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Edward J. Bloustein School
of Planning and Public Policy

Technology Adoption and Structural Poverty: Statewide Evidence from the Broadband Technology Opportunities Program

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Technology Adoption and Structural Poverty:
Statewide Evidence from the Broadband Technology Opportunities Program

Presentation Overview

I. The Digital Divide, the Stimulus Package and Poverty

II. The Larger Project: Multi-level Analyses under the BTOP

III. Findings of the Household-Level Research

IV. Implications and the Changing Landscape

I. The Digital Divide, the Stimulus Package and Poverty

The Digital Divide

As originally defined, the digital divide spoke to the affordability of a household computer, peripheral equipment, and software required for Internet access.

Over time the term expanded to encompass the personal skills and social infrastructure necessary for effective use of increasingly sophisticated Internet access equipment and increasingly diverse online content and transactional opportunities .

This leads us to the…

First Premise: Poverty, as a structural driver of inequality in Internet access and effective use, has been woven through the definition of digital exclusion from early household adoption around 1994-95 through to the United State's current policy initiative, the National Broadband Plan of 2010.

Step One: The Stimulus Package Funds the Broadband Technology Opportunities Program

The American Recovery and Reinvestment Act of 2009 (ARRA, the Recovery Act, or the Stimulus Package) allocates $7.2 billion in broadband funding (≈0.92% of the total original estimated $787 billion):

$4.7 billion dollars to the Department of Commerce's National Telecommunications and Information Administration (NTIA) to establish and operate the Broadband Technology Opportunities Program (BTOP); and,

$2.5 billion, to Department of Agriculture's Rural Utilities Service to support distance learning, telemedicine, and provide additional funding for the BTOP.

Step Two: ARRA's language is very specific regarding the relationship of poverty and the digital divide:

→ The BTOP is established to "…facilitate greater **use** of broadband service by low-income, unemployed, aged, and otherwise vulnerable populations…"

→ through competitive grants that shall "…facilitate **access** to broadband service by low-income, unemployed, aged, and otherwise vulnerable populations…"

→ in order to: "…**provide** educational and employment opportunities to members of such populations."

ARRA further directs the Federal Communications Commission to develop a National Broadband Plan that "…shall seek to **ensure that all people** of the United States **have access** to broadband…"

Step Three: The National Broadband Plan of 2010 (NBP) incorporates the language of poverty in its policy goals:

Policy Goal #3: "Every American should have affordable access to robust broadband service, and the means and skills to subscribe if they so choose."

To accomplish this policy goal, the FCC articulates three domains in which the NBP shall be operative:

(1) **access** "for every American home;"
(2) **affordability** of service for "every household," and,
(3) availability of **skill training** to make Internet access meaningful.

Step Four: The FCC gets specific in Section 9.2 of the NBP "Addressing Cost Barriers to Broadband Adoption and Utilization" with two recommendations that speak to the interrelationship of poverty and the digital divide:

1. Expand the Lifeline and Link-Up America programs "to make broadband more affordable for low-income households;" and
2. Extend access to low income households, specifically calling for the consideration of "free or very low-cost wireless broadband."

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These four steps lead us to the…

Second Premise: Under the expanded definition of the digital divide, remedial efforts in each of the individual domains is necessary but not sufficient to remedy digital exclusion; the satisfaction of all three is required to bridge the structural inequality of the digital divide.

II. The Larger Project: Multi-level Analyses under the BTOP

Against that background, particularly the FCC's designation of three domains under the BTOP, we introduce the scope of the research under discussion, which corresponds to the three designated domains: access, affordability, and skill.

The project operates at three levels, each of which manifests a collaborative effort between Rutgers' academic experts and researchers and Applied Communication Science's (ACS) telecommunication industry experts and researchers in broadband technologies and markets.

ACS is formerly known as Telcordia Technologies, Inc., which was formerly known as Bell Communications Research, Inc., i.e., Bellcore.

Levels of Analyses

Household Level: Lead Researcher: Marc Weiner (Bloustein Center for Survey Research):

***Goals*:** Conduct primary survey research to inform mapping and planning work. Systematically assess household adoption of broadband access across New Jersey. Identify areas of lower adoption. Analyze and model attitudinal, behavioral, and demographic factors associated with and influencing household level broadband adoption and non-adoption.

Community Level: Lead Researcher: Todd Wolfson (School of Communication & Information):

***Goals*:** Understand and assess the dynamics of urban broadband adoption and education programs, especially with regard to disenfranchised groups. Identify key success factors in the planning, development and implementation of successful broadband adoption and education programs. Identify best practices for building community-based collaborations in underserved areas.

State Level: Lead Researcher: Nancy Mantell (R/ECON™):

***Goals*:** Understand and assess the impact of the broadband industry and market on the state's economy. Isolate and analyze the employment-related implications and outcomes of Internet-related training programs in cooperation with the New Jersey Department of Labor and Workforce Development.

Methodological Approaches

Household Level:

A. Primary Data Collection: Gold standard statewide dual-frame (landline and cell-phone) household level probability sample survey; fielded 12/10; bilingual: Spanish/English; N=3,100 completed interviews; stratified over-sample yielding 1,860 broadband adopters and 1,241 non-adopters (Weiner and Puniello / Abt SRBI).

B. Quantitative Modeling and Analyses: Focus on isolating and assessing primary determinants of broadband non-adoption, analyzed as barriers to household-level broadband adoption and information technology services (Weiner and Puniello).

Community Level:

Qualitative Research and Analyses: Focus on addressing gaps, developing and assessing programs for improving broadband penetration and digital literacy at the community level and with concern for disenfranchised populations (Wolfson and Bach).

State Level:

State and Market Level Econometric Analyses: Focus on analyzing and assessing the impact of the proliferation of broadband on New Jersey's economy and forecasting mid-term and long-term demand for broadband services (Mantell).

Detail on Household-Level Primary Data Collection: Sampling Plan

Table 1: Sampling Strategy/Met-Projections
Source: Rutgers-ACS Telephone Survey, *N*=3,101, Nov. – Dec. 2010

Total *N*: 3,100	**Landline:**	**Cellular:**	**Total:**
Adopters:	1,395 (45% *of total N*)	465 (15%)	1,860 (60%)
Non-Adopters:	465 cross-section (15%) 775 stratified oversample (25%) 1,240 (40%)	0	1,240 (40%)
Total:	1,395 adopters by landline (45%) 1,240 non-adopters by landline (40%)	465 adopters by cell (15%)	1,860 adopters (60%) 1,240 non-adopters (40%) **3,100 total *N* sample (100%)**

Survey Eligibility Qualifications and Cross-Data Reference Validation

Screening: To assure that the responding individual was knowledgeable about broadband-related issues in the household, potential respondents were screened to identify the utility and service bill payer in the household and were then sorted into broadband-adopters, dial-up users only, or non-internet adopters.

Validation: February 2011 NTIA Research Preview, "Digital Nation: Expanding Internet Usage," point estimate, based on the October 2009 Internet Use Supplement to the Current Population Survey (nationwide *N*=54,000 households), is 73.3% (+/- 1.90% MoSE at 90%), which is < 1 percentage point of our point estimate, 72.4% (+/- 2.1% MoSE at 95%).

Detail on Household-Level Primary Data Collection: Survey Parameter Outcomes

Table 2: Broadband Mapping Survey Executive Summary of Survey Parameters
Source: Rutgers-ACS Telephone Survey, *N*=3,101, Nov. – Dec. 2010

Completed Interviews, Unweighted Total	3,101
Statewide Cross-Section Landline	1,801
Statewide Cross-Section Cell Phone	452
Nonadopter Oversample	848

AAPOR3 Response Rates	23.4%
Statewide Cross-Section Landline	23.2%
Statewide Cross-Section Cell Phone	20.0%
Nonadopter Oversample	24.1%

Margins of Sampling Error (95% c.i. - 45/55 margins)	
Statewide Cross-Section (unweighted N=2,253)	2.1%
All Broadband Adopters (unweighted N=1,860)	2.3%
All Broadband Nonadopters (unweighted N=1,241)	2.8%

AAPOR3 Cooperation Rates	40.4%
Statewide Cross-Section Landline	36.9%
Statewide Cross-Section Cell Phone	38.8%
Nonadopter Oversample	42.0%

Pretest	Thurs/Fri, Nov 4/5, 2010 (*n*=30; 16 adopters; 14 non-adopters)
Field Period	Tuesday, November 9 through Thursday, December 23, 2010
Mean Interview Duration	10.1 to 10.4 minutes
Sampling Approach	
Statewide Cross-section	New Jersey
Statewide Oversample	Nonadopters; stratified by high-density zip codes
Call Design	11-call design; one refusal conversion on 50% of soft refusals
Weighting Schema	
Cross-Section	Household-based design weight; respondent-driven post-stratification rim
Nonadopter Oversample	Household-based design weight; respondent-driven post-stratification rim

III. Findings of the Household-Level Research: Survey Sample Demography

Table 3: Difference in Means/Proportions of Basic Demographic Indicators by Adoption/Non-adoption Status
Source: Rutgers-ACS Telephone Survey, *N*=3,101, Nov. – Dec. 2010

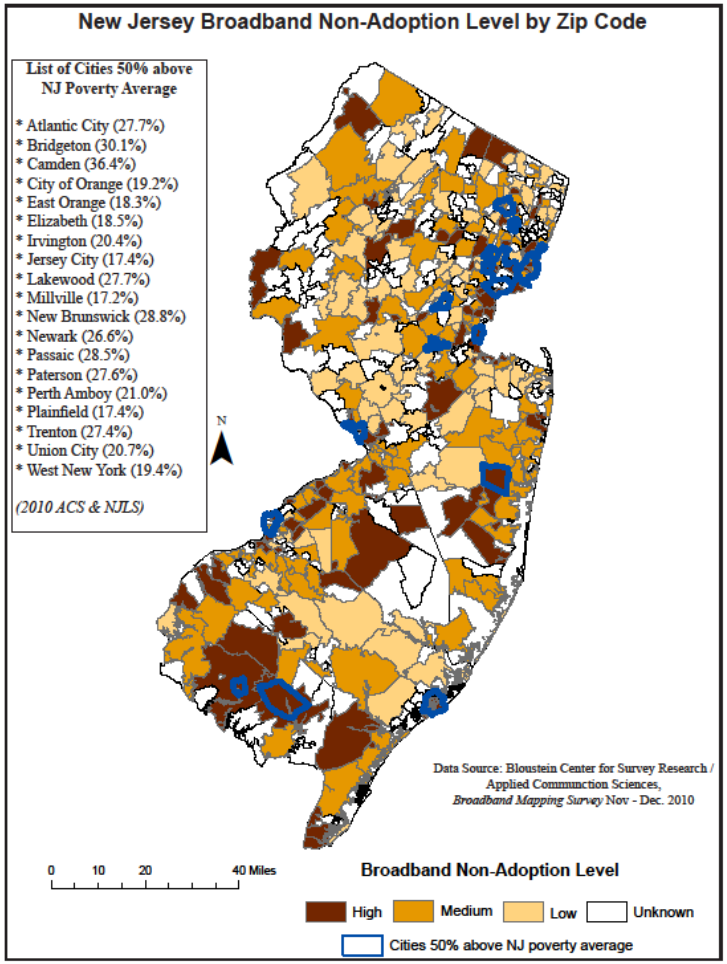
Category	*N*	Broadband Adopters	Broadband Non-adopters	p value	t/Z value
Age, mean	2,961	48.7	64.5	p<0.00001	t=-26.8073
Reporting respondent's education, mean category	3,051	between "some college" and "college grad"	nearer to "technical, trade, vocational, school" than "some college"	p<0.00001	t=23.0190
Household income, mean category	2,265	approx. $59,750	approx. $30,500	p<0.00001	t=28.2298
Hispanic ethnicity, proportion (n=266)	3,048	0.0853	.09020	p=0.6388	Z=-0.4694
Race=Asian, proportion (n=118)	2,989	0.0542	0.0169	p<0.00001	Z=5.1085
Race=Black, proportion (n=357)	2,989	0.0956	0.1559	p<0.00001	Z=-4.9689
Lives alone, proportion (n=941)	3,014	0.1742	0.5240	p<0.00001	t=-20.5777

Prevalence of High Non-Adoption by Zip Code

Table 4: High Non-Adoption Zip Codes (≥20%) by Primary State-Region Zip Category
Source: Rutgers-ACS Telephone Survey Nonadopter Subsample, *N*=1,241, Nov. – Dec. 2010

High NonAdoption Zip Codes		High NonAdoption Zip Codes	
Town	***Zip Code***	***Town***	***Zip Code***
Atlantic City	08401	Paterson	07514
Millville	08331	Paterson	07522
Camden	08105	Passaic	07013
Trenton	08609	Union City	07087
Trenton	08610	East Orange	07018
Trenton	08618	Elizabeth	07206
Perth Amboy	08861	Jersey City	07304
		Jersey City	07306
		Newark	07105
		Newark	07106
		Newark	07107
		Newark	07108
		Newark	07111
		Newark	07112

Sample of Mapping of Adoption Rates by Zip Code (producer: Orin Puniello, MPP)



Narrative Summary of Key Survey Findings: Broad Policy Overview

1. New Jersey ranks 12th among all states in terms of household broadband adoption (72%); this means that 28%, or more than 850,000 New Jersey households, do not have broadband access in the home.

2. Demographically, household broadband non-adopters are *somewhat* more likely to be older, lower income, less educated, African-American, and clustered in urban areas.

3. Over 86% of household broadband adopters were either very (50%) or somewhat (36%) satisfied with their broadband service.

4. When asked whether the policy of "expanding affordable high-speed Internet access to everyone in the [state] should be a [priority] for our state government," 61% indicated that it should be either a top (20%) or "important, but [a] lower" (41%) priority.

Narrative Summary of Key Survey Findings: Reasons Given that Household Broadband Adoption is Important (Subsample, New Jersey Cross-section, *N*=2,253)

Respondents indicated that "people who do not have high speed Internet access at home" were at a disadvantage in the following areas (percentage of sample agreeing):

- Telecommuting or working from home (71.7%);
- Finding out about job opportunities or gaining new career skills (69.3%);
- Education (67.4%);
- Using government services (59.0%);
- Learning new things that might improve or enrich your life (62.2%);
- Getting health information (57.9%);
- Keeping up with news and information (47.5%);
- Keeping up with what is happening in your local community (46.4%); and
- Shopping (44.4%).

Narrative Summary of Key Survey Findings: Reasons Given for Nonadoption (Subsample, Broadband Nonadopters, N=1,241)

There are four categorical bases for nonadoption:

1. **Lack of Inclination:** Over four in ten of all non-adopters – 41.2% – report their "main reason [they] don't use the internet or email" is either that they're "just not interested," "don't need it/don't want it," "it's a waste of time," or they're "too busy/just don't have the time."

2. **Lack of resources:** Just under one-third – 30.4% – state their main reason as either "it's too expensive," "don't have a computer," "don't have access," or assert that while they don't currently use it, they're "getting it."

3. **Lack of training or skill:** 16.1% of non-adopters report it's "too difficult/frustrating," they "just don't know how," or that they're "too old to learn" as their main reason for non-adoption. Only 24% to 28% of nonadopters report using a computer at any time on at least an occasional basis, or that they ever did so, or would like to do so in the future. Over half (53.5%) indicate they "would need someone to help" them with computers or technology to start using the Internet.

4. **Fear of Technology:** 5.10% – or 53 respondents – report their main reason for non-adoption is worry about "computer viruses," "spam" "spyware," "adware," "privacy," or that "it's an evil thing," or, simply, "religion."

Inferential Analysis: Moving Beyond Demography
Overview of Household Level Primary Data Modeling: Step One

The two-step model first estimates a probability of household non-adoption. The theoretical determination is:

$$\textbf{pr(non-adoption)} = \alpha + \beta(D) + \varepsilon$$

where **D** represents a set of demographic factors; the constant term is shown as **α** and the set of parameters associated with **D** is represented by **β**, with an error term, **ε**.

The empirical specification of this binary logit model is:

$$\textit{pr}(\text{non-adoption}) = \alpha + \beta_{1\text{-}14}(\text{age}_{2\text{-}15}) + \beta_{15\text{-}22}(\text{hhincome}_{2\text{-}9}) + \beta_{23\text{-}28}(\text{education}_{2\text{-}7}) + \beta_{29}(\text{black}) + \beta_{30}(\text{lives alone}) + \varepsilon$$

where the dependent variable is a binary categorization variable (0/1=adopt/nonadopt); and,

age, household income, and education are entered into the model as sets of dichotomous variables; in each case, the lowest category is the reference group (age, 15 categories, 14 coefficients; household income, 9 categories, 8 coefficients; and education, 7 categories, 6 coefficients); and,

race (as black=1; nonblack=0) and household size (as lives alone=1; more than 1 in household=0) are entered as stand-alone dichotomous variables.

Inferential Analysis: Moving Beyond Demography
Overview of Household Level Primary Data Modeling: Step Two

We then use the *Model of Technology Adoption in Households* and, following the *Unified Theory of Acceptance and Use of Technology*, include a demographic moderating control variable to assess the impact of the attitudinal and behavioral characteristics of the designated head of household under the following linear ordinary least squares model:

$$\textbf{probability of non-adoption} = \alpha + \gamma(A) + \delta(B) + \theta(E1) + \varepsilon 2$$

where the dependent variable is the set of predicted values from the initial logit regression;

A is a vector of attitudinal variables (inclination, money, skill and fear);

B is a vector of variables representing the behavioral bases of non-adoption (familiarity with and use of computers and the Internet);

E1 is a vector of the residuals from the first-step logit regression;

γ, **δ**, and **θ** are vectors of model parameters associated with, respectively, the attitudinal and behavioral predictors and the residual control term; and,

α is the constant term and **ε2** is the error term.

Inferential Analysis, Final Model Outcomes

Table 5: Final OLS Model Estimating Probability of Non-adoption from Attitudinal and Behavioral Predictors
Source: Rutgers-ACS Telephone Survey Nonadopter Subsample, N=1,241, Nov. – Dec. 2010

	Model #2			
Variable	**Coefficient[1]**	**t-value**	**p≥ | t |**	**Beta (rank)**
use a computer	-0.141	-6.78	0.000	-0.236 (2)
ever used the Internet	-0.041	-2.19	0.029	-0.070 (7)
wants to go online	-0.055	-2.90	0.004	-0.092 (5)
needs help to go online	-0.081	-4.23	0.000	-0.145 (4)
no inclination	-0.047	-2.83	0.005	-0.085 (6)
fear	-0.195	-5.82	0.000	-0.171 (3)
resources (logit residuals)	-0.173	-14.83	0.000	-0.441 (1)
constant	0.918	63.48	0.000	.
Observations	623			
F (df)	(7, 615)=88.71			
P > F	0.0000			
R^2	0.5021			
Adj R^2	0.4971			
Std. Err. Est. (MSE)	0.193			

[1] *While the negatively signed coefficients are counterintuitive, they are correct. Here, the dependent variable (the first-step predictions) are ordered such that 1.0 represents non-adoption and 0.0 represents adoption; thus, as the predictors–all dichotomous variables–take on a positive indicator value, i.e., as a respondent reports, "yes, I use a computer," and/or, "yes, I want to go online," and/or, "no, I do not need help to go online," the prediction of non-adoption probability is moved negatively, i.e., toward zero, i.e., the probability is moved toward adoption.*

Modeling Outcomes: Findings and Actionable Insights

By analyzing the differences in group means of standardized predictions from the final model across the key demographic, attitudinal, and behavioral characteristics of the head of household, we make the following findings:

Finding: The barriers to household level adoption are race neutral ("color-blind") once other relevant attitudinal, behavioral, and demographic factors are statistically controlled.

Actionable/Directional Insight: Targeting adoption efforts by race and ethnicity is likely to be less productive than geospatial approaches. In conjunction with recent secondary data regarding the adoption of smart-phones, to help close the digital divide, particularly in the case of urban-clustered minorities, stakeholders should consider expansion of wireless over wired broadband access.

Finding: Hispanic-Latino/a identity is wholly non-predictive of broadband adoption or non-adoption.

Actionable/Directional Insight: Still, bilingual access and training programs remain critical due to high broadband use by minorities. (Nielsen Mobile Insights, reported 8/7/12, shows percentages of smart-phone mobile broadband subscribers: 66% of Asian-American subscribers; 57% of Hispanic; 53% of African-American; 45% of white).

Finding: Living alone is a strong predictor of household-level broadband non-adoption.

Actionable/Directional Insight: Advertising for and promotion of programs to facilitate the expansion of broadband access and digital literacy education should address the social, civic, and commercial enfranchising effects of Internet connectivity and effective use.

Modeling Outcomes: Findings and Actionable Insights

Finding: Structurally, lack of resources is the strongest barrier to broadband adoption. Poverty and the digital divide are correlated and have been so since inception; this structural relationship embedded in National Broadband Plan authorizing legislation; correlation is exacerbated as definition of the "digital divide" changes over time to include social factors in addition to "equipment gap."

Actionable/Directional Insight: Findings recommend subsidies for training programs, equipment, and access, a recommendation that is wholly consistent with the authorizing legislation for the Broadband Technology Opportunities Program. As the next and final finding makes clear, once the resources barrier has been overcome, exposure to computer use and the skill-set to access the Internet are the next critical elements to facilitate household-level broadband adoption.

Finding: Behaviorally, lack of experience with the Internet is the main factor associated with non-adoption.

Actionable/Directional Insight: The generation of motivation for Internet connectivity is not so much about changing the householder's mind with regard to the idea of, or ideas about, the Internet; indeed, we found the "lack of inclination" and "fear of technology" bases of non-adoption to be extremely robust barriers to adoption. Rather, the approach is better structured experientially, i.e., exposing the householder to a "hands-on" engagement with an online computer, perhaps for the first time. This finding urges the development of effective educational programs that train individuals in ICT, including community-based programs. The sooner and more directly training and skill development programs place a trainee at a broadband accessible computer, the more likely the program is to stimulate broadband adoption and use optimization.

IV. Implications and the Changing Landscape: Back to the Interrelationship of the Digital Divide and Poverty

The preceding model of household-level broadband non-adoption is published (**Weiner, M. D., Puniello, O. T., Noland, R. B., Ciemnecki, D. & Turakhia, C. (2012).** ***Consider the Non-Adopter: Developing a Predication Model for the Adoption of Household-Level Broadband Access*****. Socio-Economic Planning Sciences: The International Journal of Public Sector Decision-Making, 46(3), pp. 183-193**).

An additional article, **Weiner, M. D. & Puniello, O. T. (under revision for 2013 publication),** ***Modeling Digital Exclusion: Statewide Evidence from the Broadband Technology Opportunity Program*****. Journal of Poverty: Innovations on Social, Political & Economic Inequalities** demonstrates an additional impact of poverty on broadband, viz., efficacy of use. The second article models poverty from a different theoretical perspective, but adds an additional critical empirical finding, #2 below:

(1) Poverty, whether expressed as economic exclusion (as in the published article) or lack of resources (as in the article under review), is the most significant stable barrier to the household-level adoption of broadband Internet access.

(2) Even **among household broadband adopters**, i.e., those who have broadband access in the home (a category including those in poverty as well as not **in poverty**), **the proportion** of the sample in poverty **actually using the internet for** the common social, educational, civic, commercial transactions that typically signify **inclusion in a digitally-driven economic society, is statistically significantly lesser than those not in poverty**.

IV. Implications and the Changing Landscape: Putting the Household Connection In Context

The Importance of Household Connectivity in a Wireless Land of Smartphone Proliferation

The finding of diminished use by those with household broadband connections, but below the poverty line, strongly supports the inference that a significant component of the digital divide is attitudinal and/or the product of a lack of exposure to the relevant technologies. The critical aspect of this finding is that it is remediable. In plain, we can do something about it.

However, with the rapid market availability of wireless broadband-enabled smart-phones, linking Internet use to a household connection may over time become redundant to these mobile devices. On the other hand, having fixed, stable, reliable in-home Internet access, on a screen large enough on which to work comfortably, facilitates the use of the Internet for stationary activities, such as online learning, telecommuting, banking, video viewing and communications, shopping and related commercial activities, and other online activities that are more amenable to a fixed location than to the mobility of smart devices.

Thus, as advanced by the National Broadband Plan, a household-level connection remains a stable and effective way to assure digital inclusion in the economic, social, and cultural transactions and relationships of modern American society.