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Computer Literacy, Online Experience or Socioeconomic Characteristics

What are the Main Determinants of Broadband Internet Adoption and Internet Usage?

Joeffrey DROUARD
Telecom ParisTech, Paris, France;
European University Institute (Florence School of Regulation, RSCAS), Italy

Abstract: In this paper, we analyze the broadband Internet adoption/usage decisions. To this end, we estimate a sample selection model. In the first stage, we analyze whether the individuals have adopted broadband Internet; in the second stage, we analyze the Internet usage diversity given adoption. We show that low income and less-educated people are less likely to have adopted broadband Internet, but they do not have a less diversified Internet usage given adoption. Furthermore, after controlling for a set of socioeconomic factors and the computer skills, we show that online experience is a powerful determinant of usage diversity.

Key words: Digital Divide; Broadband Internet Adoption; Internet Usage; Diversity.

Broadband diffusion is viewed by many authors as a critical driver of productivity, growth and economic transformation (LEHR *et al*., 2005; LITAN, 2005; CRANDALL *et al*., 2007). A question at the heart of policy debates in many countries is how to achieve an advanced and egalitarian information and communication society. Beside the policy concerns about the supply side (encouraging the deployment of broadband networks while developing competition in these markets), several policies have been implemented in order to fight against digital exclusion on the demand side. In particular, many of these policies aim at facilitating broadband Internet access to people on law incomes and with a lawer level of education.

However, having a broadband Internet connection (at home, in the work place or in a public place…) is only a first step, the second step being to be able to use the Internet effectively and autonomously. ROBINSON *et al*. (2003) notice that bridging the gap between those who do not use the Internet or do not have Internet access is essential, but we should keep in

mind that significant disparities in the nature of the uses and the appropriation of the opportunities offered by the Internet remain within the population of Internet users. This issue is becoming more and more relevant as the number of Internet applications - particularly in relation to education, health and government services - is increasing and as the importance of the Internet for seeking information, finding a job and engaging in civic or entrepreneurial activities is growing. Therefore, more and more researchers have focused their attention on the issue of Internet usage instead of the issue of Internet access. [1] This change in the object of study raises the question of the main determinants of Internet usage and if they are similar to those of Internet access.

There is vast empirical literature analyzing the determinants of Internet access (CHAUDHURI *et al*., 2005; CHAUDHURI & FLAMM, 2007; PRIEGER & HU, 2008) and the determinants of Internet usage (LENHART *et al*., 2003; SUIRE, 2007). Contrary to the digital divide related to access, inequalities in Internet usage are not mainly determined by economic and financial variables and rather by non-market interaction and cognitive determinants (LEGUEL *et al*., 2005). For example, GOLDFARB & PRINCE (2008) show that high-income, educated people were more likely to have adopted the Internet, but conditional on adoption, low income, less educated people spend more time online.

Most of the previous econometric papers analyzing Internet usage focus on specific uses (e.g., LEGUEL *et al*., 2005; LAMBRECHT & SEIM, 2006; SUIRE, 2007). Analyzing a specific usage does not provide an overall measure of the interest in the Internet; however this allows highlighting how each Internet use is differently affected by the socioeconomic factors. [2] Internet usage has also been analyzed from the intensity perspective (e.g., GOLDFARB & PRINCE (2008) define internet usage as "hours spent online for personal reasons"). Whereas the intensity of use is informative, this indicator does not take into account repeat visits to similar websites. In this paper, we analyze Internet usage from the diversity perspective. This approach provides an indication of individual-level willingness to use the expanding set of opportunities offered by the Internet. The main weakness of such approach is to group together Internet uses which might be affected in

1 See, for instance, DiMAGGIO *et al*. (2004) for a detailed literature review.

2 For example, SUIRE (2007) shows that people under 24 years old are less likely to use e-government services but not to use e-commerce services than people aged between 25 and 34 years old.

a different way by the socioeconomic factors. Consequently, the effect of certain socioeconomic factors could be smoothed.

Using data collected in the form of surveys of French households by INSEE in 2005, we estimate a sample selection model. In the first stage, individuals decide whether or not to adopt broadband Internet; in the second stage, we analyze the Internet usage diversity given adoption. Our paper allows determining the main factors that explain the cross-sectional variance (i) in broadband adoption and (ii) in the diversity of Internet use given adoption.

Our results are in line with other findings in the literature. In particular, we show that low income and less-educated people are less likely to have adopted broadband Internet, but they do not have a less diversified Internet usage given adoption. In order to gain understanding of the main driver of the cross-sectional variance in the diversity of Internet use, we also analyze the effects of the computer skills and the online experience on the diversity of Internet use. Interestingly, after controlling for a set of socioeconomic factors and the computer skills, we show that online experience has a significant effect on the usage diversity.

The rest of the paper is organized as follows. In the next section, we present the data. Then, we outline the conceptual framework to analyze broadband adoption and the diversity of Internet use. In the section after, we present the results and discuss some policy implications. Then we provide a short conclusion to this paper

■ The data

This paper was made possible by the availability of a unique database, collected in the form of surveys of French households by INSEE in October 2005. [3] In particular, the database contains information on demographic variables and on ICT equipment of French households.

The database contains initially 5603 observations and is composed of two parts: one at the household level and the other at the individual level. In

[3] The name of the survey is "Technologies de l'information et de la communication".

each household, one individual (belonging or not to the reference group [4]) was randomly drawn to participate in a detailed (individual) investigation.

Sample restriction

In our data, we observe Internet usage only for the respondent to the individual investigation, while Internet adoption is observed for the entire household. In order to avoid that a separation between the decision to adopt and the choice of usage affects our results, all the households in which the respondent to the individual investigation did not belong to the reference group have been excluded from the sample. [5] After the exclusion of missing data, the sample (used for the econometric analysis) contains 4691 observations.

The dependent variables

For each household, we observe whether or not it has a broadband connection at home and for one individual (i.e., the one drawn to participate to the detailed investigation), we observe whether she/he has used the Internet during the month preceding the survey. In case she/he did, we observe for which purpose she/he has used the Internet. More specifically, we have information on different Internet uses, which are defined in response to question such as "did you use the Internet in the last month to...".

The information relating to these Internet uses are reported in Table 1. Column (A) and Column (B) show the mean of each of these Internet uses for the Internet users without a broadband connection at home and for the Internet users with a broadband connection at home, respectively. In our sample, 54.4% (resp., 45.6%) of the Internet users have (resp., do not have) a broadband connection at home.

[4] The reference group being defined as the group of people that make decisions affecting the household (e.g., regarding the household's consumption). In our database, households specify themselves which members belong to the reference group. The children do not usually belong to the reference group.

[5] Excluding these households is similar as excluding missing at random data and therefore does not raise any issue regarding the robustness of our results

Table 1 - Detailed description of the 11 Internet uses

	Internet Users without a broadband connection at home (915 observations)	Internet Users with a broadband connection at home (1092 observations)
	(A)	(B)
Use of the Internet the month preceding the survey		
In a private purpose to participate in chats and discussion forums. (FORUM)	.065	.172
In a private purpose to communicate through instant messaging (MSN Messenger), to call (Skype, MSN, etc.) or to send and receive email. (COMMUNICATE)	.607	.908
For a private purpose in order to make private research (scientific, cultural or technical). (BASIC RESEARCH)	.786	.950
For a private purpose to download software or programs. (DOWNLOADING)	.128	.326
For a private purpose to buy or order goods and services. (SHOPPING)	.244	.514
For a private purpose to listen the radio, to read or download magazine or newspapers. (INFORMATION)	.203	.429
For a private purpose to access her/his bank account or buy shares or securities. (BANK)	.296	.611
For a private purpose to play or download games. (GAMES)	.071	.205
For a private purpose to listen to, see or download music or movies. (MUSIC-MOVIES)	.101	.321
For a private purpose to access e-government (i.e., obtain or download administrative forms or to fill in online or send by the Internet administrative forms). (ADMINISTRATION)	.516	.692
For a private purpose to access health or nutrition information. (HEALTH)	.221	.372

For the rest of the paper, we will count individuals as adopters if (i) they have a broadband connection at home and (ii) they have used the Internet during the month preceding the survey. Thus, people who use the Internet but do not have a broadband connection at home are not considered as adopters. Almost half of the Internet users are not considered as Internet adopters (we discuss this potential limit in the conclusion of the paper). However, doing this, ensures that usage diversity is analyzed with similar endowment (i.e., provided that they have a broadband connection at home) and that our results are not driven by differences in the household's ICT equipment. Notice that adoption is defined in a relatively similar manner by

GOLDFARB & PRINCE (2008). Indeed, they count individuals as adopters if, when asked about home connection, they give any response other than "I don't connect from home."

We note *A* and *D* the two dependent variables related to broadband adoption and to the usage diversity, respectively. These two variables are defined in the following manner:

$A_i=1$ if the individual i has adopted broadband Internet (i.e., she/he has a broadband connection at home and has used the Internet during the month preceding the survey), 0 otherwise.

$$D_i = \begin{cases} 0 & \text{if the individual i has had 2 or less of the 11 Internet uses} \\ 1 & \text{if the individual i has had 3 of the 11 Internet uses} \\ 2 & \text{if the individual i has had 4 of the 11 Internet uses} \\ 3 & \text{if the individual i has had 5 of the 11 Internet uses} \\ 4 & \text{if the individual i has had 6 of the 11 Internet uses} \\ 5 & \text{if the individual i has had 7 of the 11 Internet uses} \\ 6 & \text{if the individual i has had 8 of the 11 Internet uses} \\ 7 & \text{if the individual i has had 9 or more of the 11 Internet uses} \end{cases}$$

Descriptive statistics of the variables A and D are summarized in Table 2a and Table 2b, respectively.

Table 2a - Descriptive statistic of the variable A

A	
0	76.72%
1	23.28%

Table 2b: Descriptive statistic of the variable D

D	0	1	2	3	4	5	6	7
	9.52%	10.44%	14.29%	16.03%	16.21%	13.46%	9.52%	10.53%

From Table 2a and Table 2b, we can see that 23.28% of the individuals have adopted broadband Internet (i.e., have a broadband connection at home and have used the Internet during the month preceding the survey); 10.53% of the adopters have had a highly diversified Internet use (i.e., D=7) and 9.52% have had a non diversified Internet use (i.e., D=0).

The explanatory variables

The explanatory variables used for our econometric study can be separated into two sets. One set is the data at the individual level, which controls for gender, age, education, opinion on new technologies, sociability [6] and status (student or not). The second set consists of the data at the household level, which controls for adjusted income - the adjusted income is obtained by dividing the family's income by the weighted sum of its members (see GUILLEMIN & ROUX, 2001), characteristics of the metropolitan area (average income, degree of urbanization), number of persons in the household, whether or not a teenager lives in the household.

In order to gain understanding of the main driver of the cross-sectional variance in Internet usage, we also analyze the effects of the computer skills [7] and the online experience on the diversity of Internet use. To the extent that the variability of these factors is relatively weak in the subsample of non-adopters, we do not include these two variables in the set of the explanatory variables used to analyze broadband Internet adoption. Thus, these two variables are only used to explain the diversity of Internet use.

How we built the computer skills variable

In our database, we observe for each respondent (to the individual investigation) having already used a computer if she/he knows how (i) to copy or paste a file, (ii) to use the tool copy/paste to move information in a document, (iii) to install a new hardware (printer, modem…), (iv) to use basic arithmetic formulas in a spreadsheet (Excel, Quattro, Lotus…), (v) to write a

6 Similar to SUIRE (2007), we have created two variables related to the social environment of the individual. The first variable is labeled association. This variable takes two values, 1 if she/he is an active member of an association, 0 otherwise. This variable concerns the capital within the meaning of PUTNAM (1993). According to Putnam, being a member of an association strengthens, among other things, the trust between individuals. The second is named friends. This variable takes two values, 1 if she/he meets with her/his friends at least once a week, 0 otherwise. This variable refers, stricto sensu, to the social network (i.e., the number of acquaintances). Notice that the strict causal link between the levels of sociability and Internet usage is not perfectly defined. Some studies have investigated whether the use of the Internet could have a positive impact on the social network of the Internet users, but the results are not settled. See, for instance, PÉNARD & POUSSING (2006) for a detailed discussion.

7 One potential issue is that computer skills could be influenced by Internet usage and thus there will not be a strict sense of causality between these two variables. In order to diminish this potential issue, only skills related to the use of the computer and not to the use of the Internet are included in the variable related to the computer skills.

computer program using a specific computer language (Visual Basic, Fortran, Java, C++, …). The variable related to the computer skills takes 6 values according to the number of computer tasks that she/he can accomplish (the minimum value and maximum value being 0 and 5, respectively).

Table 3 - Detailed description of the explanatory variables

Household	
Number of persons	= number of persons in the household
Teenager	= 1 if there is at least one child aged over 15 years old in the household, 0 otherwise
Income (adjusted)	
less than € 899	= 1 if the monthly income is inferior than € 899, 0 otherwise
from 900 to € 1149	= 1 if the monthly income is between € 900 and 1149, 0 otherwise
from 1150 to € 1499	= 1 if the monthly income is between € 1150 and 1499, 0 otherwise
from 1500 to € 1999	= 1 if the monthly income is between € 1500 and 1999, 0 otherwise
more than € 2000	= 1 if the monthly income is superior than € 2000, 0 otherwise
Municipality	
Low average income	= 1 if annual average income in the area is lower than €20000, 0 otherwise
Urbanization	
low	= 1 if the population density in the metropolitan area is low, 0 otherwise
medium	= 1 if the population density in the metropolitan area is intermediate, 0 otherwise
high	= 1 if the population density in the metropolitan area is high, 0 otherwise
Individiual	
Man	= 1 if the individual is a man, 0 otherwise
Student	= 1 if she/he is a student, 0 otherwise
Opinion	
Oa	= 1 if she/he totally agrees that new technologies make life easier, 0 otherwise
Ob	= 1 if she/he rather agrees that new technologies make life easier, 0 otherwise
Oc	= 1 if she/he does not agree that new technologies make life easier, 0 otherwise
Computer skills	= number of computer tasks that the she/he can accomplish
Online experience	
less than 3 years	= 1 if she/he has used the Internet for less than 1 year, 0 otherwise
from 3 to 5 years	= 1 if she/he has used the Internet for more than 3 years and less than 5 years, 0 otherwise
more than 5 years	= 1 if she/he has used the Internet for more than 5 years, 0 otherwise
Education	
no diploma	= 1 if she/he does not have any diploma, 0 otherwise
school certificate	= 1 if her/his highest degree is a school certificate, 0 otherwise
high school prof. degree	= 1 if her/his highest degree is a high school/professional degree, 0 otherwise
high school acad. degree	= 1 if her/his highest degree of is a high school academic degree, 0 otherwise
university degree	= 1 if her/his highest degree is a university degree, 0 otherwise
Age	
61 years and more	= 1 if she/he is older than 61 years old, 0 otherwise
from 51 to 60 years	= 1 if she/he is older than 51 years old and younger than 60 years old, 0 otherwise
from 41 to 50 years	= 1 if she/he is older than 41 years old and younger than 50 years old, 0 otherwise
from 31 to 40 years	= 1 if she/he is older than 31 years old and younger than 40 years old, 0 otherwise
30 years and less	= 1 if she/he is younger than 30 years old, 0 otherwise
Sociability	
association	= 1 if she/he is an active member of an association, 0 otherwise
friends	= 1 if she/he meets with her/his friends at least once a week, 0 otherwise

Table 4 - Summary statistics of the explanatory variables

	Mean on the entire sample (A)	*Mean on the selected sample* (B)
Household		
Number of persons	2.29	2.69
Teenager	.114	.140
Income (adjusted)		
less than € 899	.199	.105
from 900 to € 1149	.184	.116
from 1150 to € 1499	.199	.173
from 1500 to € 1999	.201	.257
more than € 2000	.213	.347
Municipality		
Low average income	.325	.220
Urbanization		
Low	.483	.096
Medium	.348	.302
High	.483	.601
Individual		
Man	.442	.511
Student	.032	.050
Opinion		
Oa	.407	.554
Ob	.460	.395
Oc	.131	.049
Computer skills	Not Used	2.91
Online experience		
less than 3 years	Not Used	.326
from 3 to 5 years	Not Used	.275
more than 5 years	Not Used	.397
Education		
no diploma	.148	.034
school certificate	.226	.089
high school prof. degree	.249	.202
high school acad. degree	.124	.160
university degree	.251	.512
Age		
61 years and more	.306	.077
from 51 to 60 years	.185	.160
from 41 to 50 years	.174	.228
from 31 to 40 years	.194	.317
30 years and less	.138	.215
Sociability		
association	.327	.406
friends	.544	.597
Observations	4691	1092

A detailed description and the mean of these explanatory variables are displayed in Table 3 and Table 4, respectively. Column (A) of Table 4 shows the mean of these variables on the entire sample - with all the individuals:

adopters and non-adopters. Column (B) of Table 4 shows the mean of these variables on the subsample composed only of adopters. [8]

■ The adoption/usage model

We model the adoption choice and the diversity of Internet use as a two-stage process. In the first stage, individuals decide whether to adopt broadband Internet or not, in the second stage, conditional on adoption they decide for which purposes they will use the Internet. We use a sample selection model for ordinal response.

We note A^* and D^* the latent variables associated with A and D, respectively. We assume that A^* and D^* are modeled in the following way:

$$A_i^* = X_{1,i} b_1 + u_{1,i}, \qquad [1]$$

and

$$D_i^* = X_{2,i} b_2 + u_{2,i}, \qquad [2]$$

where $X_{1,i}$ and $X_{2,i}$ are vectors of explanatory variables and $u_{1,i}$ and $u_{2,i}$ are the error terms. The errors terms $u_{1,i}$ and $u_{2,i}$ are assumed to be normally distributed with mean $(0,0)$ and variance-covariance matrix Σ, where

$$\Sigma = \begin{pmatrix} \sigma_1^2 & \rho\sigma_1\sigma_2 \\ \rho\sigma_1\sigma_2 & \sigma_2^2 \end{pmatrix},$$

[8] Apart from the variables related to the numbers of persons in the household and to the computers skills all the other variables are binary variables. Therefore, we do not defer in this table 4 the minimum, the maximum and the variance of each variable. Concerning the variable number of persons, its minimum value is 1, its maximum value is 9 and 7 and its standard deviation is 1.23 and 1.31 in the whole sample and in the selected sample, respectively. Concerning the variable computer skills, its minimum value is 0, its maximum value is 5 and its standard deviation is 1.53.

and where σ_1^2 and σ_2^2 correspond to the variance of the unobservable variables in each equation and $\rho\sigma_1\sigma_2$ corresponds to the covariance between the unobservable variables. Thus we have:

$A = 1$ if and only if $A^* \geq 0$

and

$D = k$ if and only if $D^* \in [\alpha_k, \alpha_{k+1}]$, with $\alpha_0 = -\infty$ and $\alpha_8 = +\infty$.

Notice that only $\tilde{b}_1 = b_1 / \sigma_1$, $\tilde{b}_2 = b_2 / \sigma_2$ and ρ can be identified. The observations being independent and identically distributed, the log likelihood is then given by:

$$L(\tilde{b}_1, \tilde{b}_2, \rho / A, D, X_1, X_2) = \sum_{i/A_i=0} \log \Phi(-X_{1,i}\tilde{b}_1) +$$

$$\sum_{k=0}^{7} \sum_{i/A_i=1, D_i=k} \log\left(\Phi(-X_{2,i}\tilde{b}_2 + \tilde{\alpha}_{k+1}) - \Phi(-X_{2,i}\tilde{b}_2 + \tilde{\alpha}_k) + \Theta(-X_{1,i}\tilde{b}_1, -X_{2,i}\tilde{b}_2 + \tilde{\alpha}_k) - \Theta(-X_{1,i}\tilde{b}_1, -X_{2,i}\tilde{b}_2 + \tilde{\alpha}_{k+1})\right)$$

where Φ is the cumulative normal distribution function and Θ is the bivariate cumulative normal distribution function. The maximum likelihood method is used to estimate the model.

In order to allow identification on more than functional form, we include in the first stage equation, variables that are correlated with the choice to adopt broadband Internet but not with the diversity of Internet use. Our main instruments are: whether or not a teenager lives in the household, whether or not she/he is an active member of an association and the average income in the residential area. These variables are only included in the first stage equation (i.e., equation [1]) and are not included in the second stage equation (i.e., equation [2]).

These variables are good instruments if they are correlated with broadband Internet adoption but not with the usage diversity conditional on adoption. We cannot provide any formal test that ensures the validity of our instruments. To check whether or not these variables affect the usage diversity, we have estimated the model several times. For each of the estimations, one of the 3 instruments has been added to the usage diversity equation. Their coefficients were always found to be statistically insignificant. Finally, notice that if the error terms are normally distributed, the model will be identified whether the instruments are valid or not. Identification will occur on the basis of distributional assumptions about the residuals

■ The results

The model has been estimated twice in order to appreciate to which extent the results are modified when the variables related to the computer skills and the online experience are added to the set of explanatory variables.

In Table 5 the results of the estimations are displayed. [9] Column (A) and Column (B) of Table 5 show the results when the variables related to the computer skills and the online experience are added and when they are not added to the set of the explanatory variables, respectively.

Table 5 – Estimation results

	Without Computer skills and Online Experience variables				*With Computer skills and Online Experience variables*			
	Adoption (A-1)		Diversity (A-2)		Adoption (B-1)		Diversity (B-2)	
Household								
Number of persons	.116***	(.022)	-.103***	(.035)	.116***	(.022)	-.070**	(.035)
Income (adjusted)								
less than € 899	-.592***	(.086)	.210	(.159)	-.592***	(.086)	.281*	(.161)
from 900 to € 1149	-.479***	(.081)	-.017	(.136)	-.479***	(.081)	.025	(.138)
from 1150 to €1499	-.396***	(.072)	.047	(.115)	-.396***	(.072)	.117	(.117)
from 1500 to € 1999	-.161**	(.066)	.103	(.088)	-.161**	(.066)	.139	(.089)
more than € 2000	Ref.		Ref.		Ref.		Ref.	
Urbanization								
low	-.418***	(.072)	-.256***	(.127)	-.418***	(.072)	-.216*	(.128)
medium	-.290***	(.052)	-.086	(.081)	-.290***	(.052)	-.077	(.081)
high	Ref.		Ref.		Ref.		Ref.	
Individual								
Man	.224***	(.046)	.457***	(.070)	.224***	(.046)	.210***	(.074)
Student	.088	(.122)	.120	(.162)	.088	(.122)	.029	(.163)
Ooinion								

[9] In Table 5, "ref." means reference. For each dimension divided into different categories (e.g., the income, the age, the education or the online experience) one category is used as "the reference category." Thus, results must be interpreted relatively to the "reference category." For example, for the education dimension, the category "university degree" is used as the "reference category." A negative sign in Columns (A-1) and (B-1) (resp., Columns (A-2) and Columns (B-2)) associated with a category indicates that people belonging to this category have a lower probability to have adopted the Internet (resp., lower diversity of Internet use conditional on adoption) than people belonging to the "reference category."

	Without Computer skills and Online Experience variables				*With Computer skills and Online Experience variables*			
Oa	Ref.		Ref.		Ref.		Ref.	
Ob	-.257***	(.048)	-.354***	(.074)	-.257***	(.048)	-.266***	(.075)
Oc	-.495***	(.090)	-.762***	(.168)	-.495***	(.090)	-.576***	(.169)
Computer skills	Not Used		Not Used		Not Used		.239***	(.026)
Online experience								
less than 3 years	Not Used		Not Used		Not Used		-.306***	(.086)
from 3 to 5 years	Not Used		Not Used		Not Used		-.141*	(.081)
more than 5 years	Not Used		Not Used		Not Used		Ref.	
Education								
no diploma	-1.05***	(.102)	.130	(.242)	-1.05***	(.102)	.371	(.247)
school certificate	-.652***	(.077)	.090	(.153)	-.652***	(.077)	.150	(.151)
high school professional degree	-.553***	(.063)	-.016	(.115)	-.553***	(.063)	.144	(.118)
high school academic degree	-.271***	(.070)	.007	(.099)	-.271***	(.070)	.122	(.101)
4 years university degree	Ref.		Ref.		Ref.		Ref.	
Age								
61 years and more	-.977***	(.089)	-.954***	(.195)	-.977***	(.089)	-.687***	(.197)
from 51 to 60 years	-.413***	(.084)	-.639***	(.123)	-.413***	(.084)	-.552***	(.124)
from 41 to 50 years	-.144*	(.081)	-.543***	(.104)	-.144*	(.081)	-.594***	(.105)
from 31 to 40 years	-.057	(.075)	-.205**	(.095)	-.057	(.075)	-.251***	(.096)
30 years and less	Ref.		Ref.		Ref.		Ref.	
Friends	.127***	(.048)	.052	(.068)	.127***	(.048)	.068	(.069)
Instruments								
association	.132***	(.049)			.132***	(.049)		
Teenager	.058	(.079)			.058	(.079)		
Average income	-.239***	(.053)			-.239***	(.053)		
Residual correlation ρ	.017 (.203)				.038 (.205)			

Standard errors in parentheses, * p<0.10, ** p<0.05, *** p<0.01

First, notice that (in both of the models) the correlation coefficient is not significantly different from 0. This suggests that the set of observable variables reasonably covers the process that leads to broadband Internet adoption. Therefore, analyzing diversity of Internet usage from a subsample of Internet adopters will not bias the results.

While the age has a negative effect on adoption and on the diversity of Internet use, our results indicate that income and education are strong

determinants of broadband adoption but they do not affect the diversity of Internet use.

Regarding the gender effect, while it has been suggested that differences in Internet use between men and women tend to disappear (see, e.g., ONO & ZAVODNY, 2003), our results indicate that differences in Internet use between men and women remain. Conditional on adoption, we show that men have a higher diversity of Internet use than women.

Then our results suggest that the degree of sociability has a positive effect on broadband adoption but not on the diversity of Internet use. However, these results should be interpreted with caution. As noticed in the introduction, the effect of certain socioeconomic factors could be smoothed. For example, we have tested an alternative indicator of diversity which only includes Internet uses related to communication (email, chat, call). We find that the degree of sociability has a significant positive effect on the probability to use the Internet to communicate. [10] It has also been shown by SUIRE (2007) that the degree of sociability impacts the probability to use the Internet for accessing to government services and for shopping activities. To a larger extent, several studies have highlighted the positive impact of social capital on Internet adoption and usage. For example, FRANZEN (2003) shows that a strong social capital has a positive effect on the probability to use the Internet. GOLDFARB (2006) shows that people living with students in the Mid-1990s are more likely to have adopted the Internet in 2001. He notices that one of the explanations could be that the Internet may exhibit network externalities and thus the benefits of adoption will increase if a household member is online (because of university attendance in the mid-1990s).

Finally, we show that people with a positive opinion on new technologies are more likely to have adopted broadband Internet and also have higher usage diversity than others.

Computers skills and online experience

Column (B-2) shows that the computer skills and the online experience have a substantial effect on the diversity of Internet use.

[10] The results obtained with this alternative indicator are available from the author upon request.

The positive effect of computer skills on Internet usage has already been emphasized in the literature. Nevertheless, papers analyzing the disparities in computer skills only show the existence of a "knowledge gap" without introducing a causal link between computer skills and the diversity of Internet use (HARGITTAI, 2003; VENDRAMIN & VALENDUC, 2003). Our results confirm that people with low literacy resources are confined to a relatively narrow set of uses, while those with high computer skills have a significantly higher usage diversity than others.

Online experience also positively affects the diversity of Internet use. Therefore, higher benefits will be gained by people who adopted the Internet first. This result is logical, to the extent that Internet users less accustomed to efficient navigation or less experienced have a priori greater chances to be involved in routine and less diversified uses. It is interesting to notice that this effect persists over time. Indeed, even people who have been using the Internet for 3 to 5 years have a less diversified usage than those with online experience superior to 5 years.

Interestingly, after controlling for the computer skills and the online experience, Column (B-2) shows that the people on the lowest incomes have a more diversified Internet use than the wealthiest ones. Similar results have been highlighted by GOLDFARB & PRINCE (2008). They show that conditional on adoption, low-income and less-educated people spend more time online.

Even after controlling for the computer skills and the online experience, significant disparities remain in the diversity of use between men and women and young and elderly people. There are many reasons to explain why after controlling for a set of factors, the elderly people belong to the less intensive Internet users group. Among them, there are differences in learning styles, new technology approaches, social environment and interests (PAUL & STEGBAUER, 2005). Besides the differences in computer skills, the reasons commonly presented as relevant to explain the divide between men and women are the differences in the use of new technologies at work and patriarchal habits (CASTAÑO, 2008).

Policy implications

From a policy perspective, the use of more Internet applications is not necessarily valuable. Indeed, public authorities are not willing to support activities such as online games, chat or movies downloading. In order to

understand if the public authorities should favor broadband adoption, our model has also been estimated using an alternative indicator which only includes applications that policymakers might consider as socially beneficial: health information, e-government and general information (e.g., online news papers) applications. The results of this alternative model are displayed in Appendix. The main results presented above are unchanged.

Several concerns have been expressed regarding the potential barrier that the adoption costs could represent. In the first sight, our results support the argument of potential benefits of subsidizing access. Indeed, conditional on adoption, people on the lowest incomes will likely engage in online activities that policymakers considered as socially desirable (see, Table 6 in Appendix). However, this approach is relevant if the effects captured by the income are mainly attributable to budgetary constraints issue. As shown by LENHART (2003) and DROUARD (2009) this is not the case. In particular, they show that many of the excluded ones, and particularly the most socially deprived ones, are simply not interested in adopting the Internet.

Interestingly, after controlling for a set of socioeconomic factors (such the age, education, income) and also the digital abilities, we find that online experience has a significant effect on the usage diversity. One of the possible reasons might be that the most experienced Internet users have had more time to explore the Internet and are therefore more aware of the multitude of services accessible through the web. If, in fact, the information about the numerous advantages offered by the Internet is mainly obtained by using the Internet, the non-users will not be able to accurately forecast the benefits of broadband Internet adoption. Therefore, promotional campaigns aiming to inform the non-users and the recent adopters of the opportunities and the advantages offered by the Internet could be an effective policy to promote the diffusion of broadband.

To the extent that the Internet is an open system where most of the online services are available regardless of the Internet service providers used to connect to the web, the Internet service providers cannot use the multitude of online services accessible through the web as a tool to differentiate their products from the ones offered by competitors. In this context, informing the potential adopters about the large range of services accessible through the web seems to be a less profitable strategy for the Internet service providers than informing them about their subscription prices, bandwidth speed offered or after sales services. Therefore, initiatives aiming at informing the non-users and the recent adopters about the opportunities and the advantages offered by the Internet have to be

undertaken by the public authorities. In France, public authorities seem to take these needs into consideration. The last inter-ministerial mission for the digital economy's development (see, France Numérique, 2012, 2008) suggests, for example, to emphasize the opportunities offered by the Internet through a national TV advertising campaign (see, proposition "Action 23").

Moreover, in contrast with former innovations in the information and communication market, such as the phone or the radio, specific knowledge is required in order to benefit entirely from the advantages offered by the Internet. Our results indicate that the computer skills are one of the main determinants of the diversity of Internet use. Therefore, public authorities should also aim to provide universal digital literacy so as to allow individuals to autonomously and effectively use the Internet.

■ Conclusion

In this paper, we have analyzed the broadband Internet adoption/usage decisions. Our results are in line with other findings in the literature. In particular, we show that low income and less-educated people are less likely to have adopted broadband Internet, but they do not have a less diversified Internet usage given adoption. Furthermore, we show that online experience is a powerful explanation of usage diversity, suggesting that the diffusion of information about the advantages offered by the Internet is partly attributable to the use of the Internet itself.

There are several potential limitations to our paper. First, the data are from 2005. Between, 2005 and 2010 the penetration rate of broadband has been increasing significantly. In France, the percentage of people having a broadband Internet connection at home has increased from 40% to 67% between 2005 and 2009 (see, CREDOC [11], 2009). However, nowadays, high disparities in broadband adoption remain between the most socially deprived and others. For example, CREDOC (2009) shows that only 18% of the people aged over 70 years old, 35% of the uneducated people and 37% of the low income people have a connection at home in 2009. Therefore, we

[11] CREDOC refers to Centre de Recherche pour l'Etude et l'Observartion des Conditions de vie.

believe that our qualitative results are still relevant and meaningful in the context of the 2010's digital divide debate.

Second, our way to define broadband Internet adoption could also be considered as a limitation. Indeed, our model does not take into account, first, the possibility for people to use the Internet without having a broadband connection at home, and, second, to have a broadband Internet connection at home and not use it. Alternative models have been estimated: (1) where all the Internet users having an Internet connection at home (broadband or dial-up connection) were considered as adopters (2) where all the individuals (using or not the Internet) with a broadband connection were considered as adopters. In both of these alternative models, the main difference with the results presented in the core of the paper concerns the effect of the education. Indeed, in these alternative models, conditional on adoption, the less educated people have a less diversified Internet usage than others. The effects of the other explanatory variables are mostly similar. [12]

[12] The results obtained with these alternative models are available from the authors upon request.

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Appendix

We have built an alternative indicator using only three different Internet uses: administration, health and information (see, Table 1 for a description of these uses). The dependent variable takes four values according to the number of Internet uses, among the three previously mentioned, adopters have had during the month preceding the survey. The estimations results are displayed in Table 6.

Table 6 - Estimations results (administration + health + information)

	Without Computer skills and Online Experience variables		*With Computer skills and Online Experience variables*	
	Diversity		Diversity	
Household				
Number of persons	-.021	(.028)	.005	(.029)
Income (adjusted)				
less than € 899	.204	(.128)	.265**	(.130)
from 900 to € 1149	.100	(.118)	.147	(.120)
from 1150 to € 1499	.085	(.102)	.143	(.103)
from 1500 to € 1999	.112	(.087)	.138	(.088)
more than € 2000	Ref.		Ref.	
Urbanization				
low	-.277**	(.115)	-.246**	(.116)
medium	-.146**	(.074)	-.138*	(.075)
high	Ref.		Ref.	
Individual				
Man	.193***	(.065)	.002	(.070)
Student	.038	(.165)	-.026	(.165)
Opinion				
Oa	Ref.		Ref.	
Ob	-.287	(.068)	-.210***	(.069)
Oc	-.676	(.159)	-.525***	(.161)
Computer skills	Not Used		.170***	(.026)
Online experience				
less than 3 years	Not Used		-.229***	(.089)
from 3 to 5 years	Not Used		-.148*	(.083)
more than 5 years	Not Used		Ref.	
Education				
no diploma	.048	(.184)	.208	(.187)
school certificate	.009	(.122)	.061	(.123)
high school professional degree	-.121	(.089)	-.001	(.091)
high school academic degree	-.159*	(.095)	-.078	(.096)
4 years university degree	Ref.		Ref.	
Age				
61 years and more	-.522***	(.142)	-.293**	(.146)
from 51 to 60 years	-.213*	(.116)	-.129	(.117)
from 41 to 50 years	-.257**	(.106)	-.276***	(.107)
from 31 to 40 years	-.168*	(.097)	-.198**	(.098)
30 years and less	Ref.		Ref.	
Friends	-.009	(.068)	-.004	(.069)