PERSPECTIVES
PHOENIX CENTER FOR ADVANCED LEGAL & ECONOMIC PUBLIC POLICY STUDIES

Broadband as a Source of Rural Decline: A Look at the Data

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In the modern economy, digital inclusion is linked to social and economic opportunity. According to the most recent data reported by the Federal Communications Commission ("FCC"), a fixed broadband service of 10 Mbps or better is available to 96.9% of Americans, suggesting opportunity abounds.[1] In rural areas, however, nearly 12% of Americans (about 39 million persons or 15 million households) do not have fixed broadband access at that speed and mobile wireless access appears to do little to close the gap.[2] Absent closing the rural broadband divide, some policymakers and analysts worry that rural communities will soon become ghost towns.[3] Policymakers at the federal, state and local level are seeking ways to expand rural broadband availability.

Rural America's decline and the coincident rise of the Broadband Age naturally lead to a presumed linkage between the two, but rural population loss has been a feature of the American landscape for over a century, preceding the Internet generally and broadband specifically by many decades.[4] There are many contributing factors to the out-migration from rural areas including agricultural production technology, manufacturing job losses, the quality and availability of healthcare, educational opportunities, and so forth.[5] In fact, in a recent study detailing the reasons people do or do not migrate to rural areas, Internet service is barely mentioned.[6]

A better understanding of the role broadband plays in rural population changes may be obtained by studying population trends over the past few decades. If a lack of broadband is driving rural population loss, then an increase in the relative population growth between urban and rural areas should be observed during the Broadband Age. Absent such a change, the observed population loss in rural areas arguably reflects the longer-term trend in population growth differences rooted in other factors.

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In this PERSPECTIVE, I study population changes in urban and rural counties, comparing the patterns of population growth before and during the Broadband Age. I begin with a general analysis of growth trends, but then turn to more specific questions that better identify the population changes related to broadband (or not) by comparing relative growth within rural areas that do and do not have broadband and between rural and urban areas with above-average broadband.

The results are somewhat surprising, at least to some, and inconsistent with rural-broadband advocacy. The data indicate that the patterns of population growth between urban and rural counties are largely unchanged over the past fifty years. If anything, the population growth differential between urban and rural counties has shrunk during the Broadband Age. In counties with above-average broadband availability in the Broadband Age, I find that the growth rate differential between urban and rural counties has increased, providing strong evidence that broadband is not the primary cause of rural population declines. Thus, it appears that the on-going population loss in rural America is the continuation of a long-term and persistent trend and unlikely driven by the availability, or lack thereof, of high-speed Internet service.

Data and Timing

The question I seek to answer is straightforward: has the relative population growth between urban and rural America changed since the advent of broadband? In search of an answer, annual county-level population data are obtained from the Bureau of Economic Analysis ("BEA") spanning 1970 through 2017.[7] This population data includes all ages, genders, and races, and it also reflects all sources of population change including deaths, births, and migration.

The "rural" status of each county is determined using the Department of Agriculture's Urban-Rural Continuum Codes, with values greater than 3.0 determining a rural (or non-metro) county.[8] While assigning "rural" status is somewhat crude and counties are broad geographic areas of widely varying populations, county-level population figures are commonly used to study rural population trends and I employ a standard definition of "rural" counties.[9] These limits of the data, nonetheless, remain, and I cannot say whether alternative choices of either geography of "rural" status would alter my findings.

A few sample restrictions are imposed. First, I focus only on the contiguous states (dropping all data for Alaska and Hawaii). Second, because Virginia employs somewhat non-standard city/county divisions, I exclude data from that state.[10] Third, I drop any county with missing population data in any year, thus creating a balanced panel with which annual growth rates can be computed. Fourth, as I am comparing population changes between urban and rural areas over nearly fifty years, only counties labeled rural or urban in both 1983 and 2013 are retained in the sample. (Additional analysis is provided to determine the impact of this sample limitation since it involves the definition of "rural.") The final sample contains 48 years of population data for 2,541 counties, where 73.8% of counties (1,875) are classified as rural.[11] In 2017, the final sample includes just over 289 million persons with 15% living in rural counties. The final sample represents 89% of the total U.S. population in 2010.

I include a measure of broadband availability in part of my analysis. To avoid picking a specific speed that constitutes broadband, I measure broadband availability as the share of homes with access to cable's DOCSIS service using the National Broadband Map's data for year 2013. DOCSIS-based broadband normally represents the best available speeds for broadband at any particular time.[12] Prior to the Broadband Age, the availability data accounts for unobserved factors that are conducive to broadband deployment and may affect population growth. That is, the broadband variable serves as a pseudo-treatment.[13]

While we are in the Broadband Age today, what year did this Age begin? There are a number of possibilities. Here, I define the Broadband Age as a period beginning in 2000. In that year, the Pew Foundation survey indicated that fixed broadband subscriptions surpassed 5% of U.S. households, and surpassed 10% in 2001.[14] In 2004, the National Telecommunications Information Administration ("NTIA") released its *Entering the Broadband Age* report, using data from 2001.[15] Also, the FCC's first reported data on broadband subscriptions was for year 2000.[16]

Another option I consider is 1995 when a number of significant "Internet" events occurred, including the initial public offering of Netscape, Amazon's first sale, and the release of the Pamela Anderson and Tommy Lee sex video.[17] Also, year 2010 is considered as possible start for the Broadband Age, allowing the technology some time to become more influential on population and economic activity. In part of my analysis, I allow the start date to range between 1995 and 2010 to determine whether the results are sensitive to the definition of the Broadband Age.

Summary Analysis

My focus is on population growth between rural and urban counties. Population growth, labeled g_i, is defined as the annual percent change in population for county *i*. Median population growth rates for rural and urban counties are g_R and g_U. Summary statistics of median population growth and the share of total population in rural counties, by decade, are provided in Table 1.

Table 1. Descriptive Statistics

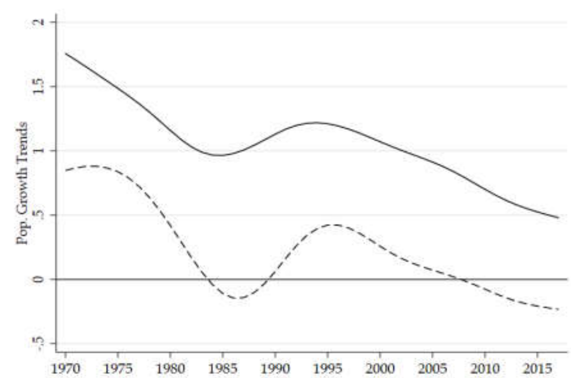
Years	Urban: g_U	Rural: g_R	U.S.: g	Pop. Share Rural
1970-79	1.529%	0.828%	1.323	19.0%
1980-89	0.913%	-0.232%	0.672	18.5%
1990-99	1.206%	0.545%	0.942	17.3%
2000-09	0.925%	0.078%	0.463	16.4%
2010-16	0.525%	-0.249%	0.300	15.5%

A number of facts are apparent from Table 1. First, median urban population growth exceeds rural population growth in each decade over the entire (near 50-year) sample period. Aside from the 1970s, population growth in rural counties is small (well below 1% annually), turning negative in the last decade as it did in the late 1980s before there was a public Internet. The share of rural population has also been in a steady decline over the entire period, falling about one percentage point per decade. Since the mid-1990s, population growth in urban areas and for the nation as a whole have declined sharply. In the 2000s, urban population growth, and growth for the nation, has fallen below 1% annually.

[T]he spread between urban and rural growth does not appear to have materially widened in the Broadband Age...

The relationship between urban and rural population growth is seen clearly in Figure 1. This figure illustrates the trends in median population growth extracted by the Hodrick-Prescott Filter ("HPF"), a smoothing technique that does not impose a linear trend and is more sensitive to long-term than short-term fluctuations.[18] We see in the figure that the spread between urban and rural population growth has been relatively stable. Median growth in rural areas became negative in 2007, and it is this loss in population that has captured the attention of policymakers.

Figure 1. Long-Term Trends (Population Growth)



Naturally, given the importance of high-speed Internet access in modern America, a link between broadband and population loss is assumed. Yet, the spread between urban and rural growth does not appear to have materially widened during the Broadband Age (even back to 1995). If broadband was driving population loss, then we would expect to see an increasing spread between the growth rates in urban and rural counties. Of course, it may be difficult to detect visually a difference from the figure alone. Statistical analysis is required.

Regression Analysis

In this first analysis, I simply compare the growth rates in population between urban and rural counties before-and-after the Broadband Age (set at year 2000).[19] A regression model is used to estimate the relative mean population growth changes in urban and rural areas:

$$g_i = \beta_0 + \beta_1 RURAL + \beta_2 BA + \beta_3 BA \cdot RURAL + \varepsilon_i \quad , \qquad (1)$$

where g_i is the population growth rate for county i, *RURAL* is a dummy variable for rural counties, *BA* is a dummy variable for the Broadband Age, and ε is the econometric disturbance term.

The estimated parameters of the model can be used to calculate the average growth rates before-and-after the beginning of the Broadband Age. The primary coefficient of interest is β_3, which measures the change in the urban-rural growth differential in the Broadband Age. A negative β_3 coefficient indicates that the differential has increased (i.e., a rise in rural migration to urban areas), while a positive value indicates the growth differential has shrunk. If broadband is causing a shift in population from rural to urban areas, then β_3 should be negative (and statistically different from zero).

Given time-series data, the standard errors of the regression are corrected for both heteroskedasticity and first-order autocorrelation.[20] The estimation samples include 121,968 observations (2,541 counties, 48 years). The β coefficients and their robust t-statistics are provided in Table 2. The table summarizes results from three distinct beginnings of the Broadband Age including the benchmark year 2000 as well as the alternatives 1995 and 2010.

Table 2. Estimates of Equation (1)

	$BA \geq 2000$ Coef (t-stat)	$BA \geq 1995$ Coef (t-stat)	$BA \geq 2010$ Coef (t-stat)
β_0	1.555***	1.587***	1.467***
	(27.48)	(27.15)	(27.73)
β_1	-1.067***	-1.126***	-1.088***
	(-17.10)	(-17.46)	(-18.72)
β_2	-0.546***	-0.498***	-0.666***
	(-17.09)	(-14.90)	(-21.12)
β_3	0.063*	0.172***	0.252***
	(1.69)	(4.50)	(6.68)
Obs.	121,968	121,968	121,968

Stat. Significance: *** 1%, ** 5%, * 10%

In the benchmark definition of the Broadband Age (the first column of Table 2), population growth for urban counties in the pre- period averaged 1.555% [= β_0] annually with rural counties growing at only 0.489% [= $\beta_0 + \beta_1$]. During the Broadband Age, the average growth rate in urban counties falls to 1.009 [= $\beta_0 + \beta_2$] and the growth in rural counties is nearly zero at 0.005% [= $\beta_0 + \beta_1 + \beta_2 + \beta_3$] (which is essentially zero). The positive coefficient β_3 indicates the growth rate differential between urban and rural areas has actually narrowed and not expanded during the Broadband Age, and the coefficient is statistically different from zero at the 10% level. Before the Broadband Age, the difference in growth rates is 1.067 while during the Broadband Age the difference is only 1.004.

Is this difference very large? The mean population of rural counties is 23,112 persons, so the observed growth rate of 0.005% implies an increase in population of about 1.2 persons annually (almost no change). Had the growth relationship from the pre-period carried over to the Broadband Age, the average growth rate in rural areas during the Broadband Age would have been -0.057%, indicating a population loss of about 13.2 persons annually, for a difference of 14.4 persons. These changes are quite small, on average.

The statistical significance of the broadband coefficient before the Broadband Age illustrates the error in analyzing the influence of broadband availability on population growth only during the Broadband Age.

Switching the beginning of the Broadband Age to 1995 has some effect on the results (reported in the second column of Table 2). For the most part, the coefficients are similar except for the coefficient β_3 which is now much larger and statistically different from zero at the 1% level. These results indicate the growth differential between urban-and-rural counties has shrunk during the Broadband Age.

Moving the initial year of the Broadband Age to 2010, the estimated coefficients are quite similar to those when the start year is 1995—the β_3 is positive and statistically different from coefficient zero at the 1% level. The urban-to-rural growth differential has shrunk during the Broadband Age (as defined). Though not reported in Table 2, I also divided the Broadband Age into early (2000-2009) and late periods (2010-2017) and tested for differences across the three periods. No differences are found.

Holding Broadband Constant

A crude attempt may be made to test for growth rate differentials holding broadband availability constant. I re-specify Equation (1) as,

$$\begin{aligned} g_i &= \beta_0 + \beta_1 RURAL + \beta_2 BA \\ &+ \beta_3 BA \cdot RURAL + \delta_0 BB \\ &+ \delta_1 BA \cdot BB + \varepsilon_i \end{aligned} \tag{2}$$

where the variable *BB* measures the share of homes with access to cable's DOCSIS broadband service in 2013. Now, the β coefficients measures the difference in population growth in rural areas relative to urban areas holding broadband availability constant; or, more accurately, holding the factors that determine broadband availability constant since the *BB* variable has a coefficient before the Broadband Age. Table 3 summarizes the results.

Table 3. Estimates of Equation (2)

	Coef (t-stat)
β_0	1.177***
	(14.06)
β_1	-0.838***
	(-11.76)
β_2	-0.414***
	(-7.95)
β_3	-0.018
	(-0.42)
δ_0	0.458***
	(5.82)
δ_1	-0.159***
	(-2.95)
Obs.	121,920

Stat. Significance: *** 1%, ** 5%, * 10%

The results from Table 3 are interesting. To begin, note that the *BB* coefficient (δ_0) is positive and statistically different from zero (at the 1% level) before the Broadband Age, despite there being no broadband during this period. The *BB* variable in the pre-Broadband Age period acts as a pseudo-treatment that accounts for the underlying yet unobserved factors that determine broadband availability. The statistical significance of the broadband coefficient before the Broadband Age illustrates the error in analyzing the influence of broadband availability on population growth only during the Broadband Age.[21] That is, there exists a factor (or set of factors) that determine both population growth (the outcome) and future broadband deployment (the treatment), leading to selection bias in simple models. As shown here and in other work, selection bias is a serious concern in the analysis of broadband on all sorts of outcomes.[22]

The β_1 coefficient is attenuated slightly but remains large (-0.838 versus -1.067). The unobserved factors that determine future broadband deployment explain about 21% of the growth differential. Accounting for broadband, during the Broadband Age there is no additional difference in population growth between rural and urban areas (the t-stat on β_3 is small). This result is comparable to that in Table 2. It appears that broadband does little to explain the differences in rural and urban population growth either before or during the Broadband Age.

Note also that the broadband variable *BB* is statistically significant and negative during the Broadband Age. The negative coefficient indicates that the growth differential related to broadband availability (and the factors that determine availability) are attenuated in during the Broadband Age (though still positive overall). Holding broadband availability constant, the spread in growth rates between urban and rural areas seems largely unaffected. Certainly, there is no evidence that broadband alone is making matters worse for rural areas.

Looking at Rural Counties

Another approach is to focus on rural counties only. For this test, I select rural counties that have almost no broadband (less than 1%) and those with above average broadband (greater than 80%, which is the urban county mean). The estimation model is

$$\begin{aligned} g_i &= \nu_0 + \nu_1 NOBB + \nu_2 BA \\ &\quad + \nu_3 BA \cdot NOBB + \varepsilon_i \end{aligned} \tag{3}$$

where *NOBB* is a dummy variable for rural counties with nearly no broadband availability in 2013. There are 740 rural counties with little-to-no broadband and 143 rural counties with above average broadband coverage. Results are summarized in Table 4. The coefficient ν_3 is the coefficient of primary interest that quantifies the change in population growth during the Broadband Age (akin to coefficient β_3 above).

Table 4. Estimates of Equation (3)

	Coef (t-stat)
ν_0	1.024*** (9.95)
ν_1	-0.707*** (-6.35)
ν_2	-0.722*** (-8.98)
ν_3	0.294*** (3.39)
Obs.	42,348

Stat. Significance: *** 1%, ** 5%, * 10%

For rural counties with sufficient broadband, the average growth rate before the Broadband Age is 1.024%. Counties that will not have broadband grew slower, on average, than did counties that will have broadband, with a growth rate for those without broadband being 0.317% [= $\nu_0 + \nu_1$]. During the Broadband Age, growth slowed for both types of counties, falling to 0.302% for those with broadband and -0.111% for those without. Inconsistent with the broadband-growth hypothesis, ν_3 is positive and statistically significant; the growth gap between the two fell, from a difference of 0.707 percentage points before to 0.413 percentage points during the Broadband Age. Again, broadband does not appear to be pulling population from unserved to served areas.

The Rural vs. Urban Haves

In many respects, the most informative comparison is between urban and rural counties that have above average broadband availability in 2013, since now the only difference between counties is that one is rural and the other is urban. Equation (1) is used for this analysis and, since broadband status is equal, the coefficient β_3 measures the change in population growth based only on the "rural" dimension. There are 491 urban counties in this group and the same 143 rural counties from the prior analysis. Results are provided in Table 5.

Table 5. Estimates of Equation (1)

	Coef (t-stat)
β_0	1.551*** (23.26)
β_1	-0.572*** (-4.79)
β_2	-0.455*** (-13.54)
β_3	-0.160** (2.02)
Obs.	38,916

Stat. Significance: *** 1%, ** 5%, * 10%

For counties that would eventually have above average broadband, urban county population growth averaged 1.551% before the Broadband Age whereas rural county growth was only 0.979%. Growth fell to 1.096% for urban counties during the Broadband Age and 0.365 for these rural counties. Despite healthy broadband availability in both areas, the spread between the urban and rural growth increased during the Broadband Age, rising from 0.572 percentage point before and 0.732 percentage points during the Broadband Age, meaning something other than broadband is driving the growth rate differential.

[A] concerted effort to deploy broadband in rural areas may turn out to be a multi-billion-dollar information superhighway to (nearly) nowhere.

All Together Now

Here, I combine the urban and rural counties that either have above-average broadband or nearly no broadband at all. There are four county types: (1) rural counties without broadband; (2) rural counties with above-average broadband; (3) urban counties without broadband; and (4) rural counties with above-average broadband. Mean growth rates are obtained using the regression equation,

$$\begin{aligned} g_i = \gamma_0 &+ \gamma_1 NOBB + \gamma_2 NOBB \cdot RURAL \\ &+ \gamma_3 YESBB \cdot RURAL + \gamma_4 BA \\ &+ \gamma_5 BA \cdot NOBB + \gamma_6 BA \cdot NOBB \cdot RURAL \\ &+ \gamma_7 BA \cdot YESBB \cdot RURAL + \varepsilon_i \end{aligned} \quad (4)$$

where *BBYES* indicates the presence of above-average broadband. Results are summarized in Table 6.

Table 6. Estimates of Equation (4)

	Coef (t-stat)		Coef (t-stat)
γ_0	1.579*** (22.88)	γ_4	-0.541*** (-13.40)
γ_1	0.038 (0.16)	γ_5	-0.072 (-0.57)
γ_2	-1.307*** (-5.59)	γ_6	0.198 (1.61)
γ_3	-0.563*** (-4.56)	γ_7	-0.164* (-1.86)
Obs.	69,648		

Stat. Significance: *** 1%, ** 5%, * 10%

Pre-Broadband Age growth for urban counties without broadband is 1.579% annually. There is no growth difference in the pre-period between urban counties with and without broadband (γ_1 is not different from zero), so whatever factors determine the deployment of broadband are on average present in urban counties. Rural counties without broadband in the Broadband Age grew much slower than urban counties (γ_2 = -1.307). This growth difference was much smaller for rural counties that will have broadband (γ_3 = -0.563). Characteristics that drive broadband deployment reduce the urban-rural growth divide, but rural counties of both sorts were growing slower prior to the Broadband Age.

During the Broadband Age, growth slowed for urban counties ($\gamma_4 = -0.541$), but there still is no growth difference between urban counties with and without broadband (γ_5 is not different from zero). For rural counties without broadband in the Broadband Age, the growth differential from the pre-period falls ($\gamma_2 = 0.198$), though the change is significant only at the 11% level. The growth differential increased further, however, for rural counties with above-average broadband ($\gamma_7 = -0.164$) and the coefficient is statistically different from zero at the 6% level.

Like the prior analysis, there is no evidence that population growth rates between urban and rural areas has materially changed for the worse in the Broadband Age. Population growth for the nation has compressed, and the spread between urban and rural areas has led to negative growth in rural areas. A long-term trend based on the many disadvantages of living in rural areas (though there are many advantages as well), rather than broadband availability, appear to be to the primary causes for the decline in rural America.

Trimming the Ends

A number of rural counties are quite small in terms of population and the reasons people live in these areas may be related to specific desires or needs. As an additional analysis, I exclude the smallest 10% of counties from the sample and re-estimate Equation (1). The cutoff population is 4,802 persons. The procedure eliminates 187 rural counties from the sample. Results are summarized in the first column of Table 7.

Also, annual population changes can be affected by particular events including bad weather, flooding, plant closings, and so forth. To account for such events, I compute the coefficient of variation (i.e., the standard deviation of the growth rate divided by its mean) and exclude from the sample the positive and negative 1% tails of the coefficient.[23] Equation (1) is estimated with this trimmed sample and the results are summarized in the second column of Table 7.

Table 7. Estimates of Equation (1)

	Eliminate Smallest Rural Counties	Eliminate High g_i Variability
	Coef (t-stat)	Coef (t-stat)
β_0	1.546*** (27.58)	1.566*** (27.60)
β_1	-0.971*** (-15.64)	-1.069*** (-17.04)
β_2	-0.521*** (-17.14)	-0.548*** (-17.15)
β_3	0.016 (0.46)	0.063* (1.70)
Obs.	112,992	109,776

Stat. Significance: *** 1%, ** 5%, * 10%

The coefficient β_3 is of primary interest. For both trimmed samples, β_3 is positive, and it is statistically significant at the 10% level for the sample trimmed on variability. So, again, there is no evidence of an increase in the urban-rural growth differential during the Broadband Age.

A Review of a Sample Restriction

The samples used above include only counties that are defined as "rural" and "urban" in both 1983 and 2010. In Table 8, I re-estimate Equation (1) using a sample that does not impose this restriction, adding back 424 counties to the sample.

Table 8. Estimates of Equation (1)

	BA ≥ 2000 Coef (t-stat)	*BA* ≥ 1995 Coef (t-stat)	*BA* ≥ 2010 Coef (t-stat)
β_0	1.505*** (34.41)	1.505*** (33.28)	1.408*** (34.56)
β_1	-1.015*** (-19.94)	-1.042*** (-19.78)	-1.027*** (-21.74)
β_2	-0.586*** (-21.78)	-0.463*** (-16.86)	-0.701*** (-27.55)
β_3	0.105*** (3.22)	0.140*** (4.24)	0.292*** (8.94)
Obs.	142,512	142,512	142,512

Stat. Significance: *** 1%, ** 5%, * 10%

The results are not materially different with these additional counties returned to the sample. In all cases, β_3 is positive and statistically different from zero at the 1% level, indicating the growth differential between urban and rural counties has become smaller in the Broadband Age (no matter how defined).

Flexibly Defining the Broadband Age

A few definitions of the Broadband Age have been considered, but any definition draws a line that is debatable. In Table 9, I summarize the β_3 coefficients for Equation (1) estimated using the initial year of the Broadband Age ranging from 2005 through 2010. These results are comparable to those in Table 2.

Table 9. Estimates of Equation (1)
(Urban v. Rural Growth)

Year	β_3	Year	β_3
1995	0.172***	2003	0.164***
1996	0.088**	2004	0.147***
1997	0.070*	2005	0.179***
1998	0.075**	2006	0.209***
1999	0.057	2007	0.159***
2000	0.063*	2008	0.241***
2001	0.055	2009	0.254***
2002	0.153***	2010	0.252***

Stat. Significance: *** 1%, ** 5%, * 10%

As shown in the table, the β_3 coefficient is consistently positive and statistically different from zero in almost all instances, especially for the later cutoff dates for the beginning of the Broadband Age. There is no evidence of an increasing growth rate differential between urban and rural areas.

Restricting the sample to urban and rural counties with above-average broadband (as in Table 5), the cutoff date for the Broadband Age has more meaningful effects on the results. From Table 10, we see that while most of the coefficients are negative, a few are positive. Only the coefficients for years 1997-2000 are statistically different from zero, however. It is reasonable to conclude, therefore, that there has been no meaningful change in the relative growth rates between urban and rural counties that have above-average broadband availability.

Table 10. Estimates of Equation (1)
(Above-Average Broadband, Urban and Rural)

Year	β_3	Year	β_3
1995	-0.111	2003	-0.017
1996	-0.111	2004	-0.012
1997	-0.134*	2005	-0.048
1998	-0.172**	2006	0.080
1999	-0.134*	2007	-0.114
2000	-0.160**	2008	0.048
2001	-0.104	2009	0.047
2002	0.010	2010	0.004

Stat. Significance: *** 1%, ** 5%, * 10%

The same analysis conducted for rural counties only (as shown in Table 4) does not reveal any meaningful changes, so the results are not reported. The β_3 coefficients are consistently positive (ranging from 0.253 to 0.416) and statistically different from zero at the 1% level for all years.

Caveats

Regression analysis measures average effects. An integral part of every regression equation is the disturbance term (ε), which measures random variations from the average relationship. While my analysis does not reveal any significant departure of the urban-rural in the average growth rate relationship before-and-after the Broadband Age, there are surely rural counties that have declined in the modern age more than others, and urban areas (e.g., Detroit) that have likewise seen decay.

To lay blame on a lack of broadband for the decline in rural America is unsupported by the data…

I do not doubt that some rural areas may be able to point accurately to harms caused by a lack of broadband access—perhaps the loss of particular businesses that moved to broadband-rich areas. Still, my analysis suggests that these events are exceptions rather than the rule. On average, the decline in rural America's population growth appears to be other than, or perhaps more than, a broadband problem. Public policy should incorporate this reality.

I also hope that this analysis is not the last word on this important policy issue. Counties are relatively large areas and the "rural" distinction is not terribly precise.[24] My statistical models are rather simple and the population data includes all ages and sources of population change. This work should be considered a first-cut at a nuanced problem. It does seem clear, at least to me, that the claim that broadband will reverse rural population declines is suspect. U.S. population growth has slowed significantly in recent decades, and rural areas grow slower than urban areas. The declining population in some rural areas may simply reflect the general trend in reduced population growth across the nation.

Finally, my analysis looks at population trends alone. The lack of broadband may influence other outcomes as well (e.g., economic opportunity).[25] Still, I expect that the lack of economic opportunity in rural areas will manifest in population migration, but I leave that question to future research.

More research in this important area is clearly warranted. My analysis should be viewed as an initial attempt to understand the role of broadband in the urban-rural population trends. Future research should present a clear hypothesis and use appropriate methods, to the extent feasible, to analyze the problem. Anecdotal evidence and exceptions provide a poor foundation for the design and implementation of multi-billion-dollar policies aimed at spurring broadband deployment.

Conclusion

While government policy has (largely unsuccessfully) tried for centuries to populate rural America, these rural areas are facing especially challenging times in the modern economy, in part due to advances in agricultural technology, manufacturing declines and retail opportunities. While the tendency is to look for simple explanations for the problems faced in rural America, including the lack of broadband access, the analysis in this PERSPECTIVE suggests the problems in rural America reach well-beyond high-speed Internet access.

Here, I look at the claim that the lack of broadband has led to a declining population in rural areas as people flee to the city for broadband access. If so, then we would expect to see a change in relative population trends during the Broadband Age between urban and rural areas. Yet, no systematic change is observed, at least using national and county-level data. If anything, it appears that the population growth differential has narrowed between urban and rural areas in the Broadband Age. Also, the data reveal that the population growth gap has risen between urban and rural areas that both have healthy broadband availability, indicating there are other factors at play. To lay blame on a lack of broadband for the decline in rural America is unsupported by the data, at least to the extent the data and my analysis are up to the task of answering the question posed.

Based on the analysis in this PERSPECTIVE, a concerted effort to deploy broadband in rural areas may turn out to be a multi-billion-dollar investment in an information superhighway to (nearly) nowhere. That said, it is the immediate delight from high-speed broadband that most credibly captures the politicians' interest, and that joy is a certainty. The billions of dollars borrowed to make that a reality is the future's problem.

NOTES:

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1 *2019 Broadband Deployment Report*, Federal Communications Commission (May 2018), at Figure 4 (available at: https://docs.fcc.gov/public/attachments/FCC-19-44A1.pdf).

2 *Id*. at Figure 3d. Given that some analysts worry the Commission's data systematically overstates availability due to the lack of location-specific data, the rural digital divide may be larger than reported. *See*, *e.g*., A. Izaguirre, *With Billions to Spend, Feds Unsure Who Lacks Broadband*, ASSOCIATED PRESS (April 15, 2019) (available at: https://apnews.com/b6700eaf758e498fa5ebd4d33db50040).

3 On population loss, *see*, *e.g*., J. Cromartie, C. von Reichert, and R. Arthun, *Factors Affecting Former Residents' Returning to Rural Communities*, U.S. Department of Agriculture, Economic Research Report No. 185 (May 2015) (available at: https://www.ers.usda.gov/webdocs/publications/45361/52906_err185.pdf?v=0); J. Cromartie, *Rural Areas Show Overall Population Decline and Shifting Regional Patterns of Population Change*, United States Department of Agriculture (September 05, 2017) (available at: https://www.ers.usda.gov/amber-waves/2017/september/rural-areas-show-overall-population-decline-and-shifting-regional-patterns-of-population-change); K.N. Stauber, *Why Invest in Rural America and How?: A Critical Public Policy Question for the 21st Century*, QII ECONOMIC REVIEW 57-87 (2001) (available at: https://www.kansascityfed.org/PUBLICAT/Exploring/RC01Stau.pdf); S.J. Goetz, M.D. Partridge, and H.M. Stephens, *The Economic Status of Rural America in the President Trump Era and Beyond*, 40 APPLIED ECONOMIC PERSPECTIVES AND POLICY 97–118 (2018) (available at: https://academic.oup.com/aepp/article-abstract/40/1/97/4863702). On broadband's role, *see, e.g*., P. Stenberg, M. Morehart, S. Vogel, J. Cromartie, V. Breneman, and D. Brown, *Broadband Internet's Value for Rural America*, U.S. Department of Agriculture (August 2009) (available at: https://www.ers.usda.gov/webdocs/publications/46200/9334_err78_reportsummary_1_.pdf?v=0); S.S. Ross, *Bad Broadband Equals Low Population Growth*, BROADBAND PROPERTIES MAGAZINE (November/December 2014) (available at: http://www.bbpmag.com/Features/1114feature-BadBroadband.php); L. Gibbons, *Rural Communities Suffer the Most Without Access to the Web*, GOVERNMENT TECHNOLOGY (June 29, 2018) (available at: https://www.govtech.com/network/Rural-Communities-Suffer-the-Most-Without-Access-to-the-Web.html).

4 Data available at: https://www.census.gov/population/censusdata/urpop0090.txt.

5 *Id*.

6 Cromartie, *et al*., *supra* n. 3.

7 The data are available at: https://www.bea.gov/data/by-place-county-metro-local.

8 The data are available at: https://www.ers.usda.gov/data-products/rural-urban-continuum-codes.aspx.

9 *See, e.g., Defining Rural Population*, Health Resources & Services Administration (available at: https://www.hrsa.gov/rural-health/about-us/definition/index.html).

10 Including Virginia has no meaningful effects on the results reported here.

11 There are 3,138 counties in the raw data. Excluding Alaska drops 53 counties, Hawaii drops 4 counties, and Virginia drops 105 counties. Missing population data drops 435 counties. Inconsistent "rural" definition drops 424 counties.

12 Data available at: https://broadbandmap.fcc.gov/#/.

13 On pseudo-treatments, *see, e.g.*, G. Imbens and J.M. Wooldridge, *Recent Developments in the Econometrics of Program Evaluation*, 47 JOURNAL OF ECONOMIC LITERATURE 5-86 (2009).

14 J.B. Horrigan, *Home Broadband Adoption 2006*, PEW INTERNET & AMERICAN LIFE PROJECT (May 28, 2006) (available at: https://www.pewinternet.org/2006/05/28/part-1-broadband-adoption-in-the-united-states).

15 *A Nation Online: Entering the Broadband Age,* NATIONAL TELECOMMUNICATIONS INFORMATION ADMINISTRATION (2004) (available at: https://www.ntia.doc.gov/files/ntia/editor_uploads/NationOnlineBroadband04_files/NationOnlineBroadband04.pdf).

NOTES CONTINUED:

16 *High-Speed Services for Internet Access: Subscribership as of June 30, 2000*, Federal Communications Commission (October 2000) (available at: https://transition.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/IAD/hspd1000.pdf).

17 *See*, *e.g.*, Q. Fottrell, *Meet Amazon's First Customer – This is the Book He Bought*, MARKETWATCH (May 15, 2017) (available at: https://www.marketwatch.com/story/meet-amazons-first-ever-customer-2015-04-22); L. Asher, *The Internet Age Began on August 5, 1995*, LITERARY KICKS (August 7, 2015) (available at: https://www.litkicks.com/AugustNine); A.C. Lewis, *Pam and Tommy: The Untold Story of the World's Most Infamous Sex Tape*, ROLLING STONE (December 22, 2014) (available at: https://www.rollingstone.com/culture/culture-news/pam-and-tommy-the-untold-story-of-the-worlds-most-infamous-sex-tape-194776).

18 R. Hodrick and E.C. Prescott, *Postwar U.S. Business Cycles: An Empirical Investigation*, 29 JOURNAL OF MONEY, CREDIT, AND BANKING 1–16 (1997); M.K. Evans, PRACTICAL BUSINESS FORECASTING (2003), at Ch. 6. The filter is applied to the median growth rate of counties in the sample. The median is less sensitive to outliers. *See*, *e.g.*, Cromartie, *et al.*, *supra* n. 3 at p. 6.

19 *See*, *e.g.*, J.D. Angrist and J. Pischke, MASTERING 'METRICS: THE PATH FROM CAUSE TO EFFECT (2015). Since both urban and rural areas are "treated," there is no "control" group in this analysis.

20 Stata's -xtgee- command is used to estimate the model.

21 *See*, *e.g.*, Ross, *supra* n. 3, for an example of this error. *See also* Imbens and Wooldridge, *supra* n. 13.

22 For a further discussion, *see* G.S. Ford, *Is Faster Better? Quantifying the Relationship Between Broadband Speed and Economic Growth*, 42 TELECOMMUNICATIONS POLICY 766-777 (2018).

23 The estimates are not materially affected by trimming the 5% tails.

24 *Supra* n. 9.

25 *See*, *e.g.*, H. Atasoy, *The Effects of Broadband Internet Expansion on Labor Market Outcomes*, 66 ILR REVIEW 315-345 (2013), reporting small employment gains from broadband deployment.