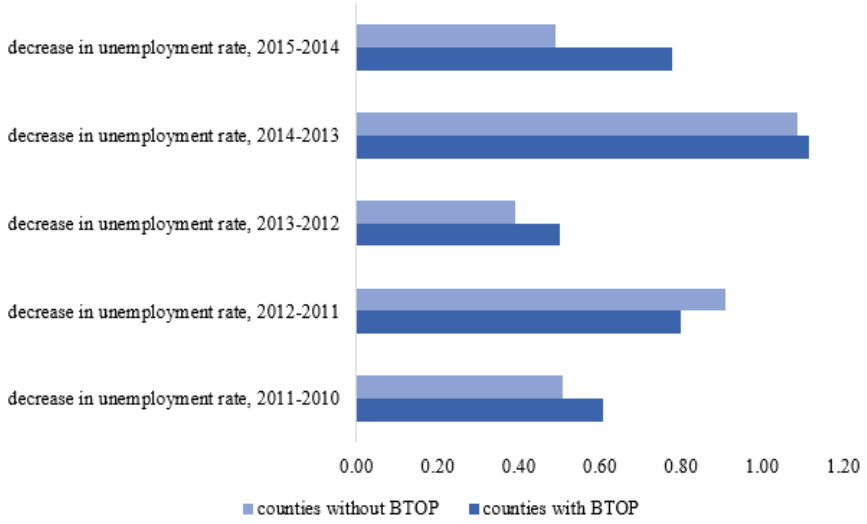
BTOP and Unemployment Change: The General Patterns

During the period under study, the national average unemployment rate dropped considerably from 9. 6% in 2010 to 5.0% in 2015. Specifically, from 2010 to 2011, the unemployment rate decreased from 9.6% to 8.5%. From 2011 to 2012, it decreased from 8.5% to 7.9%. The largest drop in the unemployment rate happened in the 2012-2013 period, during

which time the rate decreased by 1.2 percentage point to 6.7%. The unemployment rate continued to drop considerably from 6.7% in 2013 to 5.6% in 2014. During the last period under study, 2014-2015, the national average unemployment rate decreased by 0.6 percentage point to 5.0%.

As Figure 2 shows, except in the 2011-2012 period, the counties with BTOP projects experienced a greater decrease in the unemployment rate. On average, the counties covered by BTOP projects experienced 0.76 year-to-year decreases in the unemployment rate, whereas the average year-to-year decrease in counties without BTOP projects was 0.68. The difference between counties with and without BTOP-funded projects in the unemployment rate change indicates the possibility that the BTOP program had played an important role in the post-recession employment recovery. Nevertheless, more rigorous statistical analyses are needed which control for other potential factors determining the employment patterns before any conclusion can be made. Moreover, from a policymaking perspective, the general trend analysis cannot reveal the critical information about which type(s) of the BTOP projects was the main source of the observed effect, nor can it provide detailed information about the size of the effect of BTOP projects.

Figure 2. The decrease in the unemployment rate



BTOP and Employment: The Regression Analyses

As discussed in the method section, the employment effect of different types of BTOP projects might become evident at different time points. Therefore, five regression models were estimated to test whether any type of the BTOP projects had a significant impact on the change in the unemployment rate. The results of the multivariate regression analyses are presented in Table 3.

Table 3. Results of multivariate regression analyses

	Model 1	Model 2	Model 3	Model 4	Model 5
PCC	0.03	0.21	-0.05	0.02	0.02
	(0.41)	(1.23)	(-0.68)	(0.19)	(0.39)
SBA	-0.18	-0.25	-0.14	0.12	-0.02
	(-2.23) *	(-2.34) *	(-2.02) *	(1.25)	(-0.42)
CCI	0.09	-0.26	0.14	-0.15	-0.09
	(1.22)	(-2.56) *	(1.46)	(-1.76) +	(-1.98) *
Stateunemp	0.03	0.01	-0.04	0.01	-0.03
	(1.64)	(0.26)	(-3.24) **	(0.49)	(2.63)**
Stateexppc	0.02	0.13	-0.03	0.03	0.09
	(0.57)	(2.87) **	(-1.17)	(0.77)	(3.87)**
Highschool	-0.01	-0.01	-0.01	-0.002	-0.03
	(-1.78) +	(-2.01) *	(-1.18)	(-0.31)	(7.25)**
Minority	0.01	-0.001	0.003	0.01	-0.03
	(4.87) **	(-0.23)	(-1.00)	(2.45) *	(-1.45)
$Unemp_{t-1}$	-0.08	-0.14	-0.07	-0.16	-0.16
	(-6.1) **	(-7.44)**	(-2.01)*	(-9.75)**	(12.62)**
Lnpop	-0.02	0.03	-0.07	0.03	-0.03
	(-0.83)	(0.95)	(-2.45) *	(0.99)	(-1.61)

Lnworkingage	1.98 (0.25)	1.18 (1.11)	-1.62 (-0.84)	-2.40 (-2.49) *	-1.19 (-0.22)
Constant	-1.31 (-0.24)	-1.82 (-1.11)	1.45 (0.88)	1.67 (2.49) *	1.09 (0.28)
F (10, 378)	6.64 **	10.53 **	7.64**	13.66**	12.22**
R^2	0.15	0.22	0.22	0.27	0.24

Note: Unstandardized OLS coefficients reported. T statistics in the parenthesis. **p < 0.01, *p < 0.05, $^{+}$ p < 0.1.

Model 1 shows the effects of PCC, SBA and CCI projects, controlling for other factors, on the decrease of the unemployment rate from 2010 to 2011. Among the three types of BTOP projects, only the SBA projects had a significant impact on the unemployment change. Specifically, if a county was covered by SBA projects, there would be a 0.18 percentage point larger decrease in unemployment rate from 2010 to 2011.

A similar effect of SBA projects on unemployment decrease is also found in the estimation of Model 2, which is for the unemployment change from 2011 to 2012. Other factors being equal, a county with the presence of SBA projects had a 0.25 percentage-point larger decrease in the unemployment rate. Noticeably, a significant impact of CCI projects was also detected. According to the regression result, if a county was covered by CCI projects, it would experience a 0.26 percentage point larger decrease in unemployment from 2011 to 2012.

In the 2012-2013 period, however, the positive effect of CCI projects on employment growth was not observed. SBA projects still had a significant impact on the decrease in the unemployment rate, and the magnitude of the effect was 0.11 percentage point lower than that in the 2011-2012 period.

Model 4 shows the effects of BTOP projects on the change in unemployment rate from 2013 to 2014. During the year 2014, only 3 SBA projects reported to have generated new adopters of broadband services, and only 3 PCC projects indicated that they were still providing training programs. The ending of most of the SBA and PPC projects coincided with the non-significant impact of PCC and SBA projects on unemployment decrease during this period. By

the 4th quarter of 2014, 83 of the 123 CCI projects had some miles of network in active use. Although the analysis shows that the presence of CCI projects would result in a 0.15 percentage point greater decrease in unemployment rate, the effect is only marginally significant at 0.1 level.

Model 5 shows the result of the regression for the last period under study. By the end of 2015, all SBA projects were closed or near the end (NTIA, 2015). The SBA and PCC together had used up more than 99% of the assigned funding. Correspondingly, the SBA and PCC projects did not have any significant impact on the change in the unemployment rate. According to the quarterly progress data submitted to NTIA by the awardees, in 2015, 12 CCI projects were still active and a total of 673 miles of new network was constructed. According to the regression result, a county covered by the CCI project would have 0.09 percentage point larger decrease in the unemployment rate from 2014 to 2015.

It is worth emphasizing that the coefficients on the three BTOP-related variables indicate the *decrease* in unemployment rate rather than the level of the unemployment rate. To contextualize the real-world significance of the BTOP projects, during the period under study, the average year-to-year decrease in the unemployment rate in the sampled counties ranged from 0.46 to 0.84 percentage point. The effect of SBA projects was significant in three of the periods examined and ranged from 0.18 to 0.35. The presence of CCI projects significantly enlarged the decrease in unemployment during the 2011-2012 and 2014-2015 periods, and the effect ranged from 0.09 to 0.23 percentage point.

In order to test whether BTOP projects had differential effects on rural and urban counties, interaction terms between each of the BTOP variables and a location dummy (urban =1, rural = 0) were created and added to the regression model. Similarly, the model was estimated five times using the change in the unemployment rate in different periods as the

dependent variables. If the effect of a specific type of BTOP projects in urban counties was different from that in rural counties, the coefficient of the corresponding interaction term should be significant.

In most of the periods under study, none of the coefficients on the interaction terms was significant, indicating that there was no difference in the effects of BTOP projects on unemployment decrease in rural and urban counties. However, the analysis reveals that compared to rural counties, an urban county with SBA projects would have 0.34 percentage point larger decrease ($\beta = -0.34$, $t = -2.13$, $p < 0.05$) in the unemployment rate from 2013 to 2014. Noticeably, during this period, the main effect of SBA on the change in unemployment was not statistically significant. Thus, the significant effect of the interaction term does not indicate that SBA projects significantly improved employment in urban counties but not in rural counties. Instead, it only reflects that there existed some differences in the impacts of SBA projects in rural and urban counties during the 2013-2014 period.

Conclusion and Discussion

This study examines the impact of BTOP projects on the cunty-level unemployment. Using three dummy variables to capture the coverage of BTOP projects in 390 counties selected using a stratified sampling strategy, the multivariate regression analyses show the nuanced employment effects of the three types of BTOP projects. This section summarizes the main findings of the study and discusses the policy implications.

First, the analysis indicates a consistent and significant effect of SBA projects in reducing the unemployment rate. The years when the BTOP projects were in operation coincided with the recovery of the economy from the great recession in the late 2000s. Nevertheless, even after controlling for other potential variables which would lead to unemployment reduction, the

counties with SBA projects still had a larger decrease in unemployment. Specifically, the positive effect of SBA was detected in the first three periods under study, i.e., 2010 – 2011, 2011-2012, 2012 - 2013. The positive effect of SBA projects on employment might come from three sources. First, the projects themselves could generate employment since people needed to be hired to implement the projects. Second, people who used to be non-adopters of broadband might gain the critical skills necessary for jobs after they became users of the Internet. Third, gaining access to the Internet could help people more efficiently find potential career and employment opportunities. Noticeably, however, the effect ceased immediately after the termination of most of the projects in 2013. Therefore, although the gaining of skills is very often believed to be a long-term effect of Internet usage on employment (Ciriani & Perin, 2015), the analysis shows that such effects could also be immediate. Admittedly, an alternative explanation for the immediate but short-lived effect of SBA projects is that it was mainly the result of short-term hiring for projects implementation and the facilitation of job searching. Since no information is available for how many people were employed to implement the projects and what the new broadband adopters used the resource for, this study could not clearly identify the major source of the significant effect of SBA projects. However, the non-significant effect of PCC projects might provide some clues.

Similar to the SBA projects, the PCC projects aimed to promote the use of the Internet among the public. In terms of coverage, PCC and SBA projects both reached about 29% of the counties. The total amounts of funding for the two types of projects are also similar, with $201 million invested in PCC projects and $251 million invested in SBA projects. Given that the PCC project involved the construction or upgrading of public computer centers, while such activities were rare in SBA projects, it is reasonable to expect that PCC projects would generate more

employment as a result of project implementation. Meanwhile, in PCC projects, special training about using the Internet for job searching was offered to patrons of the computer centers (ASR, 2014). Therefore, if the facilitation of job searching was a major source of the drop in the unemployment rate, it would be more likely to be caused by the PCC projects. However, during all the examined periods, no significant effect of PCC projects was detected. The insignificant effect of PCC projects might indicate that the positive effect of SBA projects on employment was not caused by the short-term, project-specific hiring or the facilitation of job searching but the skill gaining as a result of Internet usage.

The significant impact of SBA projects and the absence of such for PCC projects provide a valuable implication for future policymaking. Although providing connected devices and offering digital and job-related skill training might be more directly related to the goals the policy intends to achieve, promoting the "natural adoption" of the Internet could be more effective in generating the social benefits. Nevertheless, the insignificance of the effects of PCC projects does not necessarily indicate that public computer centers are irrelevant in promoting employment. It is highly possible that the effects of PCC projects were manifested in other dimensions such as the increase in wages or higher productivity at work. Therefore, future studies would be benefited from extending the focus from unemployment rate to other job-related indicators. Moreover, unlike the SBA projects which could cover a large geographic area, the reach of the influence of computer centers was much limited. In many cases, it could reasonably be expected that only the residents in the city or even the neighborhood where the computer center was located were the beneficiaries. Therefore, the positive effect of PCC projects on employment, even if it indeed existed, might be manifested at the county level.

The study also examines whether the effect of BTOP projects was different in rural and urban counties. The finding suggests that on average, the SBA projects ceased to generate any significant impact on employment after their termination in the year 2013, its impact on urban counties was significantly different from that in rural counties. Specifically, compared to the rural counties with the presence of SBA projects, the urban counties with SBA projects would experience a larger decrease in the unemployment rate. This finding suggests that the difference in the demographics and economic characteristics between rural and urban localities should be considered when policies plan to leverage the Internet to promote socio and economic development.

A positive effect of CCI projects on county employment was detected during two periods under study, 2011-2012 and 2014 – 2015. Given that from 2011 to 2012, 39,000 miles of network were constructed or upgraded (NTIA, 2015), the positive effect observed for the 2011-2012 period was likely to be the result of the hiring for project implementation. Noticeably, the positive effect was not observed in the subsequent years until 2014-2015. Therefore, the employment opportunities created by network construction was likely to be long-term but one-time: once people were hired, no more employment was created. The fact that a positive effect was detected for the 2014-2015 period rather than the 2012-2013 and 2013-2014 periods, when the biggest increase in the number of connected CAIs took place (NTIA, 2015) is worth further exploration. Noticeably, although the CCI project can potentially benefit various parties such as households and businesses, its focus is on connecting CAIs rather than individual users. Although the importance of anchor institutes in promoting Internet usage has been well established (Menon, 2016), such focus comes with a price: the positive effect, if there is any, might not come immediately after the CAI is connected.

Limitations of the Study

All the conclusion and implications of the study should be considered under its limitations. First of all, although the county is a reasonable choice for the unit of analysis, some employment effects of BTOP projects might not be revealed at this level. Second, not all BTOP projects are equal. A new computer center which took multi-million dollars to construct would be more likely to generate social benefits than a project where a few more workstations were purchased. However, due to data availability issues, this study does not distinguish the amount of BTOP investment each county received. The use of dummy variables, though effectively reducing the chance of measurement errors, would lead to great loss of variability in the treatment variable. Finally, although the unemployment rate is a key indicator of employment, other measurements, such as the median or average income and the number of establishments, can also provide useful information. Focusing on only one dimension of employment, this study might not provide a comprehensive picture of the effects of BTOP projects.

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