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Learning to surf: Spillovers in the adoption of the Internet

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ABSTRACT

This paper develops an identification strategy to generate unbiased estimates of Internet usage spillovers using a unique data set of US households. This strategy addresses the effects of variables that affect consumers' decisions but are unobservable to the researcher that lead to biased estimates. The estimator developed here examines changes in household behavior over time and uses county level instrumental variables for county level spillover measures.
Multiple potential sources of learning are identified including those from the household's locality, from educational Internet subsidies, and from universities. There is general support for all sources, but the locality and subsidy results are both more robust and larger. These findings directly address the policy relevance of these spillover sources and they have implications for policies to encourage Internet use as well as for identification strategies for the effects of the Internet on behavior.

1. Introduction

This paper explores spillover mechanisms at work in household decisions to use the Internet. The adoption of a new and complex technology by one agent often depends on what the user has learned from contact with those who have already adopted the technology. Three potential sources of learning are identified and tested. Measures are constructed that are associated with learning from local community Internet users, from K-12 educational Internet subsidies, and from the nearby university communities. The locality and K-12 subsidy spillovers appear to be larger than estimates for university spillovers. In a possible falsification test, similar results do not emerge for other newer communication technologies where learning is not likely to be as important — cable television and mobile telephones. Finally, these spillover measures are related to whether households indicate that the reason why they use the Internet was for education, work or games.

Identifying spillovers is complicated by similarly situated individuals experiencing similar and unobserved "shocks" to their adoption decisions. Measuring spillovers requires a methodology that identifies spillovers from unobserved common "shocks." A unique household level data set is used that allows the implementation of two identification strategies. First, changes in household Internet usage are measured at two points in time that implicitly control for unobserved time-invariant household characteristics. Second, instrumental variables are constructed from demographic variables at the level of the spillover measure. By construction, the instrumented endogenous variable is mostly uncorrelated with unobserved household-level time-varying shocks.

The Internet in particular is thought to be an important source for more efficient markets, more efficient production, and more efficient consumer decisions. Some growth and development literature identifies a central role of technology diffusion [11,20]. Moreover, spillovers are related to network externalities which have been of interest in industrial organization [3].

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Network externalities could have large impacts on the dynamics of many industries where they are thought to be present. Users' adoption decisions must take into account the future size of the network so as to avoid unpopular networks. Firms may inefficiently invest in proprietary networks from which they can earn rents. There is a growing literature of evidence of network externalities affecting many different industries. Some examples of the effects of network externalities are found in: numerically controlled machines [15], spreadsheets [6], automated teller machines [18], prescription antiulcer drugs [2], electronic bank payments [10] and automatic clearinghouse functions [1].

Independent of externalities, there is growing interest in determining the effects of Internet use, or the use of specific Internet applications, on users' behaviors [4,14]. However, without a robust identification strategy, many studies finding an association between Internet usage and a behavior may suffer from possible reverse causation or selection bias [4,16]. Finding external influences, such as spillovers, provides possible instrumental variables for Internet adoption levels. Future studies could use similar measures to potentially identify variation in Internet usage related to the size of these spillovers that is not a result of the behavior under study. In this way, the causality from Internet usage to the behavior is more firmly established.

Spillovers occur when the decisions of one agent are affected by the independent decisions of those around her. This could occur because a more reticent adopter benefits from the information gleaned by more adventurous early adopters or because a market for related goods and services spurred by the early adopter is available to the later adopter. Network externalities are typically distinguished from spillovers by possible reciprocation in the latter (for example, “Show me how to do this on the Internet and I will increase your allowance”). This distinction is important for policy implications, however, since possible reciprocation is not observed here, we will continue to refer to spillovers and only argue for the network externality interpretation in certain cases.

The analysis below identifies potential educational spillovers emanating from the E-Rate educational Internet subsidy program and from universities. Prior research has identified the effects of the targeted E-Rate policies on classroom Internet access. Puma et al. [17] and Goolsbee and Guryan [8] find that the E-Rate subsidies to schools increased the number of Internet enabled classrooms. However, Goolsbee and Guryan [8] and Ward [19] find modest, if any, evidence of student achievements related to the E-Rate. Below, the E-Rate funding is found to affect Internet use for households with school-aged children. Hoffman and Novak [12] discuss the role of higher education with Internet adoption. Similarly, Goldfarb [7] finds that attending university has had a significant effect on Internet use later in life. The analysis below allows for the possibility of proximity spillovers from universities to households in the county.

Various policy implications might follow from this study's findings. Positive network externalities may indicate that the adoption rate is less than socially optimal and might justify public subsidies. The E-Rate is just one subsidy program that is shown to have a positive effect on the targeted audience. Likewise, one aspect of universities shown here is increased Internet usage by households exposed to the universities. This, along with other potential positive university related externalities, may justify the current public support for advanced communication technology in higher education. However, it is not clear whether these programs represent greater or less than the optimal “Pigovian” subsidy.

2. Modeling Internet spillovers

Consumers adopt a new technology, such as Internet use, when the expected future benefits exceed the expected future costs. These benefits and costs will differ across consumers because of differences in their preferences for products and services facilitated by Internet use and differences in their settings that can affect usage costs. Moreover, because the possible applications of the Internet are vast and growing, potential adopters' information sets over which these expectations can be quite heterogeneous. Many users and potential users continually expend resources to acquire new information affecting adoption decisions. The information from their resource expenditures, and the consequent adoption decisions, are endogenous to their acquisition effort. At the same time, consumers can receive information relevant for adoption decisions from a variety of sources independent of their own information gathering efforts. To the extents that these information spillovers can vary exogenously across consumers in identifiable ways, it may be possible to measure their importance in decision making. The crux of the measurement problem is measuring the effects of exogenous information spillovers that may be statistically related to consumers' own information gathering efforts.

The probability that a household will use the Internet is modeled as a function of various spillover measures and household characteristics. Spillovers are conjectured to emanate from three potential sources: local Internet usage, E-Rate funding, and university exposure. Locality based learning is measured by the effect of the share of Internet users in the household's county on usage decisions. This is constructed by simply calculating the share of households in a county and quarter that say they use the Internet. E-Rate based learning is measured by recent funding for Internet access in classrooms in the county and, especially, E-Rate funding interacted with the presence of school-aged children in the household. This is constructed by calculating the per capita level of E-Rate funding in all school districts in the county and constructing an indicator variable for children aged 6–18 in the household. University based learning is measured by the share of the county population enrolled at a university. This is constructed as the ratio of college enrollments in four year schools in the county to the county's total population.

In addition to these variables, many different household demographic variables can be used as controls. These characteristics include the usual demographics, including age, income, education, socio-economic status, household size, children, race, and occupation. It is likely that Internet use is more valuable for larger households, younger households, those with more education and those that are wealthier.