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Is faster better? Quantifying the relationship between broadband speed and economic growth

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A B S T R A C T

In this paper, I aim to quantify the relationship between higher broadband speeds (10 Mbps versus 25 Mbps) and the growth rates in important economic outcomes in U.S. counties including jobs, personal income, and labor earnings. Doing so exposes the potential for severe selection bias in studies of broadband's economic impact, which is addressed in this study using Coarsened Exact Matching. Once balanced, the data reveal no economic payoff from the 15 Mbps speed difference between the years 2013 and 2015 (when data is available). I also revisit an early and widely-cited study on broadband's effect on employment to evaluate the possible impacts of selection bias, and conclude that the positive benefits of broadband reported in that particular study are likely spurious. The selection bias problem may infect other studies on the economic impacts of broadband Internet services. Future research on broadband's economic impact should explicitly address selection bias.

1. Introduction

High-speed Internet connectivity (i.e., broadband) is seen as essential for modern life, whether consuming video and audio entertainment, interacting through social media, obtaining healthcare and education services, and a host of other activities. Many of these uses produce sizable private benefits, but significant social pay offs from broadband access have policy makers, and even private companies, across the globe seeking ways to encourage broadband availability and access (Beard et al., 2017). Any effort to promote broadband access presumes the policy maker knows what broadband is, who has it and who does not, and what sorts of companies and technologies might get subsidized to expand availability and subscriptions. Before a policy to promote broadband can be implemented and administered, broadband must be defined.

In the United States the definitional inquiry turns up in a number of significant places. Section 706(b) of the Telecommunications Act of 1996 requires the Federal Communications Commission ("FCC") to conduct an annual inquiry to determine "whether advanced telecommunications capability is being deployed to all Americans in a reasonable and timely fashion."[1] In reaching its determination, the FCC today defines *wireline* "broadband" using an upstream/downstream standard of 25/3 Mbps (FCC 2015a). In contrast, in determining whether broadband providers are eligible for Connect America Fund ("CAF") subsidies to service high-cost, rural areas, the FCC set a 10/1 Mbps "broadband" standard, presumably to reduce subsidy obligations by introducing lower-speed, lower-cost technologies in the acceptable technology mix (FCC 2014). The lower threshold appears to have improved broadband deployment in rural areas through cheaper though less capable technologies (AT&T, 2017; Ayvazian, 2017). Recently, the Commission considered appending a 10/1 Mbps threshold for mobile broadband in its Section 706 analysis (FCC 2017). The proposal was met with substantial criticism. FCC Commissioner Jessica Rosenworcel lamented on Twitter: "#FCC is proposing to lower US #broadband

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[1] 47 U.S.C. § 1302(b).

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standard from 25 to 10 Mbps. This is crazy. Lowering standards doesn't solve our broadband problems (Brodkin, 2017).” The idea was eventually abandoned, and the Commission has yet to set a speed threshold for what constitutes “mobile broadband service.” Individual U.S. states define “broadband” at myriad “speed” levels, most of which fall below the FCC's 25/3 Mbps standard.[2] Though modern broadband networks frequently obtain download speeds of 100 Mbps or better, there remains significant disagreement about definitional thresholds in the 10-to-25 Mbps range. Also, these categories are two of the few speed classes on which the federal and state governments collect data.

While the definition of “broadband” is typically immaterial to economic outcomes, its role in subsidy determination is impactful. Some broadband advocates fear that a 10/1 Mbps standard for subsidies (or any other use) might leave rural Americans behind economically (FCC 2015a, 2015b; Finley, 2017; McCarthy, 2017; Souza, 2017). In contrast, other commentators discount the spread, noting “[t]he difference between a 10 and a 25 Mbps connection is marginal, affecting how long a large download may take or how many concurrent high-definition streams a household can run (Brake, 2017, p. 8),“ and “most people don't often need speeds of hundreds of megabits. Two HD TV streams and plenty of surfing fit easily into 12 megabits (Burstein, 2017),” and “[t]here aren't any common apps that require 25 Mbps (Singer, 2017).” Empirical evidence on the broad economic impacts of “speed” is scarce and does not address the issue as directly as I do here (Grimes, Ren, & Stephens, 2012; Kenny & Kenny, 2011; Rohman & Bohlin, 2012). Whether there is an “economic payoff” from higher speeds is interesting and policy-relevant, but the question remains largely unanswered.

Is there a payoff from a move from 10 Mbps to 25 Mbps? In this paper, I seek to provide some evidence on that very question. To do so, I link U.S. county-level data on broadband speeds from the National Broadband Map (“NBM”) to data on economic outcomes—including jobs, earnings, and total personal income—from the U.S. Bureau of Economic Analysis (“BEA”). While the data measures advertised speeds, FCC analysis suggests that actual speeds average equal advertised speeds during the period analyzed (FCC 2015b). Using this data, I test whether the growth rates in these important economic outcomes are larger for areas with a higher initial speed levels of broadband services. This analysis offers two important, policy-relevant findings. First, under current conditions, there appeared to be no broad economic payoff from higher-speed connections, at least when that difference is between download speeds of 10 Mbps and 25 Mbps and during the period 2013 through 2015. Second, the empirical analysis reveals severe selection bias, in that counties with higher-speed broadband are wholly unlike those with lower-speed broadband. Broadband services and upgrades *are not* randomly distributed, but rather such activity is systematic, presumably based on supply- and demand-side conditions. Strong caution is warranted: a failure to grant selection bias fair weight could result in misleading inferences about broadband's economic impact. As a demonstration, I revisit the early and frequently cited study by Crandall, Lehr, and Litan (2007) and find biased estimates of broadband's economic impact. While I speculate other studies may suffer from the same bias, I do not and cannot conclude that there is no evidence of an economic payoff from broadband Internet service more generally.

This paper in outlined as follows: In the next section, I present my empirical model. After demonstrating the presence of selection bias, I employ matching algorithms to address the problem. First, Coarsened Exact Matching is used to address the profound covariate imbalance between counties with mostly 25 Mbps service and those with mostly 10 Mbps service, thereby producing an acceptable control group with which to measure the treatment effect. Accounting for the differences between counties, I show there is no effect on economic outcomes from higher broadband speeds, at least for the outcomes evaluated over the sample period. If selection bias is ignored, however, large economic effects are found. The results are confirmed with Propensity Score Matching, which is one of many matching and other empirical approaches to selection bias. In the next section, I provide additional evidence from a pseudo-treatment, where a statistical test is conducted to see if a future treatment affects past outcomes—a sure sign of confounding. For the original, unbalanced data, the pseudo-treatment is statistically significant when it should not be, suggesting biased estimates of the treatment effect when ignoring selection bias. In Section III, I apply to the pseudo-treatment method to the Crandall et al. (2007) study, an early and frequently cited study on the economic effects of broadband service. I find the pseudo-treatment is statistically significant, suggesting the results from that earlier study are unreliable. Conclusions and policy recommendations are at the end.

2. Empirical model

Is there a broad economic *societal* payoff from increasing broadband speeds from 10 Mbps to 25 Mbps, or are the benefits mostly *private* in nature (e.g., faster movie downloads)? Almost all of the Internet's existing activities can be accomplished with 10 Mbps speeds or less, but consumers do prove willing to spend for higher speeds (Liu, Prince, & Wallsten, 2017). The FCC's Broadband Speed Guide indicates that social media, streaming audio, VoIP call, general browsing, email, even high-definition personal video calls can be done with less than 2 Mbps downloads speeds.[3] A 10 Mbps connection can handle most online education courses (Sabo, 2016). Studies show that it is the consumption of video entertainment that benefits most from higher speeds (Layton, 2017), but even so a 10 Mbps connection permits the streaming of multiple high-definition video streams (Gustin, 2014). Downloading a 4 GB high-definition video takes just under a minute to download on a 10 Mbps connection, but only a quarter-minute on a 25 Mbps connection.[4] Such a difference may prove a minor nuisance to users, but whether such savings are sufficiently important to have broader economic implications is unclear.

[2] Alabama, for instance, defines “broadband” as a service of 200 Kbps or greater. Ala. Code §37–2A-2. Colorado defines broadband as a service of 4 Mbps or greater. Colorado Revised Statutes §40-15-102(3.7).

[3] https://www.fcc.gov/reports-research/guides/broadband-speed-guide.

[4] http://www.download-time.com.