Triple play vs Software voice in France

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Abstract

The literature on innovation diffusion investigates the rate and shape of technology adoption. On the demand side, great attention has been given to the diffusion of ICT services and devices among consumers and households. But what determines consumers' choices when competing services appear on the market? This study applies the economics of innovation literature to an analysis of the determinants of the adoption of two services that enable unlimited voice communications (offered by VoIP providers), i.e. software voice and IP network voice services. We employ a bivariate probit model, which allows us to take account of the possible decision to adopt both services. The empirical investigation is based on French data from a survey in 2005 on ICT usage by households and individuals. The data were collected by INSEE (French Statistic Office). We aim to test three hypotheses. (1) The more technophile individuals have more probabilities to adopt Software voice services in respect to IP network consumers. (2) We test which variables determining the complementary and/or substitutes effect which involves analysing both concepts in the light of competition policy in a knowledge based industry. (3) It tests the influence of the consumers' geographical location. This captures, on the one hand, the intensity of the users' relationships and on the other hand the diffusion of IP network services were at the time of the survey, concentrated in densely populated areas.

Key words: innovation diffusion among consumers, bivariate probit

Introduction

There are two factors that determine the speed of the evolutionary process: "the characteristics of the product's technology" and the consumer preferences (Klepper, Graddy, 1990: 35). Evolutionary studies on innovation diffusion focus on the complex interactions among firms, consumers, institutions and industries (Mowery, Nelson, 1999 ; Van den Ende, Dolfsma, 2005). The choice of consumers' adoption decision in network industries can influence the rate and shape of diffusion process. We aim to investigate the determinants of the demand side adoption of unlimited voice services. On the supply side, there are two competing patterns, thus consumer choice could determine whether there will be a dominant strategy or whether the two patterns will continue to compete.

The introduction of VoIP (Voice over Internet Protocol) technology, among the technological changes in the telecommunication sector, has had a direct impact on consumers in providing voice communications that are either completely free or at very reduced prices. These voice services are of two types: software voice[1] and IP network services[2]. What determines the adoption of these two different services? Using French cross-section data (based on the responses to questions in the survey built in 2005 by the French statistics office - INSEE), we drawn on the literature on innovation diffusion to identify the determinants of consumers' patterns of adoption of the voice service offered by VoIP providers. As concerned the econometric model, the probabilities of adopting Software voice and of subscribing to IP network voice are simultaneously determined

[1] Both software voice and SOFTWAREVOICE expression would be used.

[2] At the time of the survey, France Telecom, the incumbent, had started to offer bundled services to its customers.

by a bivariate probit model, which allow for correlation of the unobserved effects and errors.

Our empirical investigation tests three hypotheses. (1) The more technophile individuals have more probabilities to adopt software voice services in respect to IP network voice subscribers. As, they have the skills for using internet related activities. (2) It identifies the features influencing the effect of complementarity or/and substitution adoption of these two services - software voice and voice service offered by IP network providers (double or triple play offers). Consumers have different perceptions of the services provided as their functionality substitution is not perfect. Indeed, software voice requires some internet related competences, whereas subscribing to an IP network service requires no specific capabilities. (3) The influence of geographical place of residence has been tested as it captures both the exchange and density of local information and the impact of IP network service diffusion (as it is endogenously determined). At the time of the survey these services were accessible only in the most populated areas, which have important implications for policy. Also, among European countries, France is one of the most advanced in terms of penetration of broadband and related services.

Section 1 reviews the literature on innovation diffusion for analysing the patterns of innovation diffusion among consumers. Section 2 presents the empirical questions and provides some data on broadband diffusion in Europe. Section 3 describes the data and Section 4 presents the econometric model and the results. Section 4 underlines the main limits of the estimations. Section 5 underlines the study limitations, conclusion will follow.

1. The innovation diffusion literature

This study uses as a base the literature on innovation diffusion coupled with that on network sector-specific industries, an approach adopted by Majumdar, Venkataraman (1998), Constantiou et al. (2008) and Michalakelis et al. (2008). Adoption takes place when consumers or firms choose products, services and new organizational structures that are shaped or supplied by other firms, consumers or organizations (Antonelli, 2006). We consider the adoption decision as part of the diffusion process, aggregate adoption describe the diffusion process[3].

The difference between innovators and imitators was defined by Schumpeter. Innovators introduce the new technology; they are not "influenced" by previous adopters, while "imitators are influenced by previous adopters" (Bass 1969, 1980: 57). In the literature on innovation diffusion consumers are categorized as: innovators, early adopters, late majority, early majority or laggards (Rogers, 1983: 246, 247). What mainly distinguishes these categories is the time lag in adoption, the propensity of consumers to adopt the technology in term of the capabilities required and thus the different degrees of marginal utility they gain (Swann, 2002). The literature has developed a framework that can be used for the purposes of forecasting (Bass, 1969, 1980). These models capture the property of asymmetric S-curves. Other methods of forecasting, such as Gompertz's curve, exploit demand elasticity due to price variations (Fildes, Kumar, 2002, Robertson et al., 2007). The decision to adopt ICT could also be

[3] As we underline in the next sections, we dispose of cross section and we do not have information about the dynamic of adoption, thus we can only a static model.

driven by non-capital costs of adoption (Astebro, 2002:673) such as ability and confidence in the technology.

The literature on innovation adoption combines different "theoretical approaches into a single framework" (Faria et al., 2002: 570; Karshenas M., Stoneman P. L., 1993;), namely the epidemic model, the rank effects model (Battisti G., Stoneman P., 2005), the model focusing on network effects as the driving force of innovation diffusion and the order effect model. We refer to the epidemic and network effects models. The epidemic model examines the speed and spread of information from users to non-users (Mansfield, 1961; Geroski, 2000; Bochet, Brossard, 2007) assuming that individuals are homogenous. The epidemic model is based on the mathematical approach of the contagion model (Bass, 1969). The adoption decision is influenced by social constraints and the satisfaction of new needs. The spread of information on the technology drives innovation diffusion. More information about the innovation reduces the degree of uncertainty. The information exchange is based on word of mouth exchanges (local information), which is also described as local spill-over (Le Guel et al., 2005; Roux, Galliano, 2007), and on common information sources (global information such as broadcast). A large base of early adopters increases the probability that adopters will contact non-adopters. These effects can be captured by region/area inhabitants' density and by data on information exchange within the social network of consumers (Steyer, Zimmerman, 2004), in other word it aims to capture the proximity among individuals (Torre, Rallet, 2005).

Where network effects[4] come into play, the value of the network depends on the numbers of individuals in the network (Economides 1995, Shapiro and Varian, 1998). This creates the conditions for a self reinforcing process (Katz and Shapiro, 1986) and increasing returns to adoption (Arthur, 1989). On the supply side, it is crucial to identify when and how innovation diffusion and adoption take place. This model supposes that individuals are heterogeneous. When the process of innovation is localised, the speed and direction of technology diffusion depends upon past experience (Metcalfe, 1981, Klepper, Graddy, 1990). At the consumer level, adoption is based on previous knowledge (Tonks, 1986). Thus, consumers familiar with a certain technology will quickly become familiar with the second generation innovation.

GPT (General Purpose Technology) innovations enable various applications, in diverse sectors, and create new applications opportunities (Bresnahan, Trajtenberg, 1995). GPT consumers are customized to the application of GPT (Steinmueller, 2006); these adopters of first generation innovations have the capabilities to adopt second generation innovation, in other words they have "how-to-knowledge" (Rogers, 1983: 167). Technological change is localised as consumers recombine their knowledge to adopt the technology. For the purposes of this study, we can assume that software voice is related to other e-service. As the survey was conducted at the beginning of voice software service introduction in 2005, these adopters could be defined as earlier adopters within the Bass qualification. Indeed, the more technophile web-users are more willing to adopt this technology because they have the capabilities and are confident

[4] The data give no information about the network effect underlying the innovation diffusion process.

with the technology. IP network voice services do not imply the need for internet competence.

Once increasing returns to adoption occur, the bandwagon or imitative effect might drive individual choice, thus the initial choice becomes the determinant. Consumers might be lock-in by services or goods. (Geroski, 2000: 619). If consumers are locked into a technology, a change might incur switching costs (David, 1985).

We need to distinguish between the general definition of network effects where it does not matter who are the members of the network, and the social network which represents the group of peers that belong to the network. There are numerous studies focusing on network effects in the telecommunication industry (Rolfhs, 1974, Majumdar, Venkataraman 1998, Birke, Swann, 2006). Here, consumers are encouraged to joint a software voice network when relatives or interest groups (Rohlfs, 1974) are members of that network (Birke, Swann, 2006).

2. Empirical analysis

Our study combines the literature on innovation diffusion with the analysis of telecommunication industry sector-specify features (Majumdar, Venkataraman,1998). In the literature on innovation diffusion with respect to consumers, the focus is largely on the patterns of ICT adoption (Demoussis, Giannakopoulos., 2006), the influence of Internet application in changing consumers' behaviour (Hong, 2007), the pattern of substitution and complementarities between mobile and fixed telephone. In terms of the telecommunication service *stricto sensu*, the literature investigates the rate of

penetration of fixed lines, mobile phones and broadband connections and provides an analysis of forecasting (Garbacz , Thomposon, 2007).

Both software service providers and IP network service are part of the info-communication sector, which is an internet-based industry (Fransman, 2003, Krafft, 2003, 2004) exploiting ICT as a GPT; it qualifies as a « demand driven » (Krafft, 2004) industry. Consumer choices determine the direction of self reinforcing process and the dominant position in the market.

One of the main technological changes in the telecommunication sector is the introduction of VoIP as it enables reduced cost or unlimited free voice traffic and value added services. Two main models of VoIP applications are identified: VoIP software (e.g. Skype, JaJah) and IP network voice providers. In France, at the time of the survey IP network voice providers (new entrants to the telecommunication sector), such as Iliad/Free, Neuf Cegetel (Internet Service Providers-ISP) were offering unlimited national and international calls to consumers within subscription fees bundled in the form of triple (data, voice and video) and double play (data and voice) with other value-added services such as email. Software voice providers allow consumers to make calls using the internet with unlimited free calls from PC to PC. Consumers download free software, which enables them to do instant messaging, send short messages and send files over the internet. As at the time of the survey, the incumbent, France Telecom, has started to offer this service as an experimental offering. It is possible to assume that person subscribing to IP network service might churn. In other words, consumers analyzed could be defined innovators or early adopters.

Table 1 presents the statistics showing the evolution of households' subscriptions of different telecommunication services in France. The last row in the table indicates the number (in millions) of VoIP subscriptions related to IP network voice services. The data do not include communication through software voice services. As already mentioned, the diffusion of the broadband is a necessary condition for access to unlimited calls offered by ISPs. Table 2 presents broadband diffusion for some European countries.

Table 1 French subscriptions to telecommunication services

Millions line	2002	2003	2004	2005	2006	Evol.
Nb of subscription in the last period	34,124	33,913	34,541	36,498	38,168	4,6%
Subscription to analogical network	28,980	28,673	28,502	27,969	26,477	-5,3%
Subscription to numeric network	5,084	5,176	5,038	5,002	4,872	2,6%
Subscription to cable	0,058	0,060	0,069	0,135	0,211	55,7%
Subscription to VoIP	-	-	0,931	3,392	6,608	94,8%

Source : ARCEP (Survey from 1998 to 2005): p. 177

Table 2: Diffusion of broadband in Europe, December 2006

	Broadband access	Penetration rate	Cable	Broadband offered by incumbents	Broadband offered on the whole market	Unbundling lines	Bitstream lines
France	10 819 301	18%	600 000	4 873 263	5 514 106	3 513 133	2 00 973
Germany	11 666 2002	14%	284 250	6 500 00	6 444 300	3 543 000	2 901 300
Italy	7 381 612	13%	0	4 928 000	2 507 122	1 432 122	1 075 000
Spain	5 362 119	13%	1 169 666	3 084 555	1 184 802	559 563	625 239
United Kingdom	11 051 967	19%	2 870 354	2 584 000	6 362 802	838 379	5 459 000
Holland	4 360 121	27%	1 550 00	1 970 690	796 560	796 560	0
Total/ Mean of the 25 European countries	66 548 642	15%	10 037 901	32 993 729	25 334 849	12 011 886	13 322 963

Arcep website ECTA (European Competitive Telecommunication Association) data, December 2006 [5]

[5] http://www.arcep.fr/index.php?id=9184#

Substitution vs complementarity

When there are two competing patterns of innovation, the substitution vs complementary effect on the demand side must be analysed to investigate the outcome of competition. In microeconomics, the substitution effect is computed by calculating the cross elasticity of the prices of two goods. In knowledge based industries, firms operate within more complex systems, and the competition dynamics are different from traditional industry. Here, competition is based on performance (Pleatsikas, Teece, 2001) and creativity, rather then price reduction, and even more so when the services offered are free. The concept of substitutability in the telecommunication sector was tackled essentially to study the substitution between fixed and mobile telephone access in developed (Rodini et al., 2003) and developing countries (Hamilton, 2003; Garbacz, Thompson, 2007), Duffy-Deno, 2001 has looked at the effect of complementarity of the second telephone line diffusion in the US. The notion of substitution and complementarity should be considered in broad terms; it overlaps with economic and technical concepts - in other words, the functionalities of goods, consumers' perceptions and barriers to substitution.

The substitution functionality includes quality of service and technical features. Technically, both types of voice services offer the possibility to receive and to make calls (Corrocher, 2003). The quality of the communication with software voice transmission initially was poor, but this is no longer the case. The quality of triple play transmissions was always better and is now almost problems free.

The consumers' perceptions of the technology (Mindel, Sicker, 2006) identify their thinking about and perception of reliability of the services. This concept is used into competition framework for determining the relevant market as it can determine the conditions for product differentiation (Andreosso, Jacobson, 2005). Triple play voice communication has characteristics similar to the classic telephone and ISP providers are challenging the incumbents. Consumers using software voice need some ICT competences, i.e. the know how to use the service reduces the "cognitive dissonance" (Klemperer, 1995) of individuals toward the technology. This leads an obstacle of the adoption and on the Klemperer's assumption, it increases the switching cost of adoption.

The barriers to substitution might lead to geographical penetration of the service. Users would have access to software voice providers through any internet connection (in the home or in a public place, although some administrations have tried to ban use of this software application). Triple play access is conditional on the geographical penetration of the broadband. The voice service is bundled with internet (double play) and television (triple play), which satisfies data transmission needs. The regulatory agencies do not consider software service providers to be telecommunication providers.

On the other hand, all characteristics holds, two services could be also defined as imperfect substitute (Greenstein, Mazzeo, 2006): they can satisfy the same needs, but the conditions of adoption are different. An alternative view is that these two voice communication services are complements. Both services give the possibility to make and receive calls and they also satisfy other diverse needs. They can be used together. Software voice enables instant messaging and transferring of files and video

conferencing, while IP network service offers unlimited voice traffic, unlimited internet connection and in the case of the triple play offers video.

3. Data description

The data for the empirical econometric analysis were collected by the INSEE, the French National Institute for Statistics and Economic Studies in the 'Permanent survey on the life of households**,** information and communication technology (ICT)' in 2005. The survey comprises six sections: housing, household, individuals' information, individuals' lifestyles, households' ICT equipment and individuals' ICT usage patterns. Some of the ICT related questions were included to provide EUROSTAT with information for monitoring ICT usage patterns in European countries. In most cases, the data consist of a sample of 5,603 respondents with the exception of the section related to personal characteristics which includes information from 13,410 individuals since this includes all household members aged 14 and over. This section was merged with the section on ICT usage controlling for IDENT_IND (individual identification). The data used for the empirical investigation relate to individuals' characteristics, household ICT equipment and ICT usage. These latter two sections are common across European countries.

Explained variables

The information used to constructed the dummy variable SOFTWAREVOICE, was based on responses to the question that asked individuals “Have you used the internet for calling during the last month (Skype, MSN)?”. SoftwareVoice takes the value 1 if consumers use the internet for calling, 0 otherwise. The dummy variable TRIPLAY[6] captures individuals with home internet and takes the value 1 if households have broadband subscriptions with one of the two options triple play or double play, 0 otherwise. The initial database includes 5,603 observations. Observations are dropped where the variable household income has missing values. Individuals without home internet connections and individuals who have never used the internet are also excluded as the questionnaire has constructed on the basis of filtering questions. The remaining sample corresponds to 1,745 observations. Table 3 presents the descriptive statistics for the variables.

Table 3: Description of the variables

DEPENDENT VARIABLES	*Description*	n	mean	**MIN**	**MAX**

[6] This variable was constructed from the HDEB variable created by INSEE and takes the value 1 if the household has a broadband connection and 0 if the household as a narrowband connection.

Triplay	Equal to 1 if individuals have access to double or triple play	1745	0.320	0	1
Software Voice adoption	1 if individuals use internet for calling, 0 otherwise	1745	0.131	0	1
INDEPENDENT VARIABLES					
Demographics (Rank effect variables)					
Gender (sexe)	Equal 1 if female	1745	0.489	0	1
Age1	Equal to 1 if age=<20	1745	0.116	0	1
Age2	Equal to 1 if age=<30	1745	0.191	0	1
Age3	Equal to 1 if age=<40	1745	0.273	0	1
Age4	Equal to 1 if age=<50	1745	0.273	0	1
Employee	Equal to 1 if individual is employed in a firm , 0 otherwise	1745	0.407	0	1
Independent	Equal to 1 if individual is self employed , 0 otherwise	1745	0.064	0	1
Diploma (dipsupebis)	Equal to 1 if individual has a high school diploma, 0 otherwise	1745	0.087	0	1
Student	Equal to 1 if individual is a student , 0 otherwise	1745	0.151	0	1
Nbhousehold	Household number of 2 or more	1745	0.822	0	1
Inc1500	Equal to 1 if household's income<=1500 euros per month	1745	0.136	0	1
Inc2500	Equal to 1 if household's income<=2500 euros per month	1745	0.486	0	1
Inc4000	Equal to 1 if household's income<=4000 euros per month	1745	0.354	0	1
Geographical location					
Rural	Equal to 1 if individual lives in countryside	1745	0.223	0	1
Urban100000	Equal to 1 if individual lives in a city with 100000 inhab. maximum	1745	0.149	0	1
Hdplus	Equal to 1 if individual lives in a city with more than 100000 inhab.	1745	0.290	0	1
Paris	Equal to 1 if individual lives in Paris	1745	0.220	0	1
Internet related competencies					
Compint4	Equal to 1 if individual knows how to delete cookies and temporary files	1745	0.782	0	1
Compint5	Equal to 1 if individual knows how to create and modify a website	1745	0.245	0	1
Calls volume					
Daily	Volume of calls make daily in log	1745	0.440	0	4.709
Weekly	Volume of calls make weekly in log	1745	0.581	0	4.382

Explaining variables

The socio-demographic variables identify the main characteristics of individuals and capture observed heterogeneity among individuals. The age of individuals is identified by four sets of dummies (AGE1, AGE2, AGE3, AGE4) taking as reference consumers over 51 years old. The variable capturing work categories is included with the dummy variables EMPLOYEE, SELF-EMPLOYED, STUDENT. The three dummy variables INC1500, INC2500, INC4000 indicating the households' revenue, take as reference households with more then 4,000 euros per month. The variable NBHOUSEHOLD takes the value 1 if individuals live with one or more people, 0 otherwise. The binary variables RURAL, URBAN100000, HBPLUS, PARIS capture the number of inhabitants, which could be a proxy for both information density and exchange (Goolsbee, Klenow, 2002) and a broadband accessible area at the time of the survey (the more populated areas had access to this service earlier). In higher population density areas there probabilities of receiving local information about the technology are also higher.

The two binary variables COMPINT4 and COMPINT5 capture competences in e–related activities which could be associated with more technophile individuals, who are supposed to have higher propensities to adopt software voice. The set of variables capturing the usage patterns for voice communication are DAILY and WEEKLY which indicate respectively the volume of calls logged daily and weekly. Individuals indicated the number of calls daily, weekly and monthly (which is considered as the reference category).

4-The model and the results

The bivariate probit is an extension of the univariate probit, it belongs among the class of simultaneous question models (Maddala, 1983). The bivariate probit allows the two equations to have correlated disturbance leading to unobserved heterogeneity (Greene, 1998, 2002). This model applies the full information maximum likelihood estimation (FIML) (Jones, 2005) considering the joint distribution of the two variables. The general specification for simultaneous equation model is:

$$\begin{cases} y_1^* = x_1'\beta_{1n} + \varepsilon_1 \quad y_1 = 1 \;\; if \;\; y_1^* > 0, \qquad 0 \; otherwise \\ y_2^* = x_2'\beta_{2n} + \varepsilon_2 \quad y_2 = 1 \;\; if \;\; y_2^* > 0, \qquad 0 \; otherwise \end{cases}$$

$$E[\tilde{\varepsilon}_1 | x_1, x_2] = E[\tilde{\varepsilon}_2 | x_1, x_2] = 0$$

$$Var[\tilde{\varepsilon}_1 | x_1, x_2] = Var[\tilde{\varepsilon}_2 | x_1, x_2] = 1$$

$$Cov[\tilde{\varepsilon}_1, \tilde{\varepsilon}_2 | x_1, x_2] = \rho$$

Wilde (2000) demonstrates that the repressors have to be exogenous and Monfardini and Radice (2008) demonstrate that the LR test is efficient for testing the exogenous nature of the variables[7]. We did the test for our variables. The explanatory variables could be the same for estimating the two equations, which is different from the probit with sample selection (Baum, 2006).

[7] They refer essentially to the recursive model.

The bivariate probit has been already used in telecommunication studies. Greenstein (2000) used a trivariate and a bivariate probit to analyse the different strategies of internet providers in the US. Eisner and Waldon (2001) analysed the joint decision of consumers to adopt both second line and online services. The bivariate probit analysis allows us to test the joint decision to adopt both services. This allows us to evaluate the determinants influencing the adoption of each model. The structure of the variables frequency is shown in Table 4. Almost 8% of the individuals in our dataset chose to adopt both services.

The two independent variables are:

y_1 =1 if consumers subscribe to the Triplay service (TRIPLAY)

y_2 =1 if consumers use internet for calling (SOFTWAREVOICE).

The probability of each event occurs:

- subscribe to TRIPLAY services and use internet for calling $(y_{1i} = 1; y_{2i} = 1)$
- subscribe to TRIPLAY services and do not use internet for calling $(y_{1i} = 1; y_{2i} = 0)$
- do not subscribe to TRIPLAY services and use internet for calling $(y_{1i} = 0; y_{2i} = 1)$
- do not subscribe to TRIPLAY services and do not use internet for calling $(y_{1i} = 0; y_{2i} = 1)$

These probabilities are:

$$\Pr(y_1 = 1; y_2 = 1) = \Phi_2(x'_1\beta_1 + x'_2\beta_2, \rho)$$

$$\Pr(y_1 = 1; y_2 = 0) = \Phi_2(x'_1\beta_1, -x'_2\beta_2, -\rho)$$

$$\Pr(y_1 = 0; y_2 = 1) = \Phi_2[(-x'_1\beta_1, \beta_2 x'_2, -\rho)]$$

$$\Pr(y_1 = 0; y_2 = 0) = \Phi_2(-x'_1\beta_1, -x'_2\beta_2, \rho)$$

The Φ_2 stands for the standard bivariate normal cumulative distribution function (cdf). We use STATA 9 to compute our estimations with the command 'biprobit' which exploits the Newton – Raphson maximisation (Monfardini, Fabbri, 2007). The result of the bivariate probit are interpreted in conjunction with the marginal effect reported in Table 7. The marginal effects for dummy variables are calculated on the basis of average probabilities[8].

The correlation coefficient ρ between the disturbances takes in account the existence of omitted variables or the unobserved heterogeneity (Savignac, 2008) which can influence simultaneously the adoption of SOFTWAREVOICE and the subscription to TRIPLAY. If $\rho \neq 0$, the two equations have to be estimated together. While, if $\rho = 0$ the errors are not correlated, thus the two equations should be analysed separately.

Table 4: Cross frequencies of the two independent variables

		Double and triple play		
		No subscription	*Subscription*	*Total*
Softwarevoice	*Do not usage*	1 096 *(62.81 %)*	420 *(24.07 %)*	1516
	Usage	91 *(5.21 %)*	138 *(7.91 %)*	229
		1 187	558	1 745

[8] The software used STATA to identify the dummy variables and calculate impact effects.

Results

Table 6 presents the results of the complete model and underlines the interaction among different groups of variables. The signs and the significativity of variables are held stable as well as the LR test and the rho value. Table 5 presents the data per group in order to underline the effects of each set of variables. The comments refer to the estimation in Table 6 and 8.

The value of Rho (equal to 0.432) is positive which implies that there are common unobserved variables which positively influence the adoption of both software voice and triple service. This confirms that individuals adopting both technologies have the propensity to use services enabling unlimited voice communications. In other words, the adopters of both technologies could be defined as innovators (as they are early adopters of these services). The statistical Likelihood ratio test of independent equations, so called the LR test, rejects the null hypothesis that the two equations should be estimated separately. Since, the, the critical value computes on the chi-squared table is 3.84. Greene (2002) indicates that the Wald test and the Lagrange test can be used to compute the independent test. Stata, the software we use, computes automatically the LR test. We test for the exogeneity of the explaining variables with the LR test (implemented into Stata software) according to Monfardini and Radice (2008).

1st hypothesis

We hypothesis according to the literature (see section 1) that more technophile users have more probabilities to adopt SOFTWAREVOICE compared to the TRIPLAY adopters. As, we accepted the variable COMPINT4 and COMPINT5 increase the

probability to adopt the softvoice model but this does not have an impact on the adoption of the TRIPLAY which is consistent since subscribing to TRIPLAY does not require internet competences. This demonstrates that SOFTWAREVOICE application could be considered as an extension of other IP applications, in other words consumers customised with the IP related activities –first order innovation- have the 'skill for using' the second order innovation.

2nd hypothesis

Second, we test the substitution and complementarity effect among the two services offering voice services to reduced costs. The result of the bivariate probit demonstrates they have different conditions of adoption and different usage patterns. It emerges that they are imperfect substitutes.

The SOFTWAREVOICE variable has a significant and positive effect on the probabilities of subscribing to TRIPLAY which implies that two services are complements for the TRIPLAY adopters. Indeed, both allow voice communication. At the time of the survey, IP service providers[9] offer unlimited national communication and the unlimited international communication was limited to some European countries and to the US. On the other hand, Software voice providers permit unlimited communication from PC –to-PC all over the world and individuals could send instant messaging and files. Thus, they can assure the same needs, but at the same time they can satisfy different complement needs.

[9] Moreover, they bundled voice to internet or to video offer.

We estimate also a recursive bivariate probit model for determining the substitution/complementarities effect on population treated. But the recursive bivariate model can not be efficiently computed. Since, the recursive bivariate model implies that two dependent variables should have causality effect (Maddala, 1983, Monfardini, Fabbri, 2007) and the treated population sample is quite small.

3rd hypothesis

The variables capturing urban density enter through four dummy variables (Urban20000 is the omitted category- city with less then 20000 inhabitants). As expected COUNTRYSIDE has significant and negative effect on subscribing to TRIPLAY because this service was not widely available in rural areas, while, Urbanplus and PARIS are positive and significant. Since, at the time of the survey the this service was available in most populated area. The magnitude effects of living in these areas are respectively 6% and 9.4%.

In terms of policy, increased diffusion of internet and broadband access could reduce the digital divide among regions, which might reduce the effect of state dependence considered as a source of serial persistence (Demoussis, Giannakopoulos, 2006). This implies that individuals who choose to not subscribe to TRIPLAY because they did not subscribe in the past. When state dependence occur, if the area dwelling has provided with the TRIPLAY services individuals might subscribe, or if they receive a subvention to adopt it. On the contrary, where the non adoption leads to unobserved heterogeneity this might be related to personal characteristics e.g. refusal to use technology, no internet ability, which implies that policy actions can not affect the decision.

On the other hand, the variables capturing urban concentration also indicate the density of information exchange among individuals – epidemic effect- which is indicative also of SOFTWAREVOICE diffusion. As we have shown, these variables have no influence on adoption; here geographic density has no effect on local information exchange. Unfortunately, the survey gives no information on either sources of ICT information or the typology of network effects supporting innovation diffusion.

Other results

As demonstrated on table 5 (column (a)) and on the table 6, individuals belong to the class of AGE1 and AGE2 have more probabilities to adopt SOFTWAREVOICE. While, individuals belong to the class of AGE2 and AGE3 have more probabilities to live in households having subscription to TRIPLAY services. In other words younger people have probabilities to adopt both services.

Being self-employed increases the probability of adopting SOFTWAREVOICE, might be this service is a good work tool. The variables measuring the incomes do not seem to have an influence on adoption decision. On the other hand, the diffusion of services such as SOFTWAREVOICE leads to more unobserved heterogeneity, as capturing the propensity to use this technology might lead to ability or propensity to use e-technology. The increased size of household MORE significantly increase the probability to subscribe to the triple play offer as the household will profit from unlimited access to voice communication. The volumes of calls DAILY have positive and significant effects on the probability of subscribing to triple or double play option, which might justify the decision of subscribe to this services. We do not have information about the particular preferences of consumers toward this bundled offer.

Table 5: Estimation of the Bivariate Probit

	(a)	(b)	(c)	(d)	(e)	(f)
Softwarevoice (constant)	-1.283	-1.188	-1.054	-1.121	-1.516	-1.140
Gender	-	-	-	-	-	-
Age1	0.376 (0120)***	-	-	-	-	-
Age2	0.320 (0103)***	-	-	-	-	-
Age3	0.170 (0.096)*	-	-	-	-	-
Age4	0.560 (0.126)	-	-	-	-	-
Student	-	0.267 (0.107)**	-	-	-	-
Self-employed	-	0.362 (0.146)**	-	-	-	-
Employee	-	-0.004 (0.085)	-	-	-	-
Diploma	-	-0.008 (0.078)				
More	-	-	-0.046 (0.107)	-	-	-
Inc1500	-	-	0.144 (0.127)	-	-	-
Inc2500	-	-	-0.112 (0.085)	-	-	-
Inc4000	-	-	-0.019 (0.085)	-	-	-
Countryside	-	-	-	-0.216 (0.132)	-	-
Urban100000	-	-	-	-0.086 (0152)	-	-
Urbanplus	-	-	-	0.075 (0.119)	-	-
Paris	-	-	-	0.122 (0.124)	-	-
Compint4	-	-	-	-	0.365 (0.110)***	-
Compint5	-	-	-	-	0.329 (0.085)***	-
Daily	-	-	-	-	-	0.033 (0.054)
Weekly	-	-	-	-	-	0.008 (0.044)
Triplay (constant)	-0.615	-0.474	-0.645	-0.527	-0.457	
Gender	-	-	-	-	-	-
Age1	0.183 (0.103)*	-	-	-	-	-
Age2	0.321 (0.085)***	-	-	-	-	-
Age3	0.220 (0.077)***	-	-	-	-	-
Age4	-0.040 (0.099)	-	-	-	-	-
Student	-	0.017 (0.093)	-	-	-	-
Self-employed	-	-0.081 (0.133)	-	-	-	-
Employee	-	-0.008 (0.068)	-	-	-	-
Diploma		-0.025 (0.064)	-	-		-
More	-	-	0.193 (0.091)**	-	-	-
Inc1500	-	-	0.088 (0.110)	-	-	-
Inc2500	-	-	0.056 (0.069)	-	-	-
Inc4000	-	-	0.051(0.069)	-	-	-
Countryside	-	-	-	-0.324 (0.109)***	-	-
Urban100000	-	-	-	-0.129 (0.126)	-	-
Urbanplus	-	-	-	0.199 (0.099)**	-	-
Paris	-	-	-	0.323 (0.104)****	-	-
Compint4	-	-	-	-	-0.070 (0.078)	-
Compint5	-	-	-	-	0.179 (0.074)**	-
Daily	-	-	-	-	-	0.126 (0.048)***
Weekly	-	-	-	-	-	0.032 (0.036)
LR test rho=0 chi2(1)	87.1752	92.2197	91.1233	84.9299	88.4002	89.0472
RHO	0.432	0.444	0.441	0.426	0.440	0.436

standard error *(.)* p<10 %(*), p<5 %(**), p<0.1 % (***)

Table 6: Estimation of the Bivariate Probit

	(1)	(2)	(3)	(4)	(5)	(6)
Softwarevoice (constant)	-1.521	-1.200	-1.205	-1.073	-1.106	-1.479
Gender	-0.168 (0.081)**	- 0.247(0.077)***	-0.242 (0.078)***	-0.231 (0.078)***	-0.238 (0.079)***	-0.164 (0.081)**
Age1	0.338 (0.207)	0.405 (0.135)***	0.347 (0.201)*	0.362 (0.202)*	0.364 (0.204)*	0.322 (0.206)
Age2	0.366 (0.133)***	0.351 (0.120)***	0.366 (0.127)***	0.383 (0.130)***	0.366 (0.131)***	0.350 (0.132)***
Age3	0.223 (0.123)*	0.198 (0.115)*	0.221 (0.119)*	0.241 (0.121)**	0.232 (0.121)*	0.212 (0.123)*
Age4	0.034 (0.134)	0.055 (0.126)	0.040 (0.132)	0.045 (0.132)	0.034 (0.133)	0.028 (0.134)
Student	0.019 (0.167)	-	0.075 (0.162)	0.056 (0.163)	0.030 (0.165)	0.012 (0.167)
Self-employed	-0.359(0.156)**	-	0.329 (0.151)**	0.316 (0.151)**	0.372 (0.153)**	0.363 (0.156)**
Employee	-0.078 (0.093)	-	-0.079 (0.090)	-0.081 (0.091)	-0.084 (0.091)	-0.084 (0.093)
Diploma	-0.117 (0.088)	-	-0.006 (0.082)	-0.039 (0.086)	-0.073 (0.087)	-0.115 (0.088)
More	-0.032 (0.115)	-	-	-0.081 (0.113)	-0.043 (0.114)	-0.027 (0.116)
Inc1500	0.015 (0.140)	-	-	0.032 (0.137)	0.059 (0.138)	0.020 (0.140)
Inc2500	-0.131 (0.092)	-	-	-0.155 (0.090)*	-0.132 (0.091)	-0.129 (0.092)
Inc4000	-0.002 (0.089)	-	-	-0.024 (0.087)	- 0.001 (0.088)	-0.003 (0.087)
Countryside	-0.181 (0.136)	-	-	-	-0.210 (0.134)	-0.177 (0.135)
Urban100000	-0.075 (0.156)	-	-	-	-0.090 (0155)	-0.071 (0.156)
Urbanplus	0.091 (0.122)	-	-	-	0.081 (0.121)	0.092 (0.122)
Paris	0.155 (0.131)	-	-	-	0.151 (0.129)	0.164 (0.130)
Compint4	0.345 (0.113)***	-	-	-	-	0.345 (0.113)***
Compint5	0.238 (0.089)***	-	-	-	-	0.241 (0.089)***
Daily	0.060 (0.058)	-	-	-	-	-
Weekly	0.028 (0.045)	-	-	-	-	-
Triplay (constant)	-0.913	-0.593	-0.571	-0.707	-0.838	-0.816
Gender	-0.028 (0.066)	-0.005 (0.063)	-0.011 (0.063)	-0.016 (0.064)	-0.029 (0.064)	-0.017 (0.066)
Age1	0.276 (0.176)	0.165(0.113)	0.279 (0.170)	0.257 (0.171)	0.261 (0.175)	0.239 (0.175)
Age2	0.355 (0.108)***	0.303 (0.097)***	0.340 (0.103)***	0.339 (0.105)***	0.315 (0.106)***	0.316 (0.107)***
Age3	0.208 (0.097)**	0.201 (0.090)**	0.222 (0.094)**	0.206 (0.095)**	0.191 (0.096)**	0.184 (0.097)*
Age4	-0.037 (0.105)	-0.040 (0.099)	-0.017 (0.102)	-0.029 (0.103)	-0.054 (0.104)	-0.053 (0.104)
Student	-0.183 (0.145)	-	- 0.144 (0.140)	-0.147 (0.141)	-0.196 (0.144)	-0.197 (0.144)
Self-employed	0.015 (0.139)	-	-0.069 (0.137)	-0.073 (0.137)	0.032 (0.139)	0.025 (0.139)
Employee	-0.038 (0.074)	-	-0.056 (0.072)	-0.051 (0.073)	-0.062 (0.074)	-0.054 (0.074)
Diploma	-0.066 (0.072)	-	-0.003 (0.067)	0.011 (0.070)	-0.054 (0.071)	-0.060 (0.072)
More	0.254 (0.097)***	-	-	0.184 (0.095)*	0.266 (0.096)***	0.264 (0.096)
Inc1500	0.061 (0.118)	-	-	0.026 (0.116)	0.080 (0.118)	0.069 (0.118)
Inc2500	0.057 (0.074)	-	-	0.018 (0.0702)	0.065 (0.074)	0.062 (0.074)
Inc4000	-0.032 (0.072)	-	-	-0.078(0.070)	-0.034 (0.071)	-0.034 (0.071)
Countryside	-0.321 (0.111)***	-	-	-	-0.317 (0.110)***	-0.310 (0.111)***
Urban100000	-0.138 (0.128)	-	-	-	-0.130 (0.128)	-0.130 (0.128)
Urbanplus	0.220 (0.101) **	-	-	-	0.226 (0.100)**	0.222 (0.100)**
Paris	0.355 (0.107)***	-	-	-	0.377 (0.106)***	0.376 (0.106)***
Compint4	-0.070 (0.081)	-	-	-	-	-0.070 (0.081)
Compint5	0.138 (0.078)*	-	-	-	-	0.145 (0.078)*
Daily	0.140 (0.048)***	-	-	-	-	-
Weekly	0.057 (0.037)	-	-	-	-	-
LR test rho=0 chi2(1)	81.976	88.9216	88.9352	89.9164	84.384	83.3164
RHO	0.432	0.439	0.439	0.443	0.431	0.434

standard error *(.)* p<10 %(*), p<5 %(**), p<0.1 % (***)

Table 7: Marginal effects

	Mfx (11)	Mfx (10)	Mfx (01)
Gender	-0.018	-0.015	0.008
Age1	0.058	0.019	0.044
Age2	0.065	0.017	0.066
Age3	-0.035	0.011	0.039
Age4	0.001	0.005	-0.015
Student	-0.007	0.011	-0.055
Self-employed	0.041	0.043	-0.036
Employee	-0.010	-0.006	-0.004
Diploma	-0.015	-0.008	-0.008
More	0.010	-0.017	0.076
Inc1500	0.004	-0.002	0.017
Inc2500	-0.010	-0.015	0.031
Inc4000	-0.002	0.001	-0.009
Countryside	-0.031	-0.003	-0.077
Urban100000	-0.014	-0.001	-0.034
Urbanplus	0.021	-0.002	0.058
Paris	0.036	-0.004	0.094
Compint4	0.029	0.031	-0.055
Compint5	0.034	0.017	0.0159
Daily	0.013	-0.001	0.036
Weekly	0.006	-0.0001	0.014

5. Limitations

One of the main limitations of our study is related to the lack of information about the needs driving the adoption of SOFTWAREVOICE. We do not have information neither about the language spoken or the frequency of travel which might give to us more information about the characteristics of diffusion pattern of this technology which could break geographical distance as it has worldwide diffusion. On the other hand, the survey does not give information on telecommunication operators chosen by households' e.g. new entrants or incumbents. This will be extremely valuable for analysing the churn consumers' propensity.

There were no questions referring to preferences for bundled services offered by the triple play providers. Here, we suppose that the individuals subscribing to the TRIPLAY, because of the earlier development of this option by France Telecom. Here, we can hypothesis that individuals subscribing to TRIPLAY have chosen new entrants, thus they could be defined as

‘innovators’ (Rogers, 1983; Dickerson, Gentry, 1983). They might churn from incumbents to new entrants. If the survey would contain all these information, it can be more useful for the telecommunication policy authorities and for the Ministry of Research and Public Administration. In addition, the cross section nature of the variables could not give us more information about the lag of the adoption.

Conclusion

The telecommunication industry has seen the emergence of numerous new technologies, including VoIP which permits unlimited voice traffic. From the empirical findings, it emerges that the two services are competing for the same group of consumers in other words internet users and youngest people, which might be defined as ‘early innovators’ (Rogers, 1983). This confirms that the two patterns of innovation diffusion are following a path dependent process. The two services could be considered as imperfect substitutes. On the one hand, both voice services enable voice communication completely free or at reduced tariffs. On the other hand, the Software service applications require that individuals should have some IP related competences and thus confidence with using the Internet. While unlimited calls offered by IP network providers do not. TRIPLAY adopters can profit of general network effects whilst SOFTWAREVOICE users benefit of social network effects.

The imperfect substitute feature is the consequences of the consumers’ perceptions and differentiation among the two models. It is not possible to determine if one of the two patterns can dominate the market. This opens up the possibility of persistence plurality of services, such as the case of Apple in the PC industry (Swann, 2002). The adoption of triple play is highly geographical determined, as it is high density areas that have access to this service.

Appendix A: Descriptive statistics

DEPENDENT VARIABLES	*Description*	Software=1 **(229 obs.)**	TRIPLAY=1 **(558 obs.)**
Gender (sexe)	Equal 1 if female	0.603 (0.490)	0.489 (0.500)
Age1	Equal to 1 if age=<20	0.393 (0.489)	0.120 (0.325)
Age2	Equal to 1 if age=<30	0.157 (0.365)	0.229 (0.421)
Age3	Equal to 1 if age=<40	0.240 (0.428)	0.296 (0.457)
Age4	Equal to 1 if age=<50	0.279 (0.550)	0.165 (0.371)
Employee	Equal to 1 if individual is employed in a firm , 0 otherwise	0.367 (0.483)	0.407 (0.492)
Independent	Equal to 1 if individual is self employed , 0 otherwise	0.100 (0.301)	0.059 (0.236)
Diploma (dipsupebis)	Equal to 1 if individual has a high school diploma, 0 otherwise	0.445 (0.498)	0.462 (0.499)
Student	Equal to 1 if individual is a student , 0 otherwise	0.205 (0.405)	0.154 (0.361)
Nbhousehold	Household number of 2 or more	0.799 (0.401)	0.846 (0.361)
Inc1500	Equal to 1 if household's income<=1500 euros per month	0.183 (0.388)	0.136 (0.343)
Inc2500	Equal to 1 if household's income<=2500 euros per month	0.345 (0.476)	0.412 (0.493)
Inc4000	Equal to 1 if household's income<=4000	0.332 (0.472)	0.344 (0.475)

	euros per month		
Rural	Equal to 1 if individual lives in countryside	0.161 (0.369)	0.140 (0.347)
Urban100000	Equal to 1 if individual lives in a city with 100000 inhab. maximum	0.096 (0.295)	0.090 (0.286)
Hdplus	Equal to 1 if individual lives in a city with more than 100000 inhab.	0.332 (0.472)	0.342 (0.475)
Paris	Equal to 1 if individual lives in Paris	0.262 (0.441)	0.288 (0.453)
Daily	Volume of calls make daily in log	0.471 (0.819)	0.509 (0.812)
Weekly	Volume of calls make weekly in log	0.574 (0.909)	0.574 (0.954)

Standard deviation in ()

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