Determinants of Internet Use for Rural and Farm Economic Sectors

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Over the last decade the Internet has increasingly become the driving force in e-business evolution. U.S. Internet access and use has increased for all regions, income groups, and most types of work places. Access and use, as would be expected given the heterogeneous nature of regions, is not unvarying across the economic-geographic spectrum.

In this study we examine Internet access and use as it pertains to farm and nonfarm rural businesses. Our study addresses the underlying causal factors for spatial variance of Internet use by examining market demand for information technologies, i.e. the Internet. We explicitly test the determinants of Internet use in the farm and nonfarm sectors using logistic regression.

Internet Use in the Private Sector

The National Telecommunications and Information Administration and Economic and Statistics Administration (NTIA and ESA) and PEW (PEW Internet & American Life Project) studies have described differences across many demographic and geographic groupings. The studies have described the increasing universality of workplace Internet use.

[1] The views expressed are those of the authors and do not necessarily reflect the views of the Economic Research Service or the U.S. Department of Agriculture.

It may be posited that farm and rural businesses may accrue more benefits from Internet use than urban businesses. The Internet compensates for their distance from major markets. Internet use increases market choices, information sources, and continuing education opportunities. These benefits, however, will not necessarily readily translate into higher demand. Demand depends on many factors such as gross income, educational attainment and age of the managers.

Little systematic research in the small business environment has been completed on the causal demand factors for Internet use. Much of the literature, as Forman (2005) has pointed out, lies in large corporate organizations. Bresnahan and Brynjolfsson (2002), for example, emphasized how prior information technology investments and new organizational structures affect new investments in information technology. Our study examines the determinants of Internet access for farm and rural businesses.

Definitions and Data

Metropolitan and nonmetropolitan areas are defined by the Office of Management and Budget (OMB). The 1993 OMB definition is used here. Metropolitan areas are counties with one or more urbanized areas or adjacent counties that are economically tied to the core counties as measured by work commuting. An urbanized area, as defined by the Bureau of the Census is any county where there is an urban nucleus of 50,000 or more people. Adjacent counties would be included if 25 percent of workers living in the county commute to the central counties or if 25 percent of the employment in the county come from the central counties.

The data analyzed in this report come from two sources. The nonfarm data comes from the Current Population Survey (CPS) conducted by Bureau of the Census (Department of Commerce). The latest data were released in November 2004. Approximately 18,000 farm operators were asked questions about Internet use as part of the annual Agriculture Resource Management Survey (ARMS). The data here are from the 2004 ARMS.

The type of technology used in connecting to the Internet, or Internet connection efficiency, is not directly addressed in this study. Access to the Internet may be dial-up or high-speed, access may be hard-wired or wireless systems. The scope of the study is limited to what socio-economic factors may be deterministic (in the decision to use the Internet). Efficiency will only be inferred by measures of geographic location introduced into the equations.

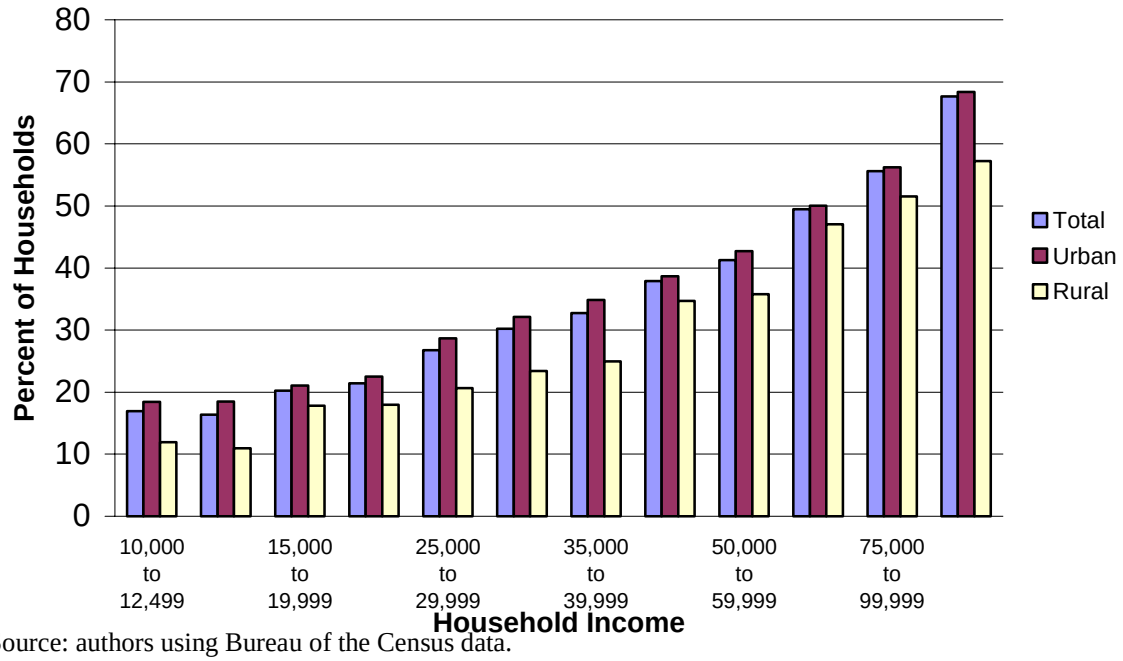
Internet Use Determinants

In the literature a number of factors have repeatedly been identified and postulated as determinates of Internet use, most common postulated socioeconomic determinants are income, education, and age. Earlier gender, ethnicity, and other factors had also been postulated as important factors. Observed differences in these, however, have largely been, it is argued more recently, the result of variances in income and education levels and other socioeconomic factors (Greenstein and Prince; Malecki; Stenberg).

As salaried income increases, the likelihood of workplace Internet use increases (figure 1). The higher the income the more likely work is more highly skilled. The more

highly skilled work the more likely the Internet is in the work environment no matter the location of the work activity. Rural and urban work places, however, are not identical. The Census survey data shows a consistent, though not great, difference within income groups between rural and urban. This may indicate a variance in types of work within income groups across regions.

Figure 1: Availability of Internet at Work by Household Income and Metropolitan Status, 2003

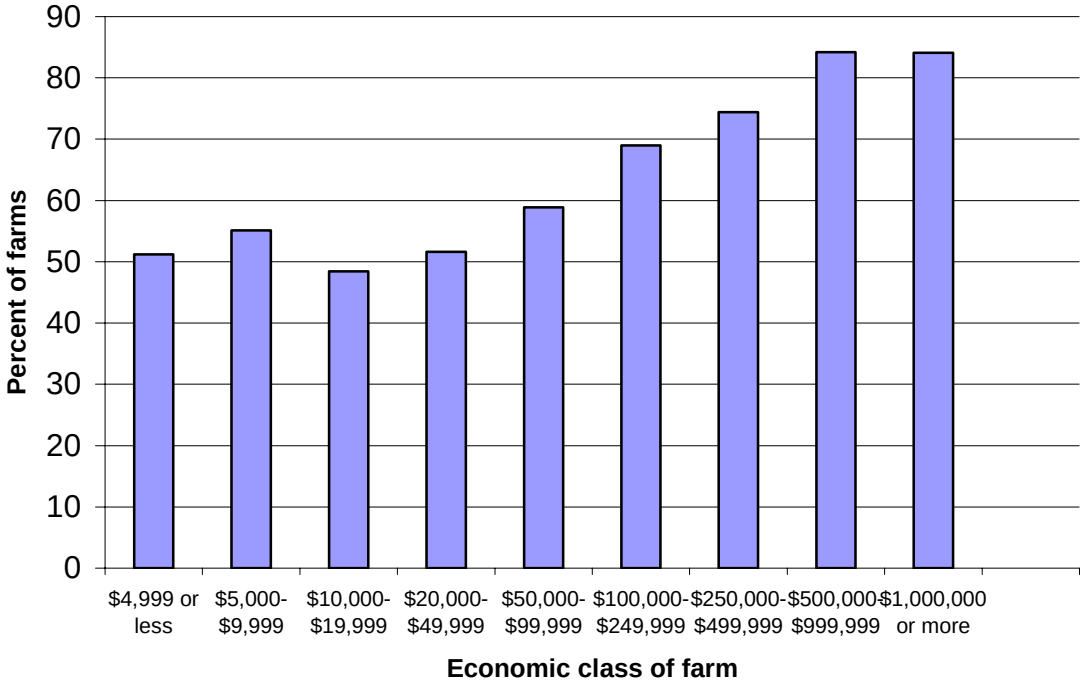


Source: authors using Bureau of the Census data.

Farm income is not measured the same as nonfarm workers' salaried incomes. Here we use a measure of gross farm income, economic class based on sales. The same relationship between income and Internet use, however, appears again. The likelihood of farm Internet use increases as the economic class of the farm increases (Figure 2). Large

operations are both more likely to use the Internet to make farm purchases as well as make purchases for household consumption than small farm operations.

Figure 2: Farm Internet Access, 2004



Source: authors using ARMS.

Education attainment is a determinant in income level (Becker). Hence one would have an a priori expectation that educational attainment will interact positively with Internet adoption. In addition the prevalence of Internet and computer technologies in educational institutions provides additional exposure and experience in Internet use as years of formal education increase. In table 1 the higher the educational attainment the more likely one is to use the Internet. The relationship holds within the metropolitan and nonmetropolitan regions. The difference within education attainment levels between

metropolitan and nonmetropolitan regions may be explained by the lower incomes in nonmetropolitan areas vis-à-vis metropolitan areas.

Table 1: Internet use by educational attainment and metropolitan status, 2003

	Total (percent)	Metropolitan (percent)	Nonmetropolitan (percent)
Less than a high school diploma	38.5	40.0	32.8
High school graduates, no college	49.3	50.9	43.7
Some college or associate degree	68.1	69.2	63.1
Bachelor's degree or higher	80.9	81.6	75.8
Total	59.6	61.6	50.7

Source: authors based on Current Population Survey, Bureau of the Census

The higher the farm operator's level of educational attainment the greater the likelihood of Internet use (table 2). The higher their educational attainment, the more likely a farm operator will use the Internet to make household purchases with a significant difference in behavior between college grads and non college grads. A more mixed picture appears for purchasing farm inputs over the Internet with lower incidence of using the Internet for farm inputs as compared to household purchase Internet activity. One causal factor may be household item/farm input price differentials. Farm operators who have obtained a college degree are more likely than those without a college degree in using the Internet to make purchases for the farm business. The difference in Internet proclivity between college grads and non college grads, however, was less for farm input purchases than household purchases.

Table 2.—USDA Agricultural Resource Management Survey estimates, by education, 2004

Item	Operator education					48-State total
	Some high school or less	Completed high school	Some college	Completed college (BA, BS)	Graduate school	
Number of farms	236,577	800,933	499,929	343,736	141,363	2,022,538
Percent of farms	11.7	39.6	24.7	17.0	7.0	100.0
Percent with Internet access	24.5	46.4	66.8	76.6	79.7	56.4
Used for farm purchases	14.1	18.7	18.0	24.0	20.7	19.7
Used for household purchases	22.6	21.1	25.7	39.8	41.4	28.9

Source: 2004 USDA Agricultural Resource Management Survey.

Oden and Strover; PEW; Grant and Meadows; NTIA[2000]; and many others have cited age as a factor in determining the likelihood of Internet use. The literature suggests that older individuals are reticent about adopting the Internet while the young readily adopt. As can be seen in table 3 age may be factor but it does not follow the same linear rules as education or income. In the table, a bell-shaped curve can be observed. This pattern may be due to the fact that younger workers may less likely have jobs that require the use of the Internet, while workers at the other end of the age spectrum may indeed be more reticent or perhaps feel less need to adopt the Internet into their work environment. The observed behavior holds for both metropolitan and nonmetropolitan workers with lower Internet use across all age groups for rural workers vis-à-vis urban workers.

Table 3: Internet use by age and metropolitan status, 2003

Age	Total (percent)	Metropolitan (percent)	Nonmetropolitan (percent)
19 to 25	58.3	60.2	48.1
26 to 35	62.0	63.0	56.3
36 to 45	67.9	69.6	59.7
46 to 55	67.1	69.0	58.9
56 to 65	57.3	59.6	48.6
over 65	33.4	35.8	25.6
Total	60.5	62.3	51.9

Source: authors based on Current Population Survey, Bureau of the Census

Farm operators exhibit the same behavior as nonfarm workers (table 4), the same bell-shaped curve for Internet access can be observed. The youngest and oldest farm operators were the least likely to use the Internet, but over 70 percent of farm operators between the ages of 35 and 54 had Internet access.

Table 4 .—USDA Agricultural Resource Management Survey estimates, by operator age, 2004

Item	Operator age					48-State total
	Less than 35 years	35 to 44	45 to 54	55 to 64 years	65 years or older	
Number of farms	81,112	286,713	531,834	553,202	569,676	2,022,538
Percent of farms	4.0	14.2	26.3	27.4	28.2	100.0
Percent with Internet access	60.5	71.9	70.2	57.4	34.0	56.4
Used for farm purchases	16.8	21.1	18.4	20.8	19.5	19.7
Used for household purchases	36.7	29.5	30.3	28.3	24.3	28.9

Source: 2004 USDA Agricultural Resource Management Survey.

Observed Internet purchase behavior, however, does not exhibit a bell-shaped curve. Irrespective of what age group a farm operator belongs to, once they are on the Internet an operator of one age group is nearly as likely to make farm purchases over the Internet as an operator of another age group. With respect to making household purchases, however, young operators are more likely to make household purchases over the Internet than older operators. It has been hypothesized that young Internet users are less risk averse with respect Internet security than older Internet users (PEW).

Modeling the Determinants of Internet Use

What determines Internet use by farm operators and rural workers? We hypothesize that income, educational attainment, age, metropolitan-nonmetropolitan

place of residence, and some other factors are determinants in Internet use. Our null hypothesis is that Internet use is a random event with no determinants.

As is often the case when the dependent variable is categorical, we employ the logit model to examine factors that influence Internet use by farm operators and rural workers. The logistic specification is well suited to this type of application and has been used in similar studies. See for example Gloy and Akridge.

It should be noted that estimates of goodness-of-fit are given in model estimations here. R-squared estimates are traditionally given for logistic regressions, but they are not the same as in noncategorical dependent variable regression models, such as in OLS. A number of different methods have been used to proxy the R-square of noncategorical regression models. Nevertheless R-squared estimates used in logistic regressions are highly controversial, with no broad acceptance of any one estimation methodology over another, and, as many statisticians argue, may be misleading and should only very carefully be used to compare models.

Nonfarm Rural Worker

The independent variables of our nonfarm rural worker model are income, age, educational attainment, and metropolitan-nonmetropolitan place of residence. The independent variables are also categorical. The inclusion of place of residence formally tests the hypothesis that where one lives makes a difference in the observed likelihood of Internet use.

The full model (with all independent variables included) predicts correctly the likelihood of Internet use 69 percent of the time. The model has an adjusted R-square

value of 0.224. The Wald test indicated no reason to a priori exclude any of the variables. They all have some predictive power in the observed likelihood of Internet use.

As mentioned in the literature, such as articles by Becker, education and age are highly deterministic for income. As a consequence we also test a simple model with only income as the independent variable for the observed likelihood of Internet use. The simple model predicts correctly the likelihood of Internet use 73 percent of the time. The adjusted R-square value is 0.281. The results are nearly identical for the full and simple models. Exclusion of nonmetropolitan-metropolitan place of residence has no affect on the predictability of either model. We can reject the null hypothesis that Internet use is a random event.

Farm Businesses

Most farm operators have Internet access. Only a minority of farm operators, however, make farm and household purchases on-line. We separated farm operators into three groups based on their Internet activity: those without Internet access, Internet users that did not conduct e-commerce and those with Internet access that made sales or purchases. We fitted a multinomial logistic regression model with the independent variables:

- Government payments for farm operations
- Spouse works off-farm
- Number of persons in the household
- Combined years of education of farm operator and spouse

- Gross farm income
- Age of farm operator, and
- Miles from farm for shopping.

Under USDA's e-commerce initiative, transactions for participating farms can be conducted more quickly and efficiently on-line. We hypothesize that this may encourage adoption by those who receive government payments.

A spouse who works off the farm may be indicative of financial stress and less financial wherewithal to invest in farm specified Internet usage. On the other hand, off-farm employment may provide more exposure to Internet technologies and spur home or farm adoption.

The number of persons in the household greater than two would be indicative of children or young adults in the farm operations. It is commonly hypothesized that the presence of children or young adults increases the rate of Internet usage among their elders in any household.

The combined farm operator and spouse years of education variable are one of the many proxies for educational attainment. The combined factor allows both operator and spouse, who are frequently involved in day-to-day farm operations, to be taken into account. It is hypothesized that the higher the educational attainment the greater the likelihood of farm Internet use. It is hypothesized that the greater the gross farm income the larger the business increasing the likelihood the Internet is used in the farm operation.

Miles from farm for shopping reflects how close the farm is to the core of the telephone infrastructure and the ease of obtaining Internet service. It is hypothesized that the further away from shopping, the more difficult it is to obtain Internet service and the

less the likelihood of Internet use. It is also hypothesized that the further away, but the farm still uses the Internet, the more likely the farm will make purchases over the Internet.

The McFadden's R-square for the model is 0.1045. The gross farm income, age of operator, and the combined years of education of the operator and spouse were found to be significant and the signs supported the hypotheses (table 5). The results of miles to shopping variable do not support the hypothesis that distance is an inhibiting factor in Internet use.

Table 5: Farm model results, 2004

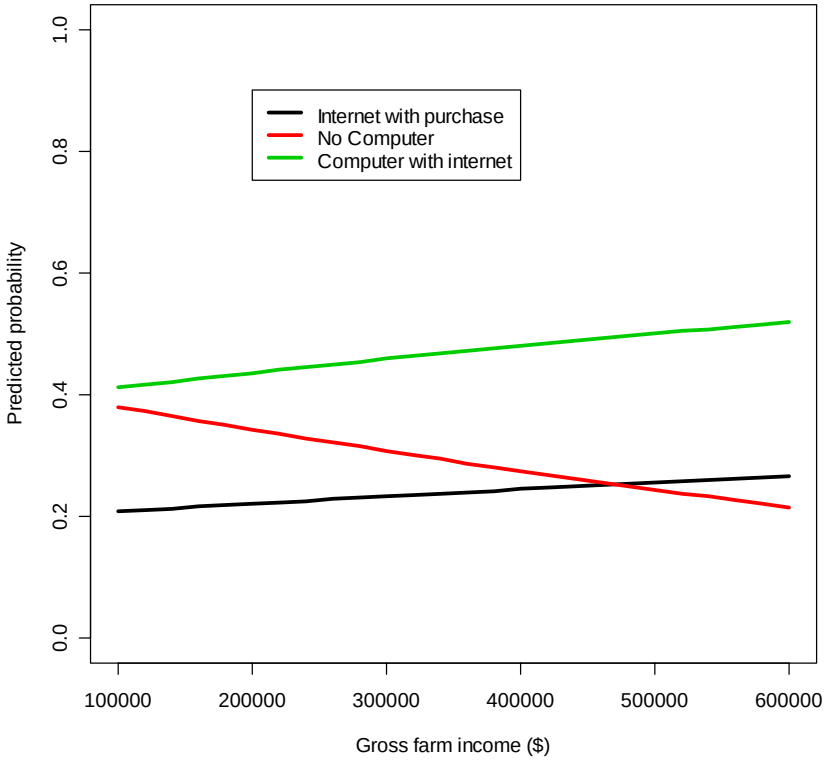
Variable	Estimate	Std. Error	T value	Marg. Effects
(Intercept):1	4.2946	1.0673	4.0237	0.4638
(Intercept):2	2.4473	1.3665	1.7909	0.0495
Government Payments:1	-0.1437	1.3998	-0.1027	-0.0359
Government Payments:2	0.0909	0.9554	0.0951	0.0376
Spouse works off-farm:1	-0.3029	1.9054	-0.1590	-0.0707
Spouse works off-farm:2	0.1492	0.8205	0.1818	0.0697
Household size: 1	-0.0393	0.3277	-0.1199	0.0000
Household size: 2	-0.0585	0.3108	-0.1883	-0.0087
Combined education: 1	-0.1895	0.0254	-7.4731	-0.0249
Combined education: 2	-0.0703	0.0410	-1.7148	0.0064
Gross farm income: 1	0.0000	0.0000	-1.6884	0.0000
Gross farm income: 2	0.0000	0.0000	-0.1669	0.0000
Age of operator: 1	0.0340	0.0105	3.2298	0.0056
Age of operator: 2	0.0032	0.0134	0.2417	-0.0033
Miles to shopping: 1	-0.0138	0.0810	-0.1701	-0.0018
Miles to shopping: 2	-0.0050	0.1313	-0.0378	0.0005

Source: authors using ARMS.

Predicted probabilities are the most conclusive and clearest results that may be obtained from the multinomial logistic regression and here we get some of our most substantive and interesting results. They show clearly the interaction of one variable, constricted within the logistics model, on farm information technology behavior.

As gross farm income increases the likelihood of farm operator Internet use (figure 3)[2]. As farm income increases the likelihood of not having a personal computer or Internet access steadily decreases. Also as gross farm income increases so does the likelihood of using the Internet for farm and household purchases. The increases are uniform over the entire range reflecting the log transformation of the income data. Across all income levels a majority of farm operators use the Internet.

Figure 3: Predicted Probability by Gross Farm Income, 2004

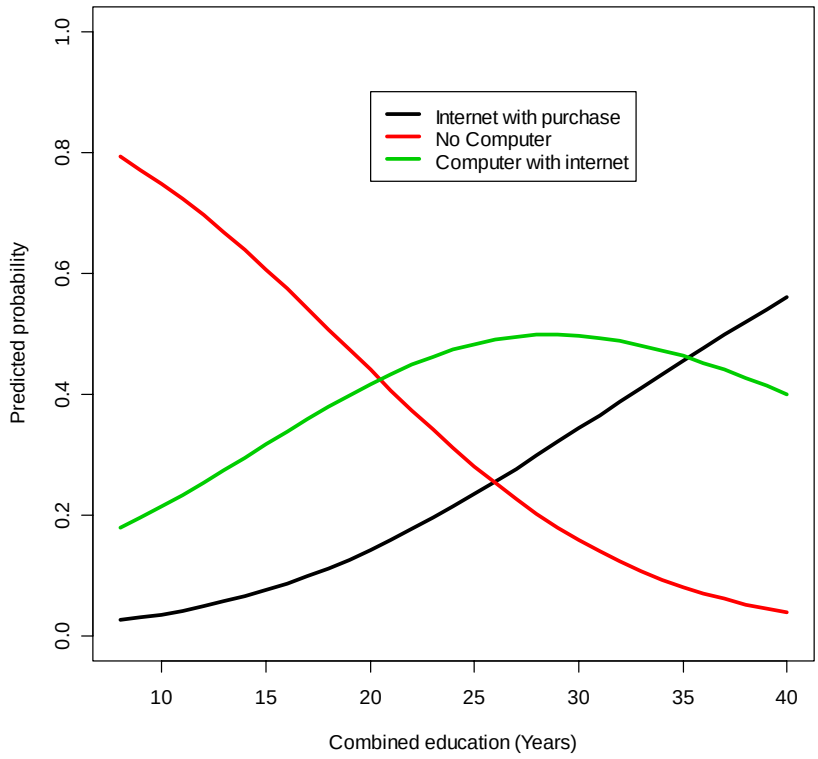


Source: authors using ARMS.

[2] Note: graphs sum vertically to 1 over entire range.

Level of educational attainment has a more complex relationship than has gross income with information technologies (figure 4). As educational attainment increases the likelihood that the farm operation does not have a personal computer decreases sharply. Type of Internet use, however, is more dynamic. As educational attainment increases the probability of having a personal computer with Internet access increases whether the Internet is used in making farm and household purchases or not. Initially the probability of having Internet access while making no on-line purchases increases in unison with making on-line purchases. After a certain point of educational attainment, however, the probability of making no on-line purchases begins to decline while the probability of making on-line purchases sharply increases. The likelihood of making on-line purchases increases exponentially with increasing level of educational attainment and exceeds not making on-line purchases for those with a post-graduate level of educational attainment. Education significantly determines on-line behavior.

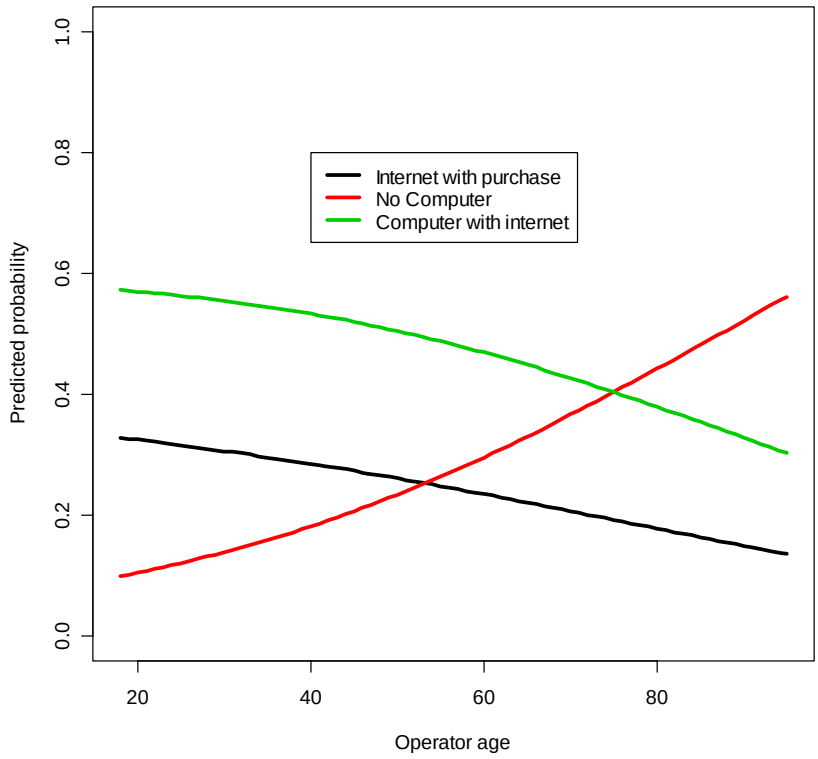
Figure 4: Predicted Probability by Educational Attainment, 2004



Source: authors using ARMS.

The probability diagram for age of farm operator shows a more uniform relationship than what appeared in the simple descriptive statistics (figure 5). The older the farm operator is, the greater the likelihood they will not use a personal computer on the farm. The decline in likelihood of Internet use is gradual but increases more rapidly with age. Only by the age of 80, however, would a majority of farm operators be expected not to have a computer or Internet access.

Figure 5: Predicted Probability by Age of Farm Operator, 2004



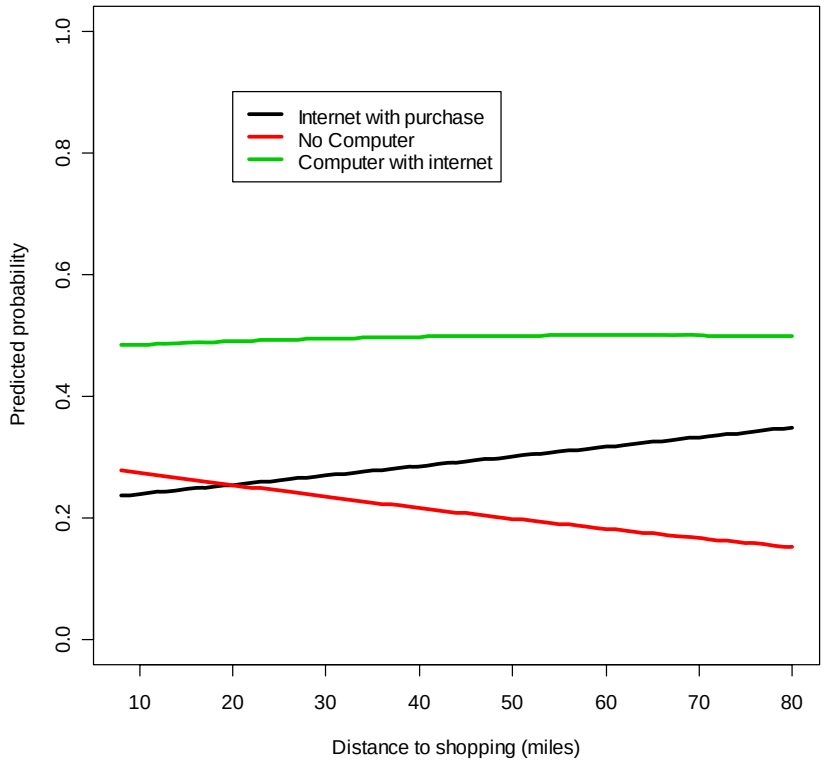
Source: authors using ARMS.

For any given age a farm operator with the Internet is more likely not to make on-line purchases than will make on-line purchases. Interestingly, as age increases, the decline in probability is less for making purchases on-line than for not making purchases. On-line purchase behavior is determined less by age than is getting Internet access in the first place.

Access to shopping is a proxy for how far out of town the farm is situated and where the core of telecommunication services would be located. Distance to shopping appears to have no effect on the likelihood of Internet access. Farms far out of town were more likely to have Internet access than farms close to town. For policy makers this

means Internet access is not the issue, though quality of access may still be an important issue. Distance to shopping does affect the probability of on-line purchase activity, the greater the distance to shopping the greater the likelihood of making on-line purchases.

Figure 6: Predicted Probability by Distance to Shopping, 2004



Source: authors using ARMS.

Conclusion and Policy Implications

In 2003 42 percent of all employees in the U.S. had accessed and used the Internet through work over the previous year. Rural workers, however, were less likely than urban workers to use the Internet. The higher a worker's income the more likely they would have used the Internet. Differences in demographic characteristics across rural-

urban space account for the observed gap in the aggregate rural-urban worker Internet rates.

In 2004 56 percent of farm operators reported that they had a computer with Internet access. A significant proportion of those with Internet access used the Internet for farm and household purchases. Difference in Internet use across farm size (as measured in farm sales) was striking. The share of farms with both farm and household Internet purchases was the highest for the largest farms, the lowest for the smallest farms.

Results from the logistics regression model suggest that income is a critical determinate though other factors such as age and education are significant in market demand determination. Distance from urban centers was not a factor in Internet access. Distance, however, is a factor in the proclivity of making on-line purchases for the farm and household. Differences in socio-economic characteristics across nonmetropolitan-metropolitan space may largely explain the observed gap in aggregate Internet access rates.

As a consequence policies targeting income and education likely would have some positive effect on take up rate for Internet use. Continuing or extension education may reduce some of the barriers of entry to Internet access for some of the smaller farm and rural businesses. It is not clear that policies targeting assistance to more remote farm and rural businesses would have much affect.

References

Becker, Gary (1964). **Human Capital**, New York: Columbia University Press.

Bresnahan, Timothy F., Erik Brynjolfsson, and Lorin M. Hitt (1999). *Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence*, National Bureau of Economic Research, NBER Working Paper Series, Working Paper 7136.

Forman, Chris (2005). "The Corporate Digital Divide: Determinants of Internet Adoption," **Management Science**, 51:4, pp.641-654.

Gloy, Brent A. and Jay T. Akridge (2000). "Computer and Internet Adoption on Large U.S. Farms," **The International Food and Agribusiness Management Review**, 3:3, pp.323-338.

Grant, August E., and Jennifer H. Meadows, editors (2002). **Communication Technology Update**, eighth edition, Woburn, MA: Elsevier Science.

Greenstein, Shane, and Jeff Prince (2006). *The Diffusion of the Internet and the Geography of the Digital Divide in the United States*, National Bureau of Economic Research, NBER Working Paper Series, Working Paper 123182.

Malecki, Edward J. (2003). "Digital Development in Rural Areas: Potentials and Pitfalls," **Journal of Rural Studies**, 19, pp.201-214.

National Telecommunications and Information Administration and Economics and Statistics Administration (2004). **A Nation Online: Entering the Broadband Age**, Washington, DC: NTIA and ESA, U.S. Department of Commerce.

National Telecommunications and Information Administration and Economics and Statistics Administration (2000). **Falling Through the Net: Toward Digital Inclusion**, U.S. Department of Commerce, Washington, DC.

Oden, Michael, and Sharon Strover (2002). **Links to the Future: The Role of Information and Telecommunications Technology in Appalachian Economic Development**, Appalachian Regional Commission, Washington, DC.

PEW Internet & American Life Project, http://www.pewinternet.org/index.asp.

Stenberg, Peter L. (2006). "Investment and Household Adoption of Communication and Information Services Across the United States" in **The Emerging Digital Economy: Entrepreneurship, Clusters and Policy**, Johansson, Borge, Charlie Karlsson, and Roger Stough (Eds.), Springer, Berlin, Heidelberg, New York, pp. 263-76.