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How much does broadband infrastructure matter? Decomposing the metro–non-metro adoption gap with the help of the National Broadband Map

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ABSTRACT

Although overall residential broadband adoption rates have increased dramatically over the past decade, the metropolitan–non-metropolitan gap has been consistent at 12–13 percentage points. Policy prescriptions to address this problem have focused on either increasing broadband supply (typically via funding for infrastructure) or demand (such as educational efforts about why broadband is useful) in rural areas. However, the appropriate programmatic mix remains an open question, since little empirical analysis has actually assessed the degree to which a lack of infrastructure is responsible for this 'digital divide.' In this article, information on broadband adoption from 2011 Current Population Survey data are meshed with detailed broadband infrastructure data from the newly available National Broadband Map. A non-linear decomposition technique is used to demonstrate that existing metro–non-metro differences in infrastructure availability comprised approximately 38% of the 2011 broadband adoption gap. This same technique also shows that 52% of the gap is due to differences in characteristics such as education and income, suggesting that future policies and programs addressing this issue should include a heavily-weighted demand component.

1. Introduction

The existence of a rural–urban (or metro–non-metro)[1] divide in Internet access and use has been well documented. From the early days of computer and dial-up Internet use (Malecki, 2003; NTIA, 2000, 2002; Strover, 2001) to the more recent introduction of broadband[2] access (Dickes, Lamie, & Whitacre, 2010; NTIA, 2010; Whitacre & Mills, 2007), non-metropolitan areas have consistently lagged behind their metropolitan counterparts in terms of both access to the relevant technology and adoption of it. Many state and federal-level programs have attempted to address this "digital divide," with concerns that non-participation in the digital revolution can impact economic outcomes and quality of life. This is especially true as information technology continues to become entrenched in many societal tasks, such as applying for jobs, acquiring skills desired by potential employers, or becoming civically engaged.

Household broadband adoption rates have increased dramatically over the past decade, from about 4% in 2000 to nearly 70% by 2011 (Fig. 1). A multitude of digital divides have continued to persist over that time, including those based on race, age, education, income, and geography. The most recent (2013) estimate indicates that rural residents lag behind their urban counterparts by 10 percentage points in terms of residential broadband adoption rates (PEW Internet, 2013).

While the vast majority of federal programs dealing with broadband have focused on the provision of infrastructure, many economists and others involved in the debate have argued that the emphasis should instead be on increasing demand in the areas that are lagging behind. Historically, the primary federal vehicle for dealing with broadband

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[1] Throughout the remainder of this paper, we use the terms rural and non-metro (and urban and metro) interchangeably. Our focus is on metro vs. non-metro areas since the adoption data we use is obtained for that classification (as opposed to community level generally used for rural vs. urban).

[2] The Federal Communication Commission's (FCC) definition of broadband has changed over time. Historically, the definition has been 200 kilobits of data transfer per second (kbps) in at least one direction. The most recent (2010) definition is 4 megabits (mbps) download and 1 mbps upload. This paper incorporates various thresholds, depending on the data used for analysis.

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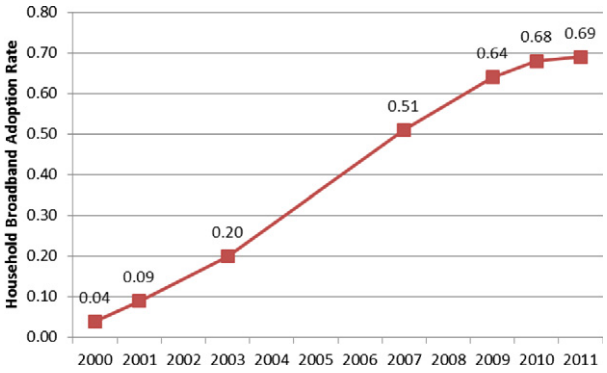

Source: Current Population Surveys, Computer and Internet Use Supplements

Fig. 1. Household broadband adoption rates, 2001–2011.
Source: Current Population Surveys, Computer and Internet Use Supplement.

infrastructure in rural parts of the country has been the Rural Utility Service's broadband loans and Community Connect grants programs (Kruger, 2013).[3] These have each been directly appropriated between $6 M and $30 M annually since 2002. In 2009, the American Reinvestment and Recovery Act (ARRA) included approximately $7.2 B to enhance broadband across the country, and was overwhelmingly focused on delivering infrastructure to places where it was not currently available. Although some funding ($350 M) was dedicated to developing and maintaining comprehensive maps of existing broadband service and capability and another pot ($250 M) was allocated to encourage broadband adoption, these efforts represented less than 7% of the total broadband-related funding in the act. More recently, Phase I of the Federal Communication Commission's (FCC) Connect America Fund – which essentially re-purposed the traditional Universal Service Fund – invested $438 M in an effort to bring broadband infrastructure to over 1.6 million people without it. This investment is expected to increase to nearly $9B over the next several years (Buckley, 2014). Many economists have argued, however, that this focus on supply is misguided, and that efforts would be better spent on the demand component (Atkinson, 2009; Hauge and Prieger, 2010; Whitacre, 2010b; Whitacre & Mills, 2007). This argument is given more credence by recent survey results in which "not available where I live" ranked only 4th on a list of reasons for why households do not adopt broadband (NTIA, 2010). However, until recently, detailed maps on exactly where broadband coverage exists were not publicly available.

The National Broadband Map (NBM) that came out of the ARRA effort represents an unprecedented amount of data that, when combined with other sources of broadband data, can be used to assess the state of rural broadband and provide the basis for policy suggestions. For the first time, comprehensive information is available on *both* of the primary broadband components (availability and adoption). This paper meshes the 2011 NBM availability data with household-level adoption information from that year's Current Population Survey (CPS) to assess infrastructure's role in the metro–non-metro broadband divide.

2. The digital divide and prior work related to broadband availability

The notion of a digital divide goes back at least to the 1990s when studies focused on inequalities related to computer use for home, work, and school (NTIA, 1995). Differences in specific demographic characteristics, including rural vs. urban location, were noted. Research related to these rural – urban disparities quickly moved on to Internet access (Mills & Whitacre, 2003) and then broadband access (LaRose, Gregg, Strover, Straubhaar, & Carpenter, 2007) as those technologies gained in popularity. Strover (2003) analyzed the policies in place to address rural broadband deployment as of the early 2000s, and concluded that "the prospects for near-term broadband services in rural regions are dim." More recently, studies have continued to document lower broadband rates – both for availability and adoption – in rural areas (FCC, 2012).

Several studies have attempted to assess the relationship between broadband adoption and infrastructure availability. Most have focused on whether demand changes with increased competition. The Government Accountability Office (2006) found that the number of providers in an area did not impact demand. Prieger and Hu (2008) suggest that increased provider competition helped close racial gaps in adoption. LaRose et al. (2014) review some of the ARRA-related infrastructure awards and note that these subsidies could help close the digital divide domestically, while making broadband services available to new households. Each of these studies, however, uses a relatively incomplete set of data related to broadband availability, and leaves unanswered the question of how much emphasis should be placed on the supply component as opposed to the demand.

Some efforts have been made to explicitly answer this question, including Whitacre and Mills (2007), who use CPS data to decompose the rural–urban broadband adoption gap in 2000, 2001, and 2003. They pay particular attention to the role of infrastructure, and use bootstrapped decompositions to suggest that rural–urban broadband infrastructure differences were only minor contributors to the adoption gap. Whitacre (2010a) performs a similar analysis using 2006 data and finds that as much as 26% of the metro–non-core broadband gap is due to differences in infrastructure, but his analysis is limited to the state of Oklahoma. However, many elements associated with these studies have changed as broadband has matured across the U.S. Detailed infrastructure data were not available for either of these studies, and both the Whitacre and Mills (2007) and Whitacre (2010a) studies limited their availability analysis to Digital Subscriber Lines (DSL) and cable Internet lines. More recent data suggests that while 90% of residential fixed connections still come from DSL and cable, other forms of infrastructure such as fiber to the premises (FTTP) and Power Line technology are becoming much more prevalent (FCC, 2013a,b). In fact, the percentage of all residential fixed lines comprised by FTTP increased from a mere 0.07% in 2003 to 6.8% in 2011 (FCC, 2004, 2013a). Further, while the DSL and cable Internet data used in these studies were the most complete sources available, not all providers were required to report and so the data did not necessarily capture the availability picture accurately. Finally, and most importantly, both broadband adoption rates and levels of broadband infrastructure have increased dramatically since the Whitacre and Mills (2007) study. Rates of residential broadband adoption more than tripled between 2003 and 2011, and the percentage of the population with broadband infrastructure available to them has seen substantial increases in both rural and urban areas.

3. CPS household data and National Broadband Map data

The Current Population Survey is a monthly survey of roughly 50,000 households conducted by the U.S. Census Bureau. Supplementary surveys dealing with the topic of Internet use (including type of connection) have been included for a single month in 2001, 2003, 2007, 2009, and 2010, and 2011. We focus on the years 2003 and 2011 to answer the questions in this paper, primarily because broadband adoption was still in its infancy in 2001. The downside of these data is that the lowest level of geographic detail is the state of residence and whether the household resides in a non-metropolitan area. No county or community

[3] Kandilov and Renkow (2010) studied whether the RUS loan program had impacts on local employment, payroll, and number of business establishments. They found that the current (as opposed to the pilot) program did not have any impact.