The economics of universal service: An analysis of entry subsidies for high speed broadband

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ABSTRACT

Universal service is a policy objective that all individuals or households have access to some service. Subsidy policies to accomplish universal service may arise when private provision is non-universal. In the context of rural high speed wired broadband subsidies, this paper examines novel household-level cable and satellite broadband subscription data from North Carolina to examine household adoption and substitution patterns across broadband types to evaluate how many currently unserved regions warrant an entry subsidy. This paper has three main findings: (i) fewer than 43% of households adopt high speed broadband in areas currently served by a single broadband provider, (ii) there exists evidence of a significant elasticity of substitution between high speed wired broadband and the lower speed options of satellite broadband and DSL, and (iii) a generous upper bound on the number of regions that warrant an entry subsidy is 64%. These results suggest a policy of universal high speed wired broadband service in North Carolina would be unlikely to achieve universal adoption, would connect many households already with internet access and who would not substitute, and in many regions would be prohibitively costly even assuming very generous estimates of the consumer surplus generated. From the perspective of social welfare, to justify connecting the 5% least dense areas of North Carolina would require each adopting household value high speed wired broadband access at more than $1519 per month.

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1. Introduction

Universal service policies arise from an equilibrium in which private firms choose not to serve all consumers. In the context of goods delivered through wired infrastructure to the household, firms choose not to extend their wired network to all geographic areas. In this equilibrium, the two primary theoretical justifications for government provided subsidies are the existence of (positive) network externalities, or that private infrastructure costs lie in a region where they exceed variable profits but not variable profits plus consumer surplus (Goolsbee, 2002). In the case of the former, the prescribed policy is a per unit subsidy up to the marginal positive externality created by an additional user, and in the case of the latter, an entry subsidy up to the amount of consumer surplus not extracted by the private provider. This paper is entirely focused on an evaluation of the latter case of entry subsidies.

In 2011, the Federal Communications Commission established the Connect America Fund, an entry subsidy scheme to support the development of rural high speed broadband with an annual budget of $4.5 billion. To evaluate such entry subsidy schemes in the simplest setting requires estimates of consumer surplus and the cost of expanding the existing infrastructure.[2] While universal access is a prerequisite for universal service, universal adoption is also required to meet the intended objective. This paper documents significant variance in adoption across regions, the different choices of download speeds across households conditional on adoption, and relates these decisions to the cost and quality of alternative technologies available to them. To do so, I exploit novel data regarding household-level adoption decisions collected from the fourth largest cable provider in the United States as well as data provided to me by the largest satellite broadband provider in the United States. To my knowledge, this is the first paper to

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[2] More complicated settings would involve predicting the arrival of new and superior technologies, how to allocate those subsidies across firms, circumstances under which subsidies would cease, etc.

document household-level adoption of satellite broadband and its determinants; this form of broadband delivery has often been ignored in previous empirical research and in public policy discussions despite serving well over one million U.S. households.

I present three sets of results: (i) the facts of household-level adoption in regions that exhibit the market structure that would prevail in currently unserved regions after subsidized entry of a wired broadband provider, (ii) evidence of low willingness to pay for high speed broadband among an economically significant number of households that currently accept slower broadband (DSL and satellite), and (iii) estimates of an upper bound on the number of regions qualifying for a welfare improving entry subsidy. The main implication of these findings is that a blanket rollout of wired broadband funded by untargeted entry subsidies will lead to significant variance in adoption across regions and therefore variance in the universal service objective being met. In particular, if the universal service objective is to maximize the number of newly adopting households, then these findings suggest a need to better understand the determinants of household broadband adoption among competing alternative technologies such as satellite broadband and DSL and to target subsidies appropriately.

In my empirical setting of North Carolina, I am able to characterize broadband adoption decisions (not including DSL, wireless, other) for many regions at the household level. The regions currently served by a single high speed wired broadband provider are most of interest because they have the market structure that would prevail in currently unserved regions if subsidized entry of a wired broadband provider were to take place. The high speed wired broadband provider of interest is Charter Communications, as of 2015 the fourth largest cable provider in the United States. In North Carolina's regions where Charter is a monopolist of high speed wired broadband, fewer than 43% of households adopt. The remaining households choose either satellite broadband (≈2.5%), DSL, wireless, or no access at all.

At the time of writing, Charter Communications does not vary its broadband prices across regions in North Carolina nor do most of its rivals. In the absence of price variation, it is difficult to identify the curvature of demand to estimate consumer surplus or the elasticity of substitution towards slower speed technologies. Instead, I identify one measure of effective price variation at the household level (whether the dwelling is a manufactured/modular home) and one measure of the quality of a slower form of broadband access (distance to the nearest DSL distribution facility). Manufactured/modular homes are frequently built without pre-wiring for cable or telephone lines: households dwelling in such homes face an additional one-time cost of adopting wired internet access in the range of a few hundred dollars. I find that households dwelling in manufactured/modular homes, conditional on the value of the home, are 9% less likely to adopt wired broadband despite the amortized monthly cost of connection being quite low. This result cannot be explained by these households having lower disposable income to spend on internet access because such households are 20–67% *more* likely to adopt satellite broadband compared to households in non-manufactured homes, even in regions where there is no wired broadband provider. Secondly, households located within 5 km of a DSL distribution facility (the effective radius of the range of DSL broadband) are 17–49% less likely to adopt cable and at least 67% less likely to adopt satellite broadband.[3] Further, households within this radius are less likely to adopt either cable or satellite broadband the closer they are located to the DSL distribution facility. This evidence indicates that a non-negligible number of households are willing to substitute be-

tween cable broadband and DSL and therefore suggests these internet providers compete in the same market. While it is natural to expect satellite adoption to decline with proximity to a DSL distribution facility since such facilities are usually located in cities (where demand for satellite technology is lower), it is difficult to provide an alternative hypothesis for why cable adoption also declines in proximity to DSL facilities.

While Nevo et al. (2016) studies the intensive margin of high speed broadband usage, I examine the extensive margin of adoption since evaluating entry subsidies requires estimates of how many households will actually adopt high speed broadband to begin with. Nevo et al. (2016) provide a number of estimates of consumer surplus conditional on adoption of fiber-to-the-home broadband that delivers download speeds of 1GB/s and at various prices. Using the most generous of these monthly consumer surplus estimates, $279 for 1GB/s at a price of zero, I find that at most 64% of unserved census block regions in North Carolina warrant an entry subsidy to provide broadband quality comparable to urban areas. The estimate of 64% is a firm upper bound: the consumer surplus figure used is based on a much higher quality of broadband and a much lower price than what currently exists in most urban areas. The fraction of census block regions qualifying for an entry subsidy would have to be adjusted downward by a more accurate estimate of the prevailing consumer surplus in urban areas.

2. Existing literature

Broadly speaking, this paper contributes to the vast literature on public goods and the associated private under provision of such goods. For standard public goods such as roads and bridges, the government often contracts out to the private sector and compensates them fully for provision of the good. Here, the concept is similar except the entry subsidy only partially contributes to the revenue of the broadband provider: upon completion of the project, the provider will receive ongoing private revenues from subscribing households.

This paper more directly contributes to the empirical literature examining the economics of universal service and related subsidies. This literature evaluates whether universal service policies are warranted (eg. Downes and Greenstein, 2007), how to define service in terms of its quality or available price (eg. Downes and Greenstein, 2002), and whether universal service policies implemented were effective in causing universal access and adoption and how to adapt such policies in response to new entrants and technologies (eg. Rosston and Wimmer, 2000). In the context of broadband entry subsidies, I find that entry subsidies are not warranted for at least one third of the unserved regions of North Carolina, that a meaningful number of households substitute between broadband and slower technologies such as DSL and satellite broadband, and that while universal access is feasible, it is unlikely to lead to universal adoption.

This paper also contributes to the literature examining the broadband market itself. Work in this area seeks to identify the determinants of broadband adoption (eg. Goldfarb and Prince, 2008; Forman et al., 2005a; 2005b; Rosston et al., 2010), and the effect of broadband market structure on quality and price of service which has implications for market definition (eg. Molnar and Savage, 2015). Relatedly, it documents and seeks to explain heterogeneity in willingness to pay for speed (eg. Varian, 2002; Savage and Waldman, 2008). In the context of the broadband market itself, I confirm the existence of substantial heterogeneity across households in terms of their willingness to adopt different broadband technologies and also in terms of their willingness to pay for faster speeds. Relatedly, I find that wired broadband, DSL, and satellite broadband are viable substitutes for many consumers.

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[3] See Prieger and Hu (2008) for an extensive empirical analysis featuring the effective range of DSL.