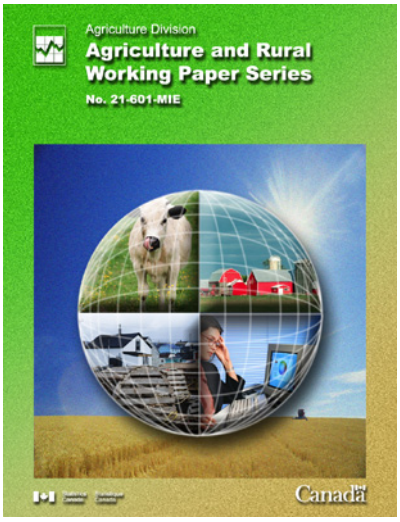
Catalogue no. 21-601-MIE — No. 066
ISSN: 1707-0368
ISBN: 0-662-35771-X

Research Paper

Factors Associated with Household Internet Use in Canada, 1998-2000



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Agriculture and Rural Working Paper Series
Working Paper No. 66

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January 2004

Statistics
Canada
Agriculture Division

Agriculture and Rural Working Paper Series
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Published by authority of the Minister responsible for Statistics Canada.

January 2004

Catalogue No. 21-601-MIE

ISSN: 1707-0368
ISBN: 0-662-35771-X

Frequency: Occasional

Ottawa

La version française est disponible sur demande (n° 21-601-MIF au catalogue)

Note of appreciation: Canada owes the success of its statistical system to a longstanding partnership between Statistics Canada and the citizens, businesses and governments of Canada. Accurate and timely statistical information could not be produced without their continued cooperation and good will.

Abstract

New developments in information and communication technology (ICT) such as the growth of Internet use, have been portrayed as an innovative medium of information exchange and thus providing new opportunities to rural Canadians. However, recent studies have shown that fewer rural Canadians were using the Internet compared to urban Canadians (Thompson-James, 1999; M^{c}Laren, 2002). The purpose of this study is to estimate and to analyze the determinants of Internet use by Canadians in order to understand the factors associated with lower Internet use in rural Canada with specific emphasis on whether 'rurality' acts as an independent factor on Internet use. A logit model using the "Household Internet Use Survey" (HIUS) from 1998 to 2000 is used to analyze various socioeconomic determinants such as age, household income, location, self-employment and education. Our research indicates that although factors such as low income and an older population restrict Internet use by rural Canadians, "rurality" per se *also appears to be a constraint on Internet use in Canada. It is necessary to analyze and understand the determinants of Internet use since this can help public and private agencies in customizing and altering information infrastructure, which can help in increasing Internet use among rural Canadians.*

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1.0 Introduction

> *"Access to the Information Highway is critical to Canada's future as an information society and its success as a knowledge economy"* (IHAC, 1997)

The rapid increase in "Information and Communication Technology (ICT)," spiraled by the unprecedented growth and the use of the Internet, has opened new avenues of public policy interest. The medium of the Internet has been hailed as the harbinger of the *Global Information Infrastructure and the Global Information Society* (OECD, 1997, p.5) and has assumed great significance and importance in the global economy.

There is a growing interest in the field of public policy in Canada to use this innovative medium of communication to bridge the gap between the rural and urban areas in order to improve the quality of life of citizens. The ability of Canadians to use ICT to interact and transmit information can be considered an important determinant in placing Canada in the increasingly global economy (Conference Board of Canada, 1999). The Internet can provide many new opportunities to individuals, businesses and government in effectively fulfilling their respective roles in society (OECD, 1998, p.3).

The use of the Internet has been perceived by many as a crucial medium for rural residents in Canada to reduce the cost of distance, since they face isolation because of their geographic location (Thompson-James, 1999). The Internet has caught the attention of various levels of government due to its ability to deliver information efficiently, accurately and with less cost than the traditional means of providing information services to the rural areas in Canada.[1]

Also with the increasing emphasis on the part of the government to increase citizen participation in government decision-making, the use of the Internet has been perceived as an efficient medium in fulfilling this task (Government of Canada, 1996).

Because of the slow pace in the development of infrastructure for high-speed Internet service, many rural regions in Canada have suffered from either a lack of Internet services or a slow Internet connection (Thompson-James, 1999). In recent years, various levels of government have made efforts to bridge the gap with different initiatives such as the "Community Access Program " and "SchoolNet." But recent studies have shown that, within rural Canada, a lower proportion of residents use the Internet (Thompson-James, 1999). Thus, one of the pressing concerns of government decision-makers is the barrier to ICT in rural areas (IHAC, 1995; Government of Canada, 1996; and OECD, 1997). The lack of access to modern technologies such as the Internet can lead to an 'information gap'[2], which may widen economic disparities and diminish economic growth. Thus, there is a growing desire among policy makers to provide universality to Information Highway services as demonstrated by the 37th Speech from the Throne (2001). The Canadian public has also indicated its desire to promote universal accessibility to Internet services across Canada (Dryburgh, 2001). This makes it important to understand the determinants of Internet use since this can help shape future public policies and also aid in monitoring the adoption of ICT across Canada. It can also help public and private agencies to alter information infrastructure in order to promote Internet use across Canada.

In this working paper, we present a logit model to examine the determinants of Internet use in Canada with special reference to whether *rurality* is one of the constraints to Internet use. We use this model to determine the contribution of each

[1] Canadian government has recently established a 'connectedness' agenda, which includes services such as Government Online (GOL), Canada Online, Canadian Content Online, Electronic Commerce and Promoting a Connected Canada to the World (Statistics Canada, 2001).

[2] Although this 'information gap' or 'digital divide' has decreased over the years (Dickinson and Sciades, 1999), it is still an issue which needs to be understood.

socioeconomic factor to the use of the Internet in Canadian households. This study uses the Statistics Canada "Household Internet Use Survey (HIUS)" for the years 1998, 1999 and 2000[3] (Box 2).

Box 1: Definitions

Census Metropolitan Area (CMA): A CMA has an urban core of 100,000 or over and includes all neighbouring municipalities where 50 percent or more of the work force commutes into the urban core. The top 15 CMAs are Halifax, Quebec, Montreal, Ottawa-Hull, Toronto, Kitchener, Hamilton, St. Catherines - Niagara, London, Windsor, Winnipeg, Calgary, Edmonton, Vancouver and Victoria.

Census Agglomeration (CA): A CA has an urban core of 10,000 to 99,999 and includes all neighbouring municipalities where 50 percent or more of the work force commutes into the urban core.

Household: Any person or group of persons living in a dwelling. A household may consist of any combination of: one person living alone, one or more families, or a group of people who are not related but who share the same dwelling.

Head of household: The head of a household is determined as follows: in families consisting of married couples with or without children, the husband is considered the head; in lone-parent families with unmarried children, the parent is the head; in lone-parent families with married children, the member who is mainly responsible for the maintenance of the family becomes the head; in families where relationships are other than husband-wife or parent-child, normally the eldest in the family is considered the head; and in a one-person household, the individual is the head.

Internet: The Internet connects computers to the global network of networks for electronic mail services, file transfer, and information search and retrieval.

[3] Statistics Canada has been collecting and analysing information regarding Internet use among Canadian households and individuals for several years. For more information regarding these studies, see Dickinson and Sciades (1997); April (2000); Ellison, Earl and Ogg (2001); Silver (2001); and Dryburgh (2001).

Box 2: Data source

The **Household Internet Use Survey** has been conducted by Statistics Canada on an annual basis since 1997. The survey provides information on the use of computers for communication purposes and the households' access and use of the Internet from home. The objective of this survey is to measure the demand for telecommunications services by Canadian households. To assess the demand, we measure the frequency and intensity of use of what is commonly referred to as "the information highway" among other things. This was done by asking questions relating to the accessibility of the Internet to Canadian households both at home, the workplace and a number of other locations. In this study, we focus on the use of the Internet from home. Note that households on Indian Reserves and households in the Yukon, Northwest Territories and Nunavut are not included in the survey.

2.0 Econometric Model

In this section, we introduce the logit model used in our study. We then explain the nature of the dependent variable and discuss the independent variables included in our model.

2.1 Logit Model Specification

Our study uses a logit model framework, with the endogenous variable defined as whether or not the individual lives in a household with Internet access. The relationship between the explanatory variables and the probability of Internet access are estimated using *Maximum Likelihood (ML) estimation*[4]. Since we deal with a dichotomous response independent variable, *Ordinary Linear Regression (OLS)* is not suitable for our model. The main objective of this model is to determine the contribution of various socioeconomic factors in explaining whether an individual lives in a household with Internet access. The logistic[5] equation used in our model[6] is shown as:

$$Y = f(X_i); \ \forall \ i=(1,\ldots,18)$$

$$\log (\pi_i)/(1-\pi_i) = \log O_i = \alpha + \beta_1 (X_1) + \beta_2 (X_2) + \ldots\ldots + \beta_{18}(X_{18})$$

where,

Y = Household Internet use

π_i = Probability of household having Internet access

$1-\pi_i$ = Probability of household not having Internet access

O_i = Conditional odds of household having Internet access

$X_{1,2,3}$ = Age of head of household

$X_{4,5,6}$ = Household income in quartiles

X_7 = Geographic location of the household

$X_{8,9,10}$ = Geographic distance of the household

X_{11} = Presence of self-employment income

$X_{12,13}$ = Education level of the head of household

$X_{14,15,16}$ = Household family type

[4] *Maximum Likelihood (ML) Estimation* is a method of estimating parameter values that chooses the set with the highest probability of generating the sample observations. ML can provide good properties in a large sample like ours – it is asymptotically efficient, i.e. it is the most precise estimator in large samples (Horowitz and Savin, 2000).

[5] For more information about logit models, see Aldrich and Nelson (1984) and Demaris (1992).

[6] See Appendix A for detailed definitions of the variables used in our model.

$X_{17,18}$ = Year[7]

It should be noted that sample weights are used in the calculation of ML estimates. Other than estimating coefficient estimates, we also estimate the odds ratio, which is a useful measure of strength of association. This ratio compares the odds of the 'yes' proportion to Class 1 to the odds of the 'yes' proportion to Class 2. The odds ratio can be calculated as:

$$\text{Odds ratio} = \frac{\pi_1 / (1-\pi_1)}{\pi_2 / (1-\pi_2)}$$

The odds ratio ranges from 0 to infinity. When the ratio is 1, there is no association between the row variable and the column variable. When the ratio is more than 1, Class 1 is more likely than Class 2 to have the 'yes' response. On the other hand if the ratio is less than 1, Class 2 is more likely than Class 1 to have the 'yes' response.

2.2 Dependent Variable

The dichotomous dependent variable refers to the response (Yes or No) whether the individual lives in a household with Internet access or not (See Appendix A). More specifically it refers to whether a member of the household used the Internet in a given month.

2.3 Independent Variables

Many studies, such as the one done by Bertolini (2001), have found that access to new technologies such as the Internet is directly related to various socioeconomic factors such as demographic distance (age), social distance (income), geographic distance (rurality), etc. We look at some of these socioeconomic factors as our explanatory variables in order to understand the determinants of Internet use.

2.3.1 Age of head of the household

This variable refers to the age of the 'head of the household' (See Appendix A). We look at the 'head of the household' since she/he is most likely the person to pay for the computer and the Internet connection.

Looking at coefficient estimates for various age classes (Table 2, Appendix B), we find that age classes A and B have positive coefficient estimates whereas class C has a negative coefficient estimate relative to the excluded class D. Thus, the younger the head of the household, the higher the probability of Internet use. Compared to the excluded age class (head of household 55-64 years of age), the ML estimator coefficients were relatively high for the 15-34 year group, somewhat high for the 35-64 year group and lower for the 65+ year group. This pattern is essentially the same within CMA and in non-CMA areas[8]. Looking at the interaction variables in Table 2, Appendix B, we find that the non-CMA young (age class 15-34) head of households are less advantaged (i.e., being non-CMA has a negative effect on the probability of Internet use for households with a young head). Comparing households located in CMA areas with households located in non-CMA areas (Table 5, Appendix B), we find similar results – class A and B have a positive effect whereas class C has a negative effect on the probability of household Internet use relative to the excluded class D. However, we do find that class A and B have a stronger effect and class C has a weaker effect on the probability of Internet use among households located in CMA areas compared to households located in non-CMA areas. Thus, the younger the head of household, the higher the probability of Internet use. Compared to the excluded age class (head of household 55-64 years of age), the ML estimator coefficients were relatively high for the 15-64 year group, somewhat high for the 35-64 year group and lower for the 65+ year group.

[7] This variable was only used when we ran the logistic model by combining the data from 1998, 1999 and 2000.

[8] Specifically, we are comparing households located in the top 15 CMAs (as listed in Box 1) with households located outside the top 15 CMAs.

Looking at the coefficients over 3 years (Table 1, Appendix B), we find consistent results for all 3 years – class A and B have positive coefficient estimates whereas class C has a negative coefficient estimate (relative to the excluded class D). This means that the younger heads of household (15-34 years of age) and those between 35 to 54 years are positive determinants of the probability of Internet use in the household. In fact, the age category A (15-34 years of age) has the biggest single effect on the dependent variable of our model (See Table 11, Appendix D). On the other hand, an older head of household (65 years of age and older) is a negative determinant of the probability of household Internet use (Table 1, Appendix A). This finding is in line with Dryburgh (2001) who also found that the seniors were least likely of any age group to use the Internet in Canada.

The odds ratio estimates in Table 7, Appendix C shows that the households with a head of household in the youngest age category (class A) are most likely to have a family member use the Internet in a given month followed by class B, C and D. Looking at the odds ratio estimates for the 3 years in Table 6, Appendix C, we find consistent results - that the households with a head of household in the youngest age category (class A) are most likely to use the Internet followed by class B, C and D. This finding is in line with many studies such as the one done by Dickinson and Sciades (1997, 1999), Dryburgh (2001) and M^{c}Laren (2002) who found that younger individuals were the most likely to use the Internet, compare to any other age class.

We also compare odds ratio estimates for households in CMAs and households not in CMAs (Table 10, Appendix C). We find that for both the households located in a CMA and not in a CMA, households with the youngest head of household (class A) are most likely to use the Internet followed by class B, C and D.

Generally, high Internet use among young heads of household may be because they are more likely to be exposed to computers and the Internet at school and at work. According to Silver (2001), the reason for low Internet use among older Canadian population can be attributed to their general lack of interest in Internet use. Also many may be resistant to computer technologies and may not recognize the possible usefulness of the Internet (Dickinson and Ellison, 1999b). Fewer older individuals have recent experiences in school and work, which means that they normally have lower skills in computer operation and Internet use (Silver, 2001). Lower Internet use among older individuals in Canada can be an important contributing factor towards low Internet use in rural Canada, since a higher share of rural Canadians are in the older age group.

2.3.2 Household income

This categorical variable refers to the four household income quartiles (see Appendix A). A strong relationship between computer use and household income has been documented in a number of studies such as the one by Dickinson and Sciades (1996, 1999). Thompson-James (1999) stated that there was a positive relationship between the ability to use a computer and higher household income. Higher income means greater affordability and higher consumption levels of services such as the Internet, which could refer to a positive correlation between higher income and higher Internet use.

Looking at the coefficient estimates of the various income classes (Table 2, Appendix B), we find that the households with the highest household income (Class H $60,000+) have a positive effect on the probability of household Internet use (relative to the excluded class G). On the other hand, households with lower household income (Classes E and F) have a negative effect on the probability that a household member uses the Internet in a given month (relative to the excluded class G). Comparing households located in CMA areas and households located in non-CMA areas (Table 5, Appendix B), we find that each of class E and class F has a negative effect among both kinds of households (relative to the excluded class G). On the other hand, class H has a positive effect among households located in CMA areas but the effect

among non-CMA households is not significantly different, compared to the excluded class G. We also find that classes E and F have a stronger negative effect on the probability of Internet use among households located in non-CMA areas compared to households located in CMA areas.

The coefficient estimates for the 3 years (Table 1, Appendix B) show consistent results - households in the income class H have a positive effect whereas households in income classes E and F have a negative effect on the probability of household Internet use (relative to the excluded class G).

The odds ratio estimates in Table 7, Appendix C show that the households in the richest income class H ($60,000+) are most likely to use the Internet followed by households in income class G ($36,000-$59,999), F ($20,001-$35,999) and E ($0-$19,999). The odds ratio estimates for 3 years (Table 6, Appendix C) show consistent results - the households in the income class H are most likely to use the Internet followed by households in income class G, F and E. We also compare odds ratio estimates for households located in CMA areas and households located in non-CMA areas (Table 10, Appendix C). We find that for both the households located in CMA areas and in non-CMA areas, the households in the income class H are most likely to use the Internet followed by households in income class G, F and E.

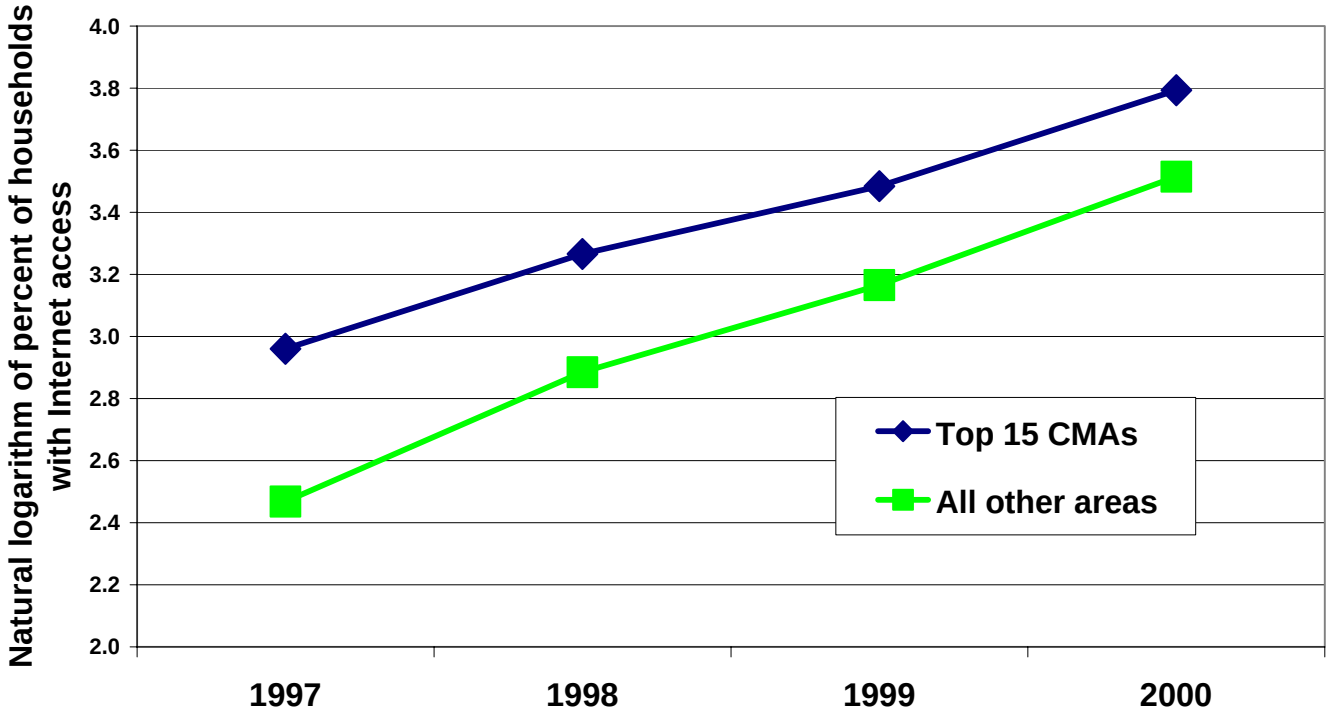
2.3.3 Geographic location of the household

One of the objectives of this study is to determine if the probability that a household has Internet access is a function of geographic location, after taking other variables into account. This categorical variable (whether the household location is in a CMA or not) helps us in analyzing whether a person's location has any impact on her/his decision to use the Internet. We are particularly interested in finding out if *rurality* has an independent effect on the probability of Internet use, after holding constant all the other independent variables. We use households located outside the top 15 CMA areas as a proxy for *rural* and try to determine if location in a non-CMA area (i.e. rural) has a negative impact on the probability of household Internet use. Ideally, a more specific definition of rural such as 'Rural and Small Town (RST)'[9] would have been a more accurate proxy for rural regions, but this was not possible for our study due to data limitations. Looking at Figure 1, we find that historically, the non-CMA areas have lagged behind the CMA areas in household Internet use.

[9] For definition of RST, see du Plessis *et al.* (2001).

Figure 1

The rate of increase of Internet access is similar within and outside the top CMAs



Source: Statistics Canada. Household Internet Use Survey, 1997 - 2000. The top 15 Census Metropolitan Areas (CMAs) are Halifax, Québec, Montréal, Ottawa-Hull, Toronto, Kitchener, Hamilton, St. Catherines - Niagara, London, Windsor, Winnipeg, Calgary, Edmonton, Vancouver and Victoria.

The coefficient estimates (Table 2, Appendix B) show that the geographic location of the household in non-CMA areas has a negative impact on probability that a household member uses the Internet in a given month. Looking at the coefficient estimates over 3 years (Table 1, Appendix B), we find consistent results - the geographic location of the household in a non-CMA area has a negative impact on the probability of a household member using the Internet in a given month. This means that holding all the other independent variables constant, this variable has a significant impact on household Internet use.

We also look at 3 other distance variables, which measure the distance of the household to the nearest CMA or CA, distance to the nearest CMA and distance to the nearest CMA with a population over 500,000 respectively (See Appendix A). Looking at the coefficient estimates over 3 years (Table 2, Appendix B), we find consistent results – all the three variables have negative coefficients. However, we find that all the 3 distance variables are insignificant (i.e. they fail the test of significance at the 0.05 significance level) as determinants of Internet use. Thus, holding all the other variables constant, distance does not have a significant impact on the probability of household Internet use.

The odds ratio estimates in Table 7, Appendix C show that the households located in CMA areas are more likely to have a household member use the Internet in a given month compared to a household not located in CMA areas. Looking at the odds ratio estimates for 3 years (Table 6, Appendix C), we find consistent results - the households located in CMA areas are more likely to have a household member use the Internet in a given month compared to households located in non-CMA areas.

This finding is in line with other findings by Dickinson and Sciades (1997) and Thompson-James (1999) who found that household location in a CMA was associated with a higher probability of Internet use in that household. The reason for higher Internet use in households located in CMA areas compared to households located in non-CMA areas could be that the infrastructure needed for the Internet tends to be first introduced to the more densely populated areas such as the CMAs (Dickinson and Ellison, 1999).

2.3.4 Household income from self-employment

This categorical variable refers to whether or not any of the household income comes from self-employment activities (See Appendix A). Individuals who are self-employed may have a greater use of the Internet for business purposes. Thus, it is hypothesized that households with self-employment income are more likely to have Internet access compared to other households with no self-employment income.

The coefficient estimates (Table 2, Appendix B) show that self-employment income in the household has a positive impact on the probability that a member of that household uses the Internet in a given month. Looking at the interaction variables in Table 2, Appendix B, we find that the self-employment income is less likely to increase the probability of household internet use in non-CMA areas.

Comparing households located in CMA areas and in non-CMA areas (Table 5, Appendix B), we find similar results – self-employment income has a positive effect on the probability of Internet use among both kinds of households. However, we do find the effect is stronger among households located in CMA areas compared to households located in non-CMA areas.

Looking at the coefficient estimates for the 3 years (Table 1, Appendix B), we find similar results - self-employment income in the household has a positive impact on the probability that a household member uses the Internet in a given month.

The odds ratio estimates in Table 7, Appendix C show that households with self-employment income are more likely to have a household member use the Internet compared to a household with no self-employment income. The odds ratio estimates for the 3 years (Table 6, Appendix C) show similar results - households with self-employment income are more likely to have a household member use the Internet compared to a household with no self-employment income. We also compare odds ratio estimates for households located in CMA areas and households located in non-CMA areas (Table 10, Appendix C). We find that for both the households located in CMA areas and in non-CMA areas, the likelihood of self-employment increases the probability that someone in that household uses the Internet in a given month compared to a household with no self-employment income.

2.3.5 Education level of the head of household

This categorical variable looks at the various levels of educational attainment of the head of the household and its effect on Internet use in Canada (See Appendix A). We look at the *head of the household* since she/he is the most likely person to pay for the computer and the Internet connection. In recent years, there has been a greater reliance on ICT in imparting education and computer education has become an integral part of the Canadian education system. There is also a greater reliance on computer and computer based training in the work force. According to Dickinson and Sciades (1997, 1999), there is a strong link between education and the use of Internet services. It is also assumed that since most educational institutions promote the use of computers in doing research and assignments, the increase in education level means an increase in computer and subsequently Internet research[10].

[10] It should be noted that although we can assume that an increase in computer use might lead to Internet use, some

The coefficient estimates (Table 2, Appendix B) show that class I (not completed high school) has a negative coefficient whereas class K (completed university degree) has a positive coefficient (relative to the excluded class J). Looking at Table 11, Appendix D, we find that class K is one of the top 5 positive determinants of household Internet use in Canada. This means that a higher education level of a head of household has a positive impact on the probability that a household member uses the Internet in a given month.

Comparing households located in CMA areas and in non-CMA areas (Table 5, Appendix B), we find similar results – class I has a negative effect, whereas class K has a positive effect on the probability of household Internet use (relative to the excluded class J). However, we do find that class I has a slightly stronger negative effect and class K has a weaker effect on the probability of Internet use among households located in CMA areas compared to households located in non-CMA areas.

The coefficient estimates for the 3 years (Table 1, Appendix B) show similar results - that class I have a negative coefficient whereas class K has a positive coefficient (relative to the excluded class J). One factor explaining this relationship may be a general link between openness towards innovation such as the adoption of the Internet and a higher level of education.

The odds ratio estimates in Table 7, Appendix C show that the household with the most educated head of household (class K – completed university degree) has the highest probability that a member of that household uses the Internet in a given month. This is followed by households in less educated classes J (completed high school but no university education) and I (not completed high school). Looking at the odds ratio estimates for 3 years (Table 6, Appendix C), we find consistent similar results - the household with the head of household in class K has the highest probability that a member of that household uses the Internet in a given month followed by classes J and I. We also compare odds ratio estimates for households located in CMA areas and households located in non-CMA areas (Table 10, Appendix C). We find that for both the households located in CMA areas and households located in non-CMA areas, the household with the head of household in class K has the highest probability that a member of that household uses the Internet in a given month followed by classes J and I.

2.3.6 Household family type

This categorical variable (See Appendix A) refers to the type of family (whether single family without children, single family with children, one person or multi-family) occupying the household. Previous studies[11] have shown that Internet use was highest among households composed of single families with children[12] followed by multi-family households and single families without children. Internet use was lowest for one-person households.

The coefficient estimates (Table 2, Appendix B) show that all the family classes (L, M and O) have a positive impact on the probability of a household member using the Internet in a given month (relative to the excluded class N).

Comparing households located in CMA areas and households located in non-CMA areas (Table 5, Appendix B), we find similar results – all the family types have a positive effect on the probability of household Internet use (relative to the excluded class N). However, we do find that each of class L and class O has a stronger effect and class M has a weaker effect on the probability of Internet use among households located in non-CMA areas, compared to households located in CMA areas.

research such as the study by Dickinson and Sciades (1999) state that a significant number of Canadians with home computers were not connected to the Internet. Thus it might not be always necessary that computer ownership leads to Internet use.

[11] Dickinson and Ellison (1999) and Dickinson and Sciades (1999).

[12] This pattern may be explained by the higher rate of Internet use by children from school for households with children (Dickinson and Sciades, 1999).

The coefficient estimates for the 3 years (Table 1, Appendix B) show consistent results – all the family classes have a positive impact on the probability of a household member using the Internet in a given month (relative to the excluded class N). Looking at Table 11, Appendix D, we find that family class L (single family household with children under age 18) is in the top 3 positive determinants of the probability that someone in the household uses the Internet in a given month.

The odds ratio estimates in Table 7, Appendix C show that the household family class L (single family with children under age 18) has the highest probability that a member of that household uses the Internet in a given month. This is followed by classes O (multi-family households), M (single family household without children under age 18) and N (one-person household).

The odds ratio estimates for 3 years (Table 6, Appendix C) show that in 1998, households in family class L (single family with children under age 18) had the highest probability of Internet use. This was followed by classes O (multi-family household), M (single family household without children under age 18) and N (one-person household). In 1999, households in family class M (single family without children under age 18) had the highest probability of Internet use followed by households in family class O (multi-family household), L (single family household with children under age 18) and N (one-person household). In 2000, households in family class L (single family household with children under age 18) had the highest probability of Internet use followed by households in family class O (multi-family household), M (single family without children under age 18) and N (one-person household).

We also compare odds ratio estimates for households located in CMA areas and households located in non-CMA areas (Table 10, Appendix C). We find that for both the households located in CMA areas and households located in non-CMA areas, households in family class L (single family with children under age 18) had the highest probability of Internet use. This was followed by classes O (multi-family household), M (single family household without children under age 18) and N (one-person household).

The reason for higher Internet use in households with children age 18 can be attributed to the fact that younger children are more likely to use computers and the Internet for educational purposes (i.e. many of the children also access the Internet from school) and thus have more interest in Internet use. Thus, it is likely that a household with children under age 18 is more likely to be connected to the Internet compared to a household with no children under age 18.

2.3.7 Year

This categorical variable (See Appendix A) refers to the year in which each of the households was surveyed. The odds ratio estimates in Table 7, Appendix C show that households in Canada in year 2000 were more likely to have a household member use the Internet in a given month followed by households in year 1999 and 1998. We also compare odds ratio estimates for households located in CMA areas and households located in non-CMA areas (Table 10, Appendix C). We find that for both households located in CMA areas and in non-CMA areas, households in year 2000 were more likely to have a household member use the Internet in a given month followed by households in year 1999 and 1998.

Conclusion

New developments in information and communication technology (ICT) such as the growth of Internet use, has been portrayed as an innovative medium of information and providing new opportunities to rural Canadians. However, recent studies have shown that fewer rural Canadians were using the Internet compared to urban Canadians. Our research indicates that although factors such as an older population with lower educational attainment and lower income tends to constrain Internet use by rural Canadians,

rurality appears to be an independent constraint on Internet use by rural Canadians.

Overall, we find that a younger head of household, a higher household income, a household head with higher education level, the presence of self-employment income, and the presence of children under age 18 living in the household each has a positive impact on the probability that a household member uses the Internet in a given month. On the other hand, an older head of household, a lower household income and a household head with lower education level has a negative impact on the probability that a member of the household uses the Internet in a given month.

We can summarize our findings[13] as followings:

All households (combining 3 year data)

- Younger (Class A) and middle age (Class B) head of household, single family household with children (Class L) and without children (Class M) and head of household with university degree (Class K) were the top 5 positive determinants of household Internet use (Table 11, Appendix D).

All households (1998) (and 1999 results were the same)

- Younger (Class A) and middle age (Class B) head of household, head of household with university degree (Class K), single family households with children under age 18 (Class L) and presence of self-employment income in the household were the top 5 positive determinants of household Internet use (Table 11, Appendix D).

All households (2000)

- Younger (Class A) and middle age (Class B) head of household, head of household with university degree (Class K), single family households with children under age 18 (Class L) and higher income households (Class H) were the top 5 positive determinants of household Internet use (Table 11, Appendix D).

Comparison between households located in CMA areas and households located in non-CMA areas

- Younger and middle age head of household, higher income, higher education and single family households with and without children under age 18, were the top 5 positive determinant of household Internet use (Table 11, Appendix D).

It should be pointed out that we did not look at the cost and its impact on Internet use in Canada. Cost can be an important determinant as indicated by Dickinson and Sciades (1999) and Dryburgh (2001). Dryburgh (2001) found that the cost of Internet use was a major reason among the individuals who lived in households without Internet access. Research also needs to be done to find if type of employment, profession or place of birth of household head could affect the probability of Internet use.

[13] Refer to Appendix D for a summary of rankings.

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APPENDIX A: Model

Model Information:

The model used a Logistic procedure using a 'binary logit' model with 'Fisher's scoring' optimization technique. The SAS software was used to work with this model. Maximum Likelihood (ML) estimation techniques were used to calculate the coefficients of various independent variables. ML estimation seeks to maximize the log likelihood (LL) which reflects how likely it is (the odds) that the observed values of the dependent variable may be predicted from the observed values of the independent variables. ML is an iterative algorithm, which begins with an arbitrary estimate of the logit coefficients. The algorithm determines the size and direction of the coefficients, which increases the LL. The residual estimates from the initial function are tested and re-estimated until convergence is achieved, i.e. until there is no significant change in LL. It should be mentioned that in our model, we do not take into account the survey design parameters and thus the results for some variables might be understated.

Dependent Variable:

Do household members use the Internet from home in a typical month?

Y = 1, if response = yes;

Y = 0, if response = no

Independent Variables:

1. Age of household head:

X_1 = 1 "if age is < 35"(Class A)
X_2 = 1 "if age is 35 to 54" (Class B)
X_3 = 1 "if age is > 65" (Class D)

The omitted age class is "if age is 55 to 64" (Class C). Thus, all coefficients on the age dummy variables will be relative to the propensity of households with a head who is 55 to 64 years old having one member who uses the Internet from home in a typical month.

2. Household income

X_4 = 1 "if household income is less than $20,000" (Class E)
X_5 = 1 "if household income is $20,000 to $35,999" (Class F)
X_6 = 1 "if household income is $60,000 and over" (Class H)

The omitted class is "if $36,000 to $59,999" (Class G). Thus all coefficients are relative to the propensity of households with an income of $36,000 to $59,999 having one member who uses the Internet from home in a typical month.

3. Geographic location of the household: We look at 2 different options:

- Use the variable that indicates whether the household is in one of the top 15 CMAs or not where the omitted class would be the top 15 CMAs and the variable would be:

  X_7 = 1 "if not living in the top 15 CMAs" (Not Living in a CMA)
  X_7 = 0 "if living in the top 15 CMAs" (Living in a CMA)

- Use the calculated "distance as the crow flies" and test each of these three formulations (but use only one in the final equation):

  X_8 = "distance to the nearest CMA or CA"
  X_9 = "distance to the nearest CMA"
  X_{10} = "distance to the nearest CMA with population over 500,000"

4. Household income from self-employment

X_{11} = 1 "if any household income from self-employment" (response = Yes)
X_{11} = 0 "if none of the household income from self-employment**"** (response = No)

5. Education level of the head of household

X_{12} = 1 "if not completed high school" (Class I)
X_{13} = 1 "if attained a university degree" (Class K)

The omitted class is "if individual has some post-secondary education but has not attained a university degree" (Class J). Thus the reported coefficients are relative to this class.

6. Household family type

X_{14}= "single family household with children under age 18" (Class L)
X_{15}= "single family household without children under age 18" (Class M)
X_{16}= "multi-family household" (Class O)

The omitted class is "one-person household" (Class N).

7. Year

X_{17} = 1 "If the household was enumerated in 1998" (Class P)
X_{18} = 1 "If the household was enumerated in 1999" (Class Q)

The omitted class is "If the household was enumerated in 2000" (Class R).

APPENDIX B: Coefficient estimates

Table 1: Maximum Likelihood (ML) estimates for households located in CMA areas and in non-CMA areas (3 years comparison)

	1998	1999	2000
MAIN VARIABLES			
Intercept	-1.2612	-0.7954	-0.6989
	(0.1358)	(0.1289)	(0.1275)
Not living in a CMA (Yes)	-0.2946	-0.2078	-0.1909
	(0.0263)	(0.0961)	(0.0275)
Distance to the nearest CMA or CA	-.5.14E-9	3.73E-9	-0.0022
	(3.99E-9)	(3.39E-9)	(0.0004)
Distance to the nearest CMA	-.5.14E-9	3.73E-9	-0.0006
	(3.99E-9)	(3.39E-9)	(0.0001)
Distance to the nearest CMA with population over 500,000	-5.14E-9	3.73E-9	-0.00003
	(4.01E-9)	(3.39E-9)	(0.00006)
Age (Class A)	1.7055	1.3435	1.4614
	(0.1388)	(0.1355)	(0.1336)
Age (Class B)	0.8521	0.5884	0.6429
	(0.1316)	(0.1232)	(0.1164)
Age (Class D)	-1.2268	-1.3316	-1.2880
	(0.1942)	(0.1712)	(0.1527)
Income quartile (Class E)	-1.5711	-1.3039	-1.0353
	(0.1600)	(0.1418)	(0.1469)
Income quartile (Class F)	-0.6314	-0.9730	-0.3736
	(0.1331)	(0.1284)	(0.1362)
Income quartile (Class H)	0.3423	0.3307	0.5709
	(0.1481)	(0.1520)	(0.1895)
Self-employment Income (Yes)	0.1318	0.4074	0.5254
	(0.0944)	(0.0986)	(0.0378)
Education level (Class I)	-1.1055	-1.3352	-1.1449
	(0.1437)	(0.1345)	(0.1295)
Education level (Class K)	1.0029	0.7856	1.2924
	(0.0889)	(0.0899)	(0.0993)
Single family household with children under age 18 (Class L)	0.8457	0.9943	1.3938
	(0.1739)	(0.1643)	(0.2344)
Single family household without children under age 18 (Class M)	0.5873	0.3593	0.5266
	(0.1350)	(0.1282)	(0.1483)
Multi-family household (Class O)	0.4857	0.3985	0.1629
	(0.2843)	(0.2953)	(0.2446)
INTERACTION VARIABLES			
Age (Class A)* Not living in a CMA (Yes)	-0.1849	-0.2255	-0.2039
Age (Class B) * Not living in a CMA (Yes)	0.0152	-0.0698	0.0264
Age (Class C)* Not living in a CMA (Yes)	0.1686	-0.0458	0.1205
Self-employment (Yes) * Not living in a CMA (Yes)	-0.1397	-0.0154	-0.2640
Single family household with children under age 18 (Class L) * Not living in a CMA (Yes)	0.3505	0.3684	0.2165
Single family household without children under age 18 (Class M) * Not living in a CMA (Yes)	0.0160	0.0050	0.0354
Multi-family household (Class O) * Not living in a CMA (Yes)	0.0428	0.0600	0.0484
Age (Class A) * Income quartile (Class E)	0.2988	0.4532	0.3549
Age (Class A) * Income quartile (Class F)	0.0494	0.4180	-0.00376
Age (Class A) * Income quartile (Class H)	-0.1328	-0.0525	-0.3378
Age (Class B) * Income quartile (Class E)	0.0764	0.1621	0.1555
Age (Class B) * Income quartile (Class F)	-0.0567	0.3214	0.0912
Age (Class B) * Income quartile (Class H)	0.0848	0.0672	-0.1234

	1998	1999	2000
Age (Class D) * Income quartile (Class E)	-0.0605	-0.2061	-0.2529
Age (Class D) * Income quartile (Class F)	-0.2068	0.1809	0.1183
Age (Class D) * Income quartile (Class H)	0.0046	-0.4950	-0.3281
Age (Class A) * Single family household with children under age 18 (Class L)	-1.6255	-1.6157	-1.4879
Age (Class A) * Single family household without children under age 18 (Class M)	-0.9258	-0.4551	-0.2763
Age (Class A) * Multi-family household (Class O)	-0.6752	-0.4811	0.3395
Age (Class B) * Single family household with children under age 18 (Class L)	-0.5879	-0.4916	-0.4567
Age (Class B) * Single family household without children under age 18 (Class M)	-0.3561	-0.1856	-0.1812
Age (Class B) * Multi-family household (Class O)	-0.4928	-0.3201	0.1543
Age (Class D) * Single family household with children under age 18 (Class L)	1.9018	1.6967	1.2167
Age (Class D) * Single family household without children under age 18 (Class M)	0.2211	0.6547	0.5238
Age (Class D) * Multi-family household (Class O)	-0.9640	0.9029	1.1583
Income quartile (Class E) * Education level (Class I)	-0.0811	-0.2145	-0.1886
Income quartile (Class E) * Education level (Class K)	0.3680	0.3622	-0.2232
Income quartile (Class F) * Education level (Class I)	-0.3318	-0.1080	-0.3384
Income quartile (Class F) * Education level (Class K)	0.00438	0.0176	-0.2077
Income quartile (Class H) * Education level (Class I)	-0.0929	-0.2382	-0.3941
Income quartile (Class H) * Education level (Class K)	0.1545	0.2472	-0.1444
Income quartile (Class E) * Single family household with children under age 18 (Class L)	0.4947	0.3817	0.0658
Income quartile (Class E) * Single family household without children under age 18 (Class M)	0.7912	0.6573	0.2663
Income quartile (Class E) * Multi-family household (Class O)	0.8577	0.7698	-0.0139
Income quartile (Class F) * Single family household with children under age 18 (Class L)	0.2988	0.3282	-0.0678
Income quartile (Class F) * Single family household without children under age 18 (Class M)	0.1679	0.2411	-0.1094
Income quartile (Class F) * Multi-family household (Class O)	0.2785	0.4346	0.0454
Income quartile (Class H) * Single family household with children under age 18 (Class L)	0.2588	0.3519	0.3539
Income quartile (Class H) * Single family household without children under age 18 (Class M)	0.4643	0.4895	0.3754
Income quartile (Class H) * Multi-family household (Class O)	0.4597	0.1576	0.5608
Self-employment (Yes) * Single family household with children under age 18 (Class L)	0.2889	0.1014	0.0991
Self-employment (Yes) * Single family household without children under age 18 (Class M)	0.1564	-0.1155	0.2734
Self-employment (Yes) * Multi-family household (Class O)	0.2513	-0.2168	-0.2533
Education level (Class I) * Single family household with children under age 18 (Class L)	0.5143	0.6446	0.7049
Education level (Class I) * Single family household without children under age 18 (Class M)	0.4180	0.5396	0.5521
Education level (Class I) * Multi-family household (Class O)	0.0101	0.6448	0.6544
Education level (Class K) * Single family household with children under age 18 (Class L)	-0.0872	0.0002	-0.3904
Education level (Class K) * Single family household without children under age 18 (Class M)	-0.1450	-0.0454	-0.2051
Education level (Class K) * Multi-family household (Class O)	-0.2436	0.8842	-0.1548
TEST STATISTICS			
Maximum-rescaled R-square	0.3889	0.4014	0.4319
Chi-square (Pr>ChiSquare)	0.2566	0.0958	0.0467

Note: 1) Shaded numbers indicate that the variables are not significant at 0.05 significance level
2) The values in brackets represent standard errors for the respective variables.

Table 2: Maximum Likelihood (ML) estimates for households located in CMA and in non-CMA areas combining 3 years)

MAIN VARIABLES	
Intercept	-0.4842
Not living in a CMA (Yes)	-0.1379
Distance to the nearest CA or CMA	-173E-12
Distance to the nearest CMA	-174E-12
Distance to the nearest CMA with population over 500,000	-174E-12
Age (Class A)	1.3767
Age (Class B)	0.6210
Age (Class D)	-1.2718
Income quartile (Class E)	-1.2747
Income quartile (Class F)	-0.5779
Income quartile (Class H)	0.4860
Self-employment Income (Yes)	0.4040
Education level (Class I)	-1.3097
Education level (Class K)	0.8585
Single family household with children under age 18 (Class L)	1.2190
Single family household without children under age 18 (Class M)	0.4336
Multi-family household (Class O)	0.3065
Year (1998)	-0.6553
Year (1999)	-0.4860
INTERACTION VARIABLES	
Age (Class A) * Not living in CMA (Yes)	-0.2109
Age (Class B) * Not living in CMA (Yes)	-0.0303
Age (Class D) * Not living in CMA (Yes)	0.0376
Income quartile (Class E) * Not living in CMA (Yes)	-0.0929
Income quartile (Class F) * Not living in CMA (Yes)	-0.1026
Income quartile (Class H) * Not living in CMA (Yes)	-0.1581
Self-employment Income (Yes) * Not living in CMA (Yes)	-.01506
Education level (Class I) * Not living in CMA (Yes)	-0.1027
Education level (Class K) * Not living in CMA (Yes)	0.0738
Not living in CMA (Yes) * Single family household with children under age 18 (Class L)	0.3341
Not living in CMA (Yes) * Single family household without children under age 18 (Class M)	0.0472
Not living in CMA (Yes) * Multi-family household (Class O)	0.0796
Age (Class A) * Income quartile (Class E)	0.3832
Age (Class A) * Income quartile (Class F)	0.1749
Age (Class A) * Income quartile (Class H)	-0.2083
Age (Class B) * Income quartile (Class E)	0.1386
Age (Class B) * Income quartile (Class F)	0.1365
Age (Class B) * Income quartile (Class H)	0.0040
Age (Class D) * Income quartile (Class E)	-0.2297
Age (Class D) * Income quartile (Class F)	0.0585
Age (Class D) * Income quartile (Class H)	-0.3288
Age (Class A) * Self-employment Income (Yes)	-0.0538
Age (Class B) * Self-employment Income (Yes)	0.1040
Age (Class D) * Self-employment Income (Yes)	0.4163
Age (Class A) * Education level (Class I)	0.1992
Age (Class A) * Education level (Class K)	0.3807
Age (Class B) * Education level (Class I)	0.1175
Age (Class B) * Education level (Class K)	0.1178
Age (Class D) * Education level (Class I)	0.1989
Age (Class D) * Education level (Class K)	-0.1066
Age (Class A) * Single family household with children under age 18 (Class L)	-1.5469
Age (Class A) * Single family household without children under age 18 (Class M)	-0.5148
Age (Class A) * Multi-family household (Class O)	-0.1632
Age (Class B) * Single family household with children under age 18 (Class L)	-0.5201

Age (Class B) * Single family household without children under age 18 (Class M)	-0.2240
Age (Class B) * Multi-family household (Class O)	-0.1625
Age (Class D) * Single family household with children under age 18 (Class L)	1.4483
Age (Class D) * Single family household without children under age 18 (Class M)	0.4249
Age (Class D) * Multi-family household (Class O)	0.7469
Income quartile (Class E) * Self-employment Income (Yes)	0.1763
Income quartile (Class F) * Self-employment Income (Yes)	0.0041
Income quartile (Class H) * Self-employment Income (Yes)	-0.1256
Income quartile (Class E) * Education level (Class I)	-0.1632
Income quartile (Class E) * Education level (Class K)	0.1123
Income quartile (Class F) * Education level (Class I)	-0.2492
Income quartile (Class F) * Education level (Class K)	-0.0621
Income quartile (Class H) * Education level (Class I)	-0.2255
Income quartile (Class H) * Education level (Class K)	0.0881
Income quartile (Class E) * Single family household with children under age 18 (Class L)	0.3014
Income quartile (Class E) * Single family household without children under age 18 (Class M)	0.5571
Income quartile (Class E) * Multi-family household (Class O)	0.4898
Income quartile (Class F) * Single family household with children under age 18 (Class L)	0.2385
Income quartile (Class F) * Single family household without children under age 18 (Class M)	0.1133
Income quartile (Class F) * Multi-family household (Class O)	0.2251
Income quartile (Class H) * Single family household with children under age 18 (Class L)	0.3178
Income quartile (Class H) * Single family household without children under age 18 (Class M)	0.4437
Income quartile (Class H) * Multi-family household (Class O)	0.4013
Income quartile (Class E) * Year (1998)	-0.1092
Income quartile (Class E) * Year (1999)	0.1136
Income quartile (Class F) * Year (1998)	-0.1256
Income quartile (Class F) * Year (1999)	-0.0459
Income quartile (Class H) * Year (1998)	0.0477
Income quartile (Class H) * Year (1999)	0.0424
Self-employment Income (Yes) * Single family household with children under age 18 (Class L)	0.2050
Self-employment Income (Yes) * Single family household without children under age 18 (Class M)	0.1157
Self-employment Income (Yes) * Multi-family household (Class O)	-0.0112
Self-employment Income (Yes) * Year (1998)	-0.2390
Self-employment Income (Yes) * Year (1999)	-0.1358
Education level (Class I) * Single family household with children under age 18 (Class L)	0.6486
Education level (Class I) * Single family household without children under age 18 (Class M)	0.5523
Education level (Class I) * Multi-family household (Class O)	0.4765
Education level (Class K) * Single family household with children under age 18 (Class L)	-0.1592
Education level (Class K) * Single family household without children under age 18 (Class M)	-0.0592
Education level (Class K) * Multi-family household (Class O)	0.0639
Single family household with children under age 18 (Class L) * Year (1998)	-0.3693
Single family household with children under age 18 (Class L) * Year (1999)	-0.1181
Single family household without children under age 18 (Class M) * Year (1998)	-0.0232
Single family household without children under age 18 (Class M) * Year (1999)	0.0086
Multi-family household (Class O) * Year (1998)	-0.1802
Multi-family household (Class O) * Year (1999)	0.0640
TEST STATISTICS	
Maximum-rescaled R-square	0.4166
Chi-square (Pr>ChiSquare)	0.0001

Note: Shaded numbers indicate that the variables are not significant at 0.05 significance level

Table 3: Maximum Likelihood (ML) estimates for households not located in CMA areas (3 years comparison)

MAIN VARIABLES			
	1998	**1999**	**2000**
Intercept	-1.4803	-0.7565	-0.7048
Age (Class A)	1.3583	0.8049	1.2948
Age (Class B)	0.6028	0.0779	0.6863
Age (Class D)	-1.3562	-1.3700	-1.4818
Income quartile (Class E)	-1.7010	-1.6405	-1.1678
Income quartile (Class F)	-0.4534	-1.0607	-0.6533
Income quartile (Class H)	0.3541	-0.0303	-0.2270
Self-employment Income (Yes)	0.2200	0.3907	0.4158
Education level (Class I)	-0.8806	-0.9783	-0.8284
Education level (Class K)	1.0326	0.9809	1.0681
Single family household with children under age 18 (Class L)	1.3194	1.2484	1.6353
Single family household without children under age 18 (Class M)	0.5365	0.2076	0.5427
Multi-family household (Class O)	0.9630	0.9533	-0.2242
INTERACTION VARIABLES			
Age (Class A) * Income quartile (Class E)	0.4817	0.7120	0.1311
Age (Class A) * Income quartile (Class F)	-0.1383	0.5256	0.1000
Age (Class A) * Income quartile (Class H)	0.0220	0.0368	0.0545
Age (Class B) * Income quartile (Class E)	0.3101	0.4961	-0.0322
Age (Class B) * Income quartile (Class F)	-0.1048	0.5370	-0.0409
Age (Class B) * Income quartile (Class H)	0.1683	0.1772	-0.0059
Age (Class D) * Income quartile (Class E)	0.2582	0.0362	-0.1893
Age (Class D) * Income quartile (Class F)	-0.0287	0.2677	0.2282
Age (Class D) * Income quartile (Class H)	-0.3407	-0.1771	-0.2718
Age (Class A) * Single family household with children under age 18 (Class L)	-1.6624	-1.3003	-1.7281
Age (Class A) * Single family household without children under age 18 (Class M)	-0.6399	-0.0983	-0.3102
Age (Class A) * Multi-family household (Class O)	-0.9228	-0.8099	0.4679
Age (Class B) * Single family household with children under age 18 (Class L)	-0.5050	-0.0380	-0.5588
Age (Class B) * Single family household without children under age 18 (Class M)	-0.0584	0.1880	-0.1859
Age (Class B) * Multi-family household (Class O)	-0.5535	-0.4775	1.0131
Age (Class D) * Single family household with children under age 18 (Class L)	1.8943	1.6565	1.1358
Age (Class D) * Single family household without children under age 18 (Class M)	0.5035	1.5330	0.7934
Age (Class D) * Multi-family household (Class O)	-0.1970	-1.0858	1.4506
Income quartile (Class E) * Single family household with children under age 18 (Class L)	0.6586	0.3508	0.4030
Income quartile (Class E) * Single family household without children under age 18 (Class M)	0.5380	0.5707	0.2431
Income quartile (Class E) * Multi-family household (Class O)	0.7010	0.7278	-0.0122
Income quartile (Class F) * Single family household with children under age 18 (Class L)	0.1413	0.1397	0.1974
Income quartile (Class F) * Single family household without children under age 18 (Class M)	-0.0066	0.1733	-0.0297
Income quartile (Class F) * Multi-family household (Class O)	-0.1798	0.5021	0.0447
Income quartile (Class H) * Single family household with children under age 18 (Class L)	0.1899	0.4181	0.8741
Income quartile (Class H) * Single family household without children under age 18 (Class M)	0.3233	0.6373	0.8322
Income quartile (Class H) * Multi-family household (Class O)	-0.0553	0.1256	0.7628
TEST STATISTICS			
Maximum-rescaled R-square	0.3490	0.3882	0.4227
Chi-square (Pr>ChiSquare)	0.0022	0.0656	0.0098

Note: Shaded numbers indicate that the variables are not significant at 0.05 significance level

Table 4: Maximum Likelihood (ML) estimates for households located in CMA areas (comparison over 3 years)

	1998	1999	2000
MAIN VARIABLES			
Intercept	-1.3903	-1.1745	-0.6830
Age (Class A)	1.8093	1.6301	1.4514
Age (Class B)	1.0114	0.9622	0.6081
Age (Class D)	-1.1103	-1.3038	-1.1560
Income quartile (Class E)	-1.4429	-1.0505	-1.3073
Income quartile (Class F)	-0.8495	-0.8508	-0.4400
Income quartile (Class H)	0.4266	0.6562	0.7592
Self-employment Income (Yes)	0.3326	0.4026	0.6603
Education level (Class I)	-0.7629	-0.8836	-0.7747
Education level (Class K)	1.0007	0.9295	0.9407
Single family household with children under age 18 (Class L)	0.9447	1.3979	1.3534
Single family household without children under age 18 (Class M)	0.6952	0.5940	0.5316
Multi-family household (Class O)	0.1539	0.5438	0.2352
INTERACTION VARIABLES 0.6128			
Age (Class A) * Income quartile (Class E)	0.2072	0.2709	0.6128
Age (Class A) * Income quartile (Class F)	0.2830	0.3355	-0.0103
Age (Class A) * Income quartile (Class H)	-0.1967	-0.0906	-0.5170
Age (Class B) * Income quartile (Class E)	-0.0707	-0.0926	0.3538
Age (Class B) * Income quartile (Class F)	0.0494	0.1234	0.2622
Age (Class B) * Income quartile (Class H)	0.0312	-0.0236	-0.1400
Age (Class D) * Income quartile (Class E)	-0.2558	-0.4829	-0.2704
Age (Class D) * Income quartile (Class F)	-0.3168	0.0956	0.0079
Age (Class D) * Income quartile (Class H)	0.1137	-0.6899	-0.5296
Age (Class A) * Single family household with children under age 18 (Class L)	-1.6439	-1.9771	-1.3798
Age (Class A) * Single family household without children under age 18 (Class M)	-1.1356	-0.7532	-0.3261
Age (Class A) * Multi-family household (Class O)	-0.4516	-0.4318	0.3465
Age (Class B) * Single family household with children under age 18 (Class L)	-0.6530	-0.9179	-0.4190
Age (Class B) * Single family household without children under age 18 (Class M)	-0.5431	-0.4821	-0.1902
Age (Class B) * Multi-family household (Class O)	-0.3587	-0.4180	-0.2266
Age (Class D) * Single family household with children under age 18 (Class L)	1.9444	1.7307	1.4116
Age (Class D) * Single family household without children under age 18 (Class M)	0.0804	0.7458	0.4188
Age (Class D) * Multi-family household (Class O)	-1.7464	1.6146	1.3184
Income quartile (Class E) * Single family household with children under age 18 (Class L)	0.3306	0.3976	0.0822
Income quartile (Class E) * Single family household without children under age 18 (Class M)	1.0216	0.7698	0.5211
Income quartile (Class E) * Multi-family household (Class O)	0.8921	0.6512	0.1423
Income quartile (Class F) * Single family household with children under age 18 (Class L)	0.3461	0.4380	0.0843
Income quartile (Class F) * Single family household without children under age 18 (Class M)	0.2125	0.2477	-0.0728
Income quartile (Class F) * Multi-family household (Class O)	0.4256	0.2708	0.0618
Income quartile (Class H) * Single family household with children under age 18 (Class L)	0.2111	0.2309	0.1279
Income quartile (Class H) * Single family household without children under age 18 (Class M)	0.4780	0.3188	0.2660
Income quartile (Class H) * Multi-family household (Class O)	0.6128	0.1520	0.5090
TEST STATISTICS			
Maximum-rescaled R-square	0.3845	0.3947	0.4252
Chi-square (Pr>ChiSquare)	0.0779	0.3995	0.2455

Note: Shaded numbers indicate that the variables are not significant at 0.05 significance level

Table 5: Comparison of Maximum Likelihood (ML) estimates for households located in CMA areas vs. households located in non-CMA areas (combining 3 years)

	Households in CMA areas	Households in non-CMA areas
MAIN VARIABLES		
Intercept	-06089	-0.4713
Age (Class A)	1.4604	1.0372
Age (Class B)	0.7461	0.3994
Age (Class D)	-1.1654	-1.3902
Income quartile (Class E)	-1.1988	-1.3857
Income quartile (Class F)	-0.5298	-0.6985
Income quartile (Class H)	0.6433	-0.0614
Self-employment Income (Yes)	0.4247	0.3553
Education level (Class I)	-1.3678	-1.3431
Education level (Class K)	0.7794	1.1068
Single family household with children under age 18 (Class L)	1.3334	1.4302
Single family household without children under age 18 (Class M)	0.4889	0.4318
Multi-family household (Class O)	0.2777	0.5138
Year (1998)	-0.5411	-0.8160
Year (1999)	-0.4386	-0.5642
INTERACTION VARIABLES		
Age (Class A) * Income quartile (Class E)	0.3563	0.3753
Age (Class A) * Income quartile (Class F)	0.1922	0.1543
Age (Class A) * Income quartile (Class H)	-0.3337	0.0412
Age (Class B) * Income quartile (Class E)	0.0761	0.2094
Age (Class B) * Income quartile (Class F)	0.1413	0.1255
Age (Class B) * Income quartile (Class H)	-0.0664	0.4121
Age (Class D) * Income quartile (Class E)	-0.4062	-0.0297
Age (Class D) * Income quartile (Class F)	-0.0237	0.1767
Age (Class D) * Income quartile (Class H)	-0.3735	-0.2640
Age (Class A) * Self-employment Income (Yes)	-0.0393	-0.0166
Age (Class B) * Self-employment Income (Yes)	0.1545	0.0477
Age (Class D) * Self-employment Income (Yes)	0.4719	0.4014
Age (Class A) * Education level (Class I)	0.3075	0.0837
Age (Class A) * Education level (Class K)	0.4189	0.3448
Age (Class B) * Education level (Class I)	0.1594	0.0803
Age (Class B) * Education level (Class K)	0.1506	0.0516
Age (Class D) * Education level (Class I)	0.2907	0.1228
Age (Class D) * Education level (Class K)	-0.0841	-0.1225
Age (Class A) * Single family household with children under age 18 (Class L)	-1.6074	-1.4564
Age (Class A) * Single family household without children under age 18 (Class M)	-0.6701	-0.3002
Age (Class A) * Multi-family household (Class O)	-0.0907	-0.3353
Age (Class B) * Single family household with children under age 18 (Class L)	-0.6462	-0.3282
Age (Class B) * Single family household without children under age 18 (Class M)	-0.3663	-0.0153
Age (Class B) * Multi-family household (Class O)	-0.2786	0.0236
Age (Class D) * Single family household with children under age 18 (Class L)	1.4619	1.3677
Age (Class D) * Single family household without children under age 18 (Class M)	0.3122	0.5534
Age (Class D) * Multi-family household (Class O)	0.9545	0.3512
Income quartile (Class E) * Education level (Class I)	-0.2112	-0.1424
Income quartile (Class E) * Education level (Class K)	0.1126	0.1264
Income quartile (Class F) * Education level (Class I)	-0.3036	-0.2081
Income quartile (Class F) * Education level (Class K)	-0.0547	-0.1035
Income quartile (Class H) * Education level (Class I)	-0.2865	-0.1566
Income quartile (Class H) * Education level (Class K)	0.0331	0.1970
Income quartile (Class E) * Single family household with children under age 18 (Class L)	0.2390	0.3627
Income quartile (Class E) * Single family household without children under 18	0.7116	0.3706

(Class M)		
Income quartile (Class E) * Multi-family household (Class O)	0.5288	0.4377
Income quartile (Class F) * Single family household with children under age 18 (Class L)	0.3043	0.1381
Income quartile (Class F) * Single family household without children under 18 (Class M)	0.1399	0.0401
Income quartile (Class F) * Multi-family household (Class O)	0.2582	0.1230
Income quartile (Class H) * Single family household with children under age 18 (Class L)	0.2131	0.5428
Income quartile (Class H) * Single family household without children under 18 (Class M)	0.3627	0.6506
Income quartile (Class H) * Multi-family household (Class O)	0.4526	0.3145
Income quartile (Class E) * Year (1998)	-0.1994	0.0196
Income quartile (Class E) * Year (1999)	0.1365	0.0896
Income quartile (Class F) * Year (1998)	-0.2610	0.0356
Income quartile (Class F) * Year (1999)	-0.1411	0.0616
Income quartile (Class H) * Year (1998)	-0.0140	0.1098
Income quartile (Class H) * Year (1999)	0.0586	-0.0102
Self-employment Income (Yes) * Single family household with children under age 18 (Class L)	0.2653	0.0018
Self-employment Income (Yes) * Single family household without children under age 18 (Class M)	0.0846	-0.0055
Self-employment Income (Yes) * Multi-family household (Class O)	-0.1283	0.0742
Self-employment Income (Yes) * Year (1998)	-0.3274	-0.1850
Self-employment Income (Yes) * Year (1999)	-0.2754	-0.0160
Education level (Class I) * Single family household with children under age 18 (Class L)	0.6032	0.6755
Education level (Class I) * Single family household without children under age 18 (Class M)	0.6614	0.4233
Education level (Class I) * Multi-family household (Class O)	0.5274	0.3760
Education level (Class K) * Single family household with children under age 18 (Class L)	-0.0737	-0.3798
Education level (Class K) * Single family household without children under age 18 (Class M)	0.0389	-0.2577
Education level (Class K) * Multi-family household (Class O)	0.1043	0.0068
Single family household with children under age 18 (Class L) * Year (1998)	-0.4316	-0.2742
Single family household with children under age 18 (Class L) * Year (1999)	-0.1729	-0.0299
Single family household without children under age 18 (Class M) * Year (1998)	-0.0183	-0.0077
Single family household without children under age 18 (Class M) * Year (1999)	0.0371	-0.0015
Multi-family household (Class O) * Year (1998)	-0.1975	-0.1550
Multi-family household (Class O) * Year (1999)	0.0341	0.1158
TEST STATISTICS		
Maximum-rescaled R-square	0.4144	0.4033
Chi-square (Pr>ChiSquare)	0.0918	0.0025

Note: Shaded numbers indicate that the variables are not significant at 0.05 significance level

APPENDIX C: Odds ratio estimates

Table 6: Odds Ratio Estimates for 3 years (households located in CMA areas + households not located in CMA areas)

	1998	1999	2000	Explanation
Not living in a CMA (Yes vs No)	0.814	0.837	0.837	Households located in CMA areas are more likely to use Internet
Age (Class A vs. Class C)	2.230	2.215	2.442	A is more likely than C to use the Internet
Age (Class A vs. Class B)	1.175	1.208	1.323	A is more likely that B to use the Internet
Age (Class B vs. Class C)	1.898	1.883	1.877	B is more likely than C to use the Internet
Age (Class D vs. Class C)	0.352	0.394	0.390	C is more likely than D to use the Internet
Income quartile (Class E vs. Class G)	0.393	0.481	0.418	G is more likely than E to use the Internet
Income quartile (Class E vs. Class F)	0.649	0.753	0.627	F is more likely than E to use the Internet
Income quartile (Class F vs. Class G)	0.606	0.639	0.664	G is more likely than F to use the Internet
Income quartile (Class H vs. Class G)	2.000	1.995	1.881	H is more likely than G to use the Internet
Self-employment Income (Yes vs. No)	1.330	1.488	1.717	Self-employed more likely to use the Internet
Education level (Class I vs. Class J)	0.435	0.396	0.427	J is more likely than I to use the Internet
Education level (Class K vs. Class J)	2.828	2.680	2.760	K is more likely than J to use the Internet
Family Type (L vs. N)	1.581	2.265	2.736	L is more likely to use the Internet than N
Family Type (L vs. M)	1.005	1.312	1.157	L is more likely than M to use the Internet
Family Type (M vs. N)	1.572	1.727	1.839	M is more likely to use the Internet than N
Family Type (O vs. M)	1.007	1.276	1.157	O is more likely than M to use the Internet
Family Type (O vs. L)	1.002	0.972	0.750	O is more likely than L to use the Internet
Family Type (O vs. N)	1.583	2.203	2.053	O is more likely to use the Internet than N

Table 7: Odds Ratio Estimates (combining 3 years) (households located in CMA areas + households not located in CMA areas)

		Explanation
Not living in a CMA (Yes vs. No)	0.829	Households located in CMA areas are more likely to use the Internet
Age (Class A vs. Class C)	2.304	A is more likely than C to use the Internet
Age (Class A vs. Class B)	1.225	A is more likely that B to use the Internet
Age (Class B vs. Class C)	1.881	B is more likely than C to use the Internet
Age (Class D vs. Class C)	0.376	C is more likely than D to use the Internet
Income quartile (Class E vs. Class G)	0.431	G is more likely than E to use the Internet
Income quartile (Class E vs. Class F)	0.673	F is more likely than E to use the Internet
Income quartile (Class F vs. Class G)	0.640	G is more likely than F to use the Internet
Income quartile (Class H vs. Class G)	1.962	H is more likely than G to use the Internet
Self-employment (Yes vs. No)	1.489	Self-employed more likely to use the Internet
Education level (Class I vs. Class J)	0.419	J is more likely than I to use the Internet
Education level (Class K vs. Class J)	2.768	K is more likely than J to use the Internet
Family Type (L vs. N)	2.145	L is more likely than N to use the Interne
Family Type (L vs. M)	1.243	L is more likely than M to use the Internet
Family Type (M vs. N)	1.726	M is more likely than N to use the Internet
Family Type (O vs. M)	1.122	O is more likely than M to use the Internet
Family Type (O vs. N)	1.936	O is more likely than N to use the Internet
Year (P vs. R)	0.413	Households in year R were more likely to use Internet than in year P
Year (P vs. Q)	0.690	Households in year Q were more likely to use Internet than in year P
Year (Q vs. R)	0.599	Households in year R were more likely to use Internet than in year Q

Table 8: Odds Ratio Estimates for 3 years (households located in CMA areas)

	1998	1999	2000	Explanation
Age (Class A vs. Class C)	2.507	2.515	2.770	A is more likely than C to use the Internet
Age (Class A vs. Class B)	1.331	1.353	1.511	A is more likely that B to use the Internet
Age (Class B vs. Class C)	1.884	1.832	1.833	B is more likely than C to use the Internet
Age (Class D vs. Class C)	0.333	0.391	0.372	C is more likely than D to use the Internet
Income quartile (Class E vs. Class G)	0.375	0.524	0.446	G is more likely than E to use the Internet
Income quartile (Class E vs. Class F)	0.633	0.800	0.606	F is more likely than E to use the Internet
Income quartile (Class F vs. Class G)	0.592	0.656	0.736	G is more likely than F to use the Internet
Income quartile (Class H vs. Class G)	2.045	2.216	2.052	H is more likely than G to use the Internet
Self-employment Income (Yes vs. No)	1.401	1.487	1.929	Self-employed more likely to use the Internet
Education level (Class I vs. Class J)	0.458	0.418	0.434	J is more likely than I to use the Internet
Education level (Class K vs. Class J)	2.773	2.653	2.634	K is more likely than J to use the Internet
Family Type (L vs. N)	1.325	1.935	1.713	L is more likely to use the Internet than N
Family Type (L vs. M)	0.869	1.127	1.374	L is more likely to use the Internet than M
Family Type (M vs. N)	1.526	1.717	1.862	M is more likely to use the Internet than N
Family Type (O vs. M)	0.958	1.202	1.076	O is more likely to use the Internet than M
Family Type (O vs. N)	1.461	2.064	1.797	O is more likely to use the Internet than N

Table 9 Odds Ratio Estimates for 3 years (households not located in CMA areas)

	1998	1999	2000	Explanation
Age (Class A vs. Class C)	1.831	1.816	2.140	A is more likely than C to use the Internet
Age (Class A vs. Class B)	0.958	1.015	1.089	A is more likely that B to use the Internet
Age (Class B vs. Class C)	1.969	1.789	1.965	B is more likely than C to use the Internet
Age (Class D vs. Class C)	0.361	0.397	0.412	C is more likely than D to use the Internet
Income quartile (Class E vs. Class G)	0.408	0.413	0.394	G is more likely than E to use the Internet
Income quartile (Class E vs. Class F)	0.655	0.674	0.666	F is more likely than E to use the Internet
Income quartile (Class F vs. Class G)	0.629	0.613	0.592	G is more likely than F to use the Internet
Income quartile (Class H vs. Class G)	1.864	1.731	1.677	H is more likely than G to use the Internet
Self-employment (Yes vs. No)	1.168	1.494	1.489	Self-employed more likely to use the Internet
Education level (Class I vs. Class J)	0.427	0.375	0.423	J is more likely than I to use the Internet
Education level (Class K vs. Class J)	2.954	2.743	3.041	K is more likely than J to use the Internet
Family Type (L vs. N)	2.259	1.574	2.584	L is more likely to use the Internet than N
Family Type (L vs. M)	1.219	0.853	1.462	L is more likely to use the Internet than M
Family Type (M vs. N)	1.870	1.845	1.767	M is more likely to use the Internet than N
Family Type (O vs. M)	0.990	1.168	1.195	O is more likely to use the Internet than M
Family Type (O vs. N)	1.757	2.155	2.111	O is more likely to use the Internet than N

Table 10: Comparing Odds Ratio Estimates for households located in CMA areas vs. households located in non-CMA areas (combining 3 years)

	Households in CMA areas	Households in non-CMA areas	Explanation
Age (Class A vs. Class C)	2.602	1.881	A is more likely than C to use the Internet
Age (Class A vs. Class B)	1.389	1.005	A is more likely that B to use the Internet
Age (Class B vs. Class C)	1.873	1.872	B is more likely than C to use the Internet
Age (Class D vs. Class C)	0.362	0.398	C is more likely than D to use the Internet
Income quartile (Class E vs. Class G)	0.446	0.414	G is more likely than E to use the Internet
Income quartile (Class E vs. Class F)	0.672	0.677	F is more likely than E to use the Internet
Income quartile (Class F vs. Class G)	0.664	0.612	G is more likely than F to use the Internet
Income quartile (Class H vs. Class G)	2.106	1.790	H is more likely than G to use the Internet
Self-employment Income (Yes vs. No)	1.567	1.398	Self-employed more likely to use the Internet
Education level (Class I vs. Class J)	0.435	0.402	J is more likely than I to use the Internet
Education level (Class K vs. Class J)	2.686	2.908	K is more likely than J to use the Internet
Family Type (L vs. N)	1.837	2.747	L is more likely to use the Internet than N
Family Type (L vs. M)	1.090	1.492	L is more likely to use the Internet than M
Family Type (M vs. N)	1.685	1.841	M is more likely to use the Internet than N
Family Type (O vs. M)	1.065	1.195	O is more likely to use the Internet than M
Family Type (O vs. N)	1.314	2.200	O is more likely to use the Internet than N
Year (R vs. P)	2.355	2.525	Households in year R were more likely to use Internet than in year P
Year (P vs. Q)	0.704	0.668	Households in year Q were more likely to use the Internet than in year P
Year (R vs. Q)	1.658	1.685	Households in year R were more likely to use the Internet than in year Q

APPENDIX D: Comparison of coefficient estimates

Table 11: Comparison of Maximum Likelihood (ML) estimates (households located in CMA areas and households located in non-CMA areas)

RANK	ML estimates (1998+1999+2000)	ML estimates for 1998	ML estimates for 1999	ML estimates for 2000
1	Age Class A (15-34 years)	Age Class A (15-34 years)	Age Class A (15-34 years)	Age Class A (15-34 years)
2	Family Type Class L (Single family household with children under age 18)	Education level Class K (University degree)	Education level Class K (University degree)	Education level Class K (University degree)
3	Age Class B (35-54 years)	Family Type Class L (Single family household with children under age 18)	Family Type Class L (Single family household with children under age 18)	Family Type Class L (Single family household with children under age 18)
4	Family Type Class M (Single family household without children under age 18)	Age Class B (35-54 years)	Age Class B (35-54 years)	Income quartile Class H ($60,000+)
5	Education level Class K (University degree)	If children under age 18 (Yes)	If children under age18 (Yes)	Age Class B (35-54 years)
6	If children under age 18 (Yes)	Self-employment Income (Yes)	Self-employment Income (Yes)	Self-employment Income (Yes)
7	Self-employment Income (Yes)	Family Type Class M (Single family household without children under age 18)	Family Type Class M (Single family household without children under age 18)	Family Type Class M (Single family household without children under age 18)
8	Income quartile Class H ($60,000+)	Family type Class O (Multi-family household)	Family type Class O (Multi-family household)	If children under age 18 (Yes)
9	Family type Class O (Multi-family household)	Income quartile Class H ($60,000+)	Income quartile Class H ($60,000+)	Marital Status (Married)
10	*Distance to the nearest CMA*	Distance to the nearest CMA or CA	Distance to the nearest CMA or CA	Family type Class O (Multi-family household)
11	*Distance to the nearest CA or CMA*	Distance to the nearest CMA	Distance to the nearest CMA	*Distance to the nearest CMA with population over 500,000*
12	*Household not located in a CMA (Yes)*	Distance to the nearest CMA with population over 500,000	Distance to the nearest CMA with population over 500,000	*Distance to the nearest CMA*
13	*Marital Status (Married)*	*Marital Status (Married)*	*Marital Status (Married)*	*Distance to the nearest CMA or CA*
14	*Sex (Male)*	*Sex (Male)*	*Sex (Male)*	*Household not located in a CMA (Yes)*
15	*Year (1999)*	*Household not located in a CMA (Yes)*	*Household not located in a CMA (Yes)*	*Sex (Male)*
16	*Year (1998)*	*Income quartile Class F ($20,001-$35,999)*	*Income quartile Class F ($20,001-$35,999)*	*Income quartile Class F ($20,001-$35,999)*
17	*Income quartile Class F ($20,001-$35,999)*	*Age Class D (65+ years)*	*Age Class D (65+ years)*	*Income quartile Class E ($0-$19,999)*
18	*Education level Class I (Not completed high school)*	*Education level Class I (Not completed high school)*	*Education level Class I (Not completed high school)*	*Education level Class I (Not completed high school)*
19	*Age Class D (65+ years)*	*Income quartile Class E ($0-$19,999)*	*Income quartile Class E ($0-$19,999)*	*Age Class D (65+ years)*
20	*Income quartile Class E ($0-$19,999)*			

Note: **Italics = Negative values**

The above represents ranking (importance) of the independent variables

Table 12: Comparison of Maximum Likelihood (ML) estimates (households located in CMA areas vs. households located in non-CMA areas)

RANK	Households located in CMA areas	Households not located in CMA areas
1	Age Class A (15-34 years)	Family type Class L (Single family household with children under age 18)
2	Family type Class L (Single family household with children under age 18)	Age Class A (15-34 years)
3	Age Class B (35-54 years)	Education level Class K (University degree)
4	Family type Class M (Single family household without children under age 18)	Family type Class M (Single family household without children under age 18)
5	Income quartile Class H ($60,000+)	Age Class B (35-54 years)
6	Education level Class K (University degree)	Family type Class O (Multi-family household)
7	Self-employment Income (Yes)	Self-employment Income (Yes)
8	If children under age 18 (Yes)	Marital Status (Married)
9	Family type Class O (Multi-family household)	If children under age 18 (Yes)
10	*Sex (Male)*	*Income quartile Class H ($60,000+)*
11	*Year (1999)*	*Year (1999)*
12	*Income quartile Class F ($20,001-$35,999)*	*Sex (Male)*
13	*Year (1998)*	*Income quartile Class F ($20,001-$35,999)*
14	*Marital Status (Married)*	*Year (1998)*
15	*Education level Class I (Not completed high school)*	*Education level Class I (Not completed high school)*
16	*Age Class D (65+ years)*	*Age Class D (65+ years)*
17	*Income quartile Class E ($0-$19,999)*	*Income quartile Class E ($0-$19,999)*

Note: **Italics = Negative values**

The above represents ranking (importance) of the independent variables

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