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INTERNET DIFFUSION IN PIEDMONT IN THE MID 2000s

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ABSTRACT

The Internet can be considered as one of the most extraordinary technical innovation in modern times. And yet, its developmental path within local, regional and national systems is difficult to assess beyond some elementary statistics, when available.

Notwithstanding these difficulties, interest in having interpretive insights and sound metrics is increasing. This paper is a contribution in this endeavour. It reports some findings of the research activities carried out by the Piedmont Information Communication Technology Observatory (PICTO). Its purpose is to set forth a few interpretive keys by which Internet diffusion may be appreciated, measured and monitored at regional and sub-regional levels.

The paper is organized in three parts. The first provides justifications to the empirical investigations and mentions some conceptual underpinnings about Internet penetration among households. The second illustrates the trend of diffusion of Internet in Piedmont also in comparison with what is occurring in Italy and Europe. The third part highlights the results of the application of a Logit model which has been carried out to analyze the diffusion of Internet among households in the 2005-2008 period. Insights into regional Piedmont local areas are also provided.

Finally section 5 puts forward some summarizing remarks and makes suggestions for future researches.

1. INTRODUCTION

The Internet can be considered as one of the most extraordinary technical innovation in modern times (Castells, 2001, 2004, Fuchs, 2007, Leydesdorff L., 2001, Welmann and Haythornthwaite eds., 2002). And yet, its developmental path within local, regional and national systems is difficult to assess beyond some elementary statistics, when available.

The constantly upgrading of the network architecture, the clumsy methodologies for analyzing its impact on human organizations and the unsatisfactory conceptual framework of the innovation process, all concur to hamper our understanding of Internet diffusion (Beilock and Dimitrova, 2003, Wolcott, et al., 2001).

Notwithstanding these difficulties, interest in having interpretive insights and sound metrics is increasing. This is even more apparent in those areas where broadband policies are carried out in order to overcome digital divides and/or support socioeconomic growth (Bargero, Donati and Occelli, 2007, Gillett, Lehr and Osorio, 2006, OECD, 2008, Pollone and Occelli, 2007).

This paper is a contribution in this endeavour. Its purpose is to set forth a few interpretive keys by which Internet diffusion may be appreciated, measured and monitored at regional and sub-regional levels. The study is undertaken as a part of the research activities carried out by the Piedmont Information Communication Technology Observatory (PICTO). Established by the Regional Government at the end of 2004, in fact, PICTO activities are meant to provide the information basis to support the deployment of the broadband network in Piedmont (see, www.wi-pie.org).

In the following, section 2 provides justifications to the empirical investigations and some conceptual underpinnings about Internet penetration in human organizations are presented. Then in section 3 the trend of diffusion of Internet in Piedmont is briefly recalled and discussed also in comparison with what is occurring in Italy and Europe. Building upon the results of the surveys conducted by PICTO in the 2005-2008 period, section 4 highlights the results of a Logit model which has been applied to analyze the diffusion of the Internet among households. Insights into the Piedmont local areas are also provided.

Finally section 5 gives some summarizing remarks and makes suggestions for future researches.

2. CONCEPTUAL UNDERPINNINGS

While the increasing relevance of the Internet is indisputable, a satisfactory approach of its evolution and overall impacts on organizations and society is still lacking. Its multi-faceted and evolving nature, in fact calls for inter-disciplinary research endeavours and continually updating data which are difficult to provide on a timely base as the consequences of the Internet usages unfold over time.

To researchers aimed to understand by means of conceptually and significant metrics the Internet diffusion a dilemma is apparent: “If we begin by examining prior work and the theory behind the measures, we must ask readers to accept the justification without fully understanding the measures.

If we put the measures first, we must ask the reader to temporarily accept that they do, in fact, have sufficiently strong justifications “(Wolcott et al. 2001, p 5.)

In other words, a pragmatic approach is called for, by means of which a scaffolding for our justifications can be maintained and progressively revised, building upon the data that can be collected with reasonable accuracy, timeliness, and cost.

Such an approach is also at the basis of the current endeavour, which therefore makes a compromise between the need to refer to an encompassing theoretical framework and the limitations of the existing data.

As for the former reference is made to the conceptual background, recently being developed in the PICTO research activities aimed to address, at the regional level, the development of a so-called information-wired-environment, i.e. an environment which would result from an innovation kernel, consisting of ICT, information and functionalities, which are operated upon by reflexive agents (Occelli, 2005, 2008). For an information wired environment to exist, a number of requirements, associated to a four layered framework, should be met and namely: a) the existence of a convenient connectivity level in technological networks, b) able to support a critical mass of interlinked users, c) who are capable of extracting, managing and consolidating information, and d) and sustain strategic guidance, while operating in an information rich environment.

While the first two requirements have been already addressed extensively also in the relatively recent literature on telecommunications and the geographical space (see, Graham and Marvin, 1997, Batten et al. eds., 2000, Wilson and Corey eds. 2000), the latter dealing with the usages of ICT deserve more insights. In fact, as emphasized in Thorne (2003, p. 67): “Internet communication tools cannot be fully apprehended from a positivist vantage point as generically *there* in the world. Cultural artifacts such as global communication technologies are produced by and productive of socio-historically located subjects. Such artifacts take their functional form and significance from the human activities they mediate and the meanings that communities create through them”.

Notwithstanding it is not fully developed, that conceptual background is retained for the empirical investigation discussed in the following sections. The scheme shown in Fig.1, gives an overall overview of its application to the specific issues concerning Internet diffusion.

The specification of the scheme owes as much to the studies carried out by PICTO since 2005 (see, Osservatorio ICT del Piemonte) as to the findings in the literature (see, Daly, 2000, Horrigan and Rainie, 2002, Fallows, 2004).

In the scheme two main domains are emphasized: a) an external domain pointing to those main determinants at the societal levels which may affect the triggering of the spreading of the Internet in an areas; and b) an internal domain meant to refer to the area (the regional system) where the ICT penetration occurs.

The latter is the one which is will be primarily focussed on in this study.

What the scheme ultimately holds is that the use of the Internet by an individual would depend on several factors which, also for the sake of the practical investigation, can be grouped in a limited number of types.

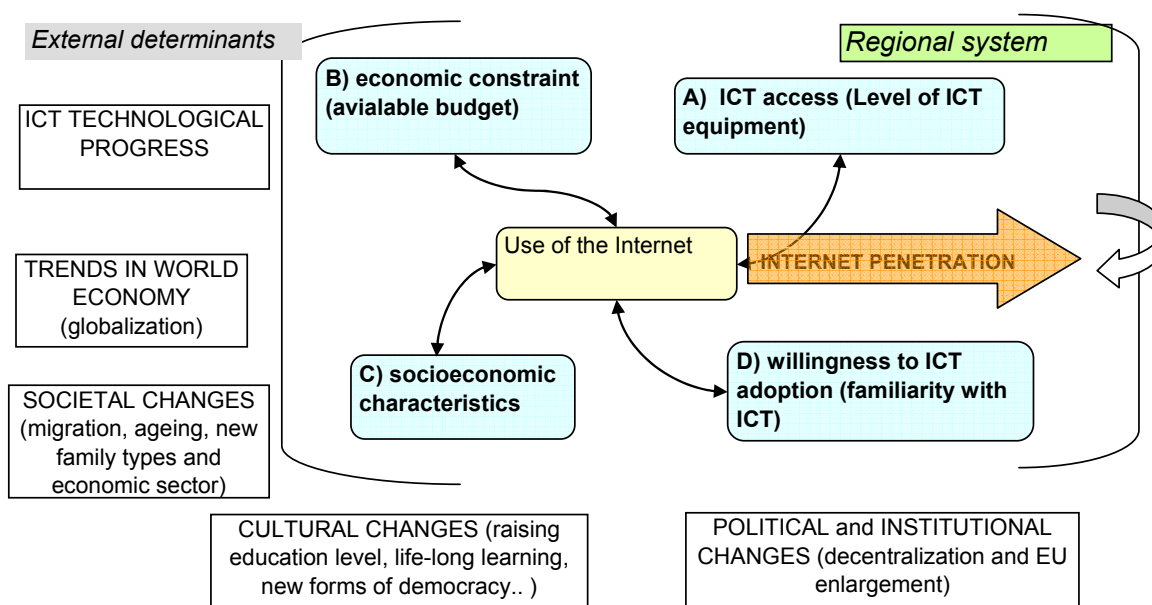


Figure 1 A scheme of the use of the Internet

In particular, Figure 1 emphasizes four main types of factors:

- the existence of a certain level of ICT connectivity. It goes without saying, in fact that without convenient ICT coverage the Internet could not be accessed ;
- the level of economic resources available to a household. ;
- the socioeconomic characteristics of individuals as, population features such as age, education, life-style, household size, have a role in influencing the utilization of a technology;
- the readiness of individuals to adopt a technology, as this would depend on psychological and cultural factors.

3. INTERNET DIFFUSION IN PIEDMONT: AN OVERVIEW

Since 2005, every year PICTO conducts a survey about ICT equipment and Internet usages among citizens, enterprises and local governments. A four year time-series databases are now available which make it possible to grasp the evolutionary trends of ICT in the region.

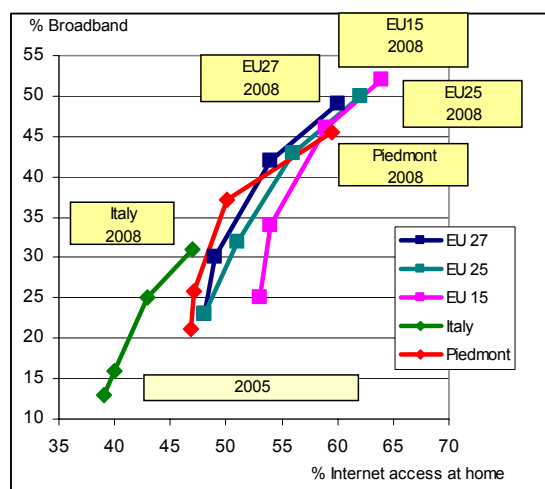
The present analysis draws from the citizen survey. It involves a sample of slightly more than 2 thousand households (individuals) who were interviewed by a means of a CATI. Built upon the experience gained in previous European Projects concerning the measurement of Information Society¹, the questionnaire has been progressively expanded in order to meet the questions raised by the implementation of the regional broadband policy².

¹ These are REGIONAL-IST, carried out in 2004 and UNDERSTAND realized in 2004-2006.

² For the sake of space it is not possible to describe all the type of data gathered in the survey. The questionnaire is available upon request.

To help understand the regional situation, in the following first we give a synthetic overview of the Piedmont situation also compared with the overall situation in Italy and Europe.

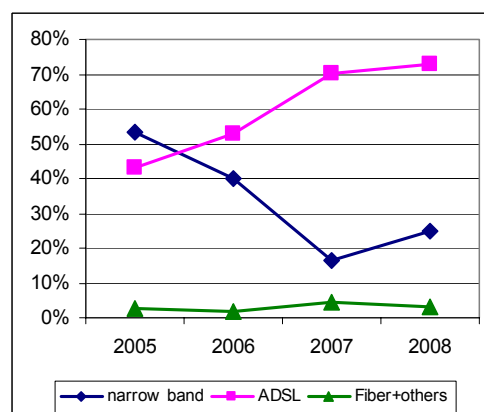
Figure 2a compares home Internet access (horizontal axis) and broadband adoption rate (vertical axis) among households in Piedmont, Italy and Europe, showing their evolution between 2005 and 2008. In spite of the significant progress which occurred in this period, Piedmont endowment is still weaker than that observed at European level. In 2008, both broadband availability (45%) and Internet access at home (59%) are lower than the European averages (52% and 64%, respectively, in EU15). However, Piedmont performs much better than Italy. As shown in Fig.2, in fact, Italy lags behind. The broadband uptake among households (31%) ranks this country in the last positions in the overall ranking of European countries for broadband availability.



Source: EUROSTAT and PICTO

Figure 2a Internet and broadband access in Europe, Italy and Piedmont, between 2005 and 2008

To date, ADSL is the main type of connectivity households use to connect to the Internet. As shown in Fig. 3, its rate of adoption increased dramatically, over the 2005-2008 period. This was also the results of the deployment of the regional broadband policy Wi-Pie which, by the end of 2008 provided wired broadband access to 94% of the (1206) municipalities.



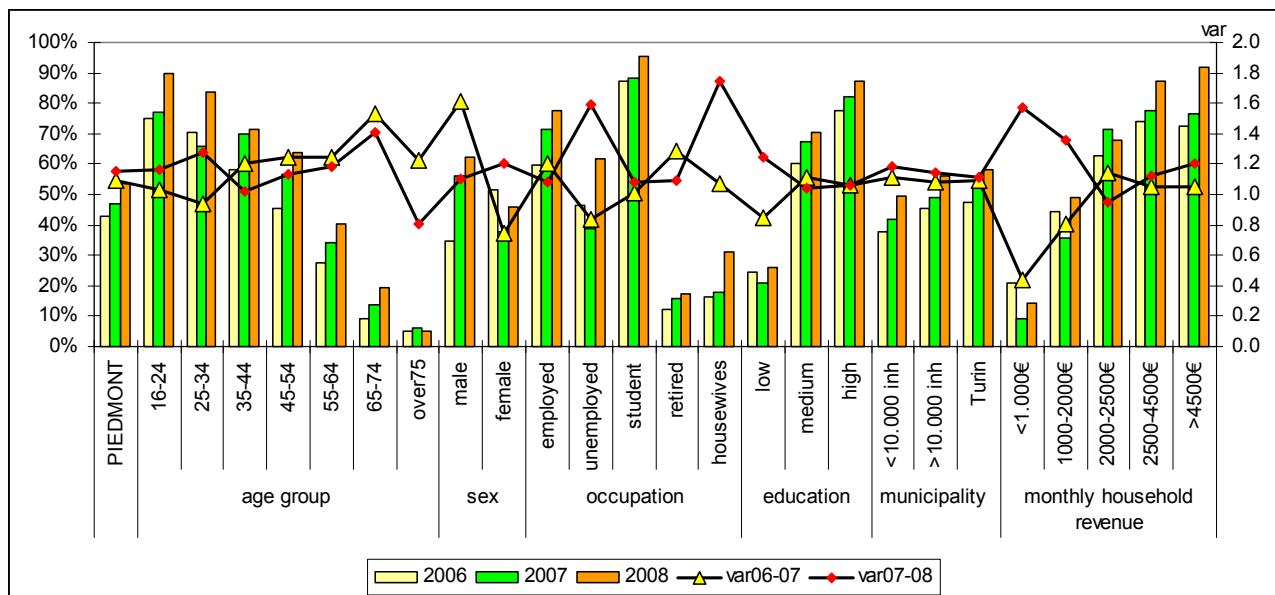
Source: PICTO

Figure 2b Evolution of Internet connectivity types among households in Piedmont, between 2005 and 2008

It is worth mentioning that a few main features of the regional profile had a relevant role in the spreading of broadband, thus affecting the speed of diffusion of the Internet and namely:

- the high number of local governmental bodies (Piedmont has 1206 municipalities and 8 Provinces);
- the existence of highly scattered settlements, made of few cities and a majority of small and very small municipalities (80% has less than 5000 inhabitants). Turin the regional capital concentrates more than 40% of the regional population (Tab. 2);
- an heterogeneous morphology: more than 40% of the regional area is mountainous. This distribution varies considerably across Provinces and also population density shows a high variability (from the highest of 279 inhabitants/sqkm in the Turin metropolitan area to the lowest 64 in the Vercelli Province) ;
- the presence of an aging and low educated population ;
- the legacy of the old industrial basis which hampers the development of a more diversified and service based economy.

More than half of the regional population older than 16, use the Internet. Fig. 3 summarizes the rates of penetration in the 2006-2008 period, according to a few main socio-economic categories: age groups, gender, employment status, education, municipality size, revenue.



Source: PICTO

Figure 3 Internet users by population characteristics in 2008 and 2007-2008 variation (*)³

³ Note that the percentage of Internet Users is slightly different (indeed, it is lower) than the percentage of Internet access at home. The availability of an Internet connection at home, in fact, does not necessarily mean that an individual is willing to use the Web.

(*) Sample population consists of individuals older than 16.

What the figure clearly shows is that in Piedmont as in the majority of developed countries, the use of the Internet is a quality of a young, educated and wealthy population, living in urban, and likely culturally rich environments.

An additional aspect revealed by the figure is that the highest positive variations over the three year period, occurred among those population groups who may be considered as more exposed to the digital divide risk, such as the older population and those belonging to weaker socioeconomic groups, such as unemployed workers, housewives, and low income households.

What the figure finally suggests is that the trend we observe in the Internet diffusion occurring in Piedmont is the result of two main processes:

- a learning process an individual undertakes on personal basis, as a result of several factors, such as the exposure to communication media, curiosity and increasing availability of leisure time;
- a collective process, resulting from the interaction with those individuals who already use the Internet. As the number of Internet users growth, also the stimuli to use it reinforce and accelerate its diffusion pace.

In addition to the above mentioned process we must also take into account the cohort effect produced by the aging of the Internet users. To investigate this process for the Piedmont region, an estimation of the Internet users in 2012 has been made on the basis the regional population forecasting, by age groups (Gehring and Occelli, 2008). Internet users by age groups in 2007 have been computed at province level, and projected into their cohorts in 2012. The only assumption made was that in 2012 all the population in the youngest cohort would use the Internet. In a regional scenario where only the demographic trend of population aging would fuel the penetration of the Internet, therefore, Internet users would growth from 48% in 2007 to 53% in 2012. As can be easily appreciated from the previous comments, this value has already been reached by 2008.

4. INSIGHTS INTO THE INTERNET DIFFUSION PROCESS IN PIEDMONT

Building upon the conceptual arguments introduced in section 2, a logit model has been developed and applied to the PICTO survey data, to sharpen the understanding of the process of Internet penetration in the Piedmont area, at the regional and sub-regional levels (provinces).

As it is well known, the logistic regression model allows us to establish a relationship between a binary outcome variable and a group of predictor variables. It models the logit-transformed probability as a linear relationship with the predictor variables. More formally, let y be the binary outcome variable indicating success/failure (in this case use or not use of the Internet) with 1/0 and p be the probability of y to be 1, $p = \text{prob}(y=1)$. Let x_1, \dots, x_k be a set of predictor variables. Then the logistic regression of y on x_1, \dots, x_k estimates parameter values for $\beta_0, \beta_1, \dots, \beta_k$ via maximum likelihood method of the following equation.

$$\text{logit}(p) = \log(p/(1-p)) = \beta_0 + \beta_1 * x_1 + \dots + \beta_k * x_k \quad (1).$$

In terms of probabilities, the equation above is written as:

$$p = \exp(\beta_0 + \beta_1 * \mathbf{x}_1 + \dots + \beta_k * \mathbf{x}_k) / (1 + \exp(\beta_0 + \beta_1 * \mathbf{x}_1 + \dots + \beta_k * \mathbf{x}_k)) \quad (2).$$

In this application, the choice of the predictor variables is the result of a compromise between the attempt to stick to the descriptions shown in Fig.1 and the data availability in the PICTO household databases. In addition, the following criteria have been retained for their selection:

- the time-series availability of the information⁴, taking also into account the possibility of their updating in future surveys. As the model was applied to each yearly data-base a meaningful set of data had to be identified;
- the ease of interpretation of the variables also from a policy point of view. Indeed, all the selected variables can be targeted by regional ICT policies;
- the robustness of the estimates as a result of the preliminary tests carried out for the different yearly databases⁵.

The selected predictor variables are (see Fig.1):

- a. ICT access. It is assumed that the availability of broadband connection at home can be considered a factor affecting positively this familiarity;
- b. households' budget. The availability of a medium-high monthly revenue (higher than 2500 euro) is included;
- c. those agents' socioeconomic attributes having a relevant role in fostering ICT adoption and namely: age and an high education level (such as degrees or masters);
- d. the agents' willingness to use ICT. An hypothesis is made that the attendance to lessons for learning how to use Internet or a personal computer can be regarded as a proxy of individuals' ICT readiness.

The model results at the regional level are graphically shown in Fig.4⁶. As it could be expected they are coherent with the empirical findings already discussed in the previous section, while allowing us to get more detailed insights into them.

First, when considering the set of variables included in the model, the results suggest that ICT access and namely the availability of broadband connection is the most influencing variable for Internet use. Improving familiarity with ICT (attending ICT lessons) is the second most relevant variable. Somehow unexpected is the fact that among the remaining variables, attending ICT lessons (improving familiarity with ICT) turns out to be the second most relevant variables. This is followed by education and household budget. Contrary to the other factors, age which is also the least influencing variable has a minus sign, clearly reflecting the fact that the use of the Internet is a quality of young population.

⁴ It is worth emphasizing that the information used do not refer to panel data but to random population samples stratified by age-groups and provinces. We cannot exclude, therefore, that some distortions in the parameter estimates may exist.

⁵ This means that for the chosen predictors the results of model applications of the model at the regional level, are always statistically significant.

⁶ The results of the statistical tests are not shown in the paper, they are available upon requests.

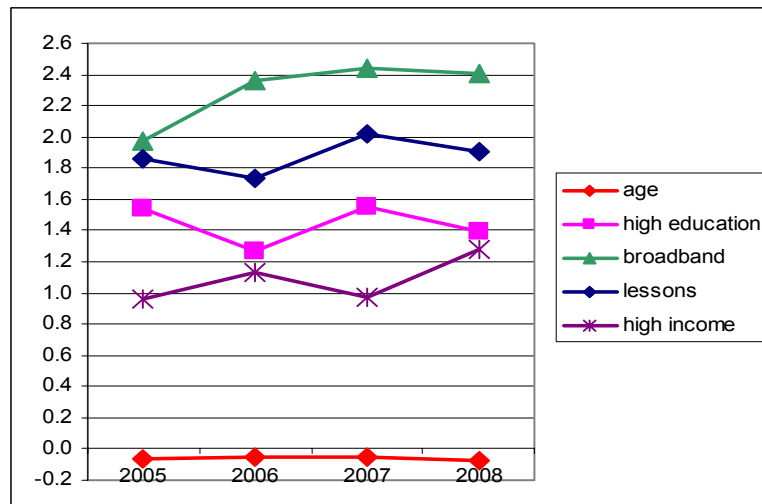


Figure 4 2005-2008 parameter values for the predictor variables

Second, although the time period is too short to identify any temporal trends, it is worth emphasizing that the impact of broadband availability tends to reinforce over all the study period except in the most recent year. In 2008, however, household economic constraints seem more tightening: to have a high income in fact turns out be relatively more important than in the earlier years.

The influence of each variable and the changes in the 2005-2009 period, can be better appreciated examining the exponential transformation of the parameters' values (see eq.2), as illustrated in Fig.5. This makes it possible to show how, *coeteris paribus*, an (unit) increase in the broadband home access provides a contribution as high as 10 to the increase of the log odd between use and no use of the Internet. Attending ICT lessons would have a contribution of about 7; having a high education or a high income, would yield about 2 and 4. It is worth noting that while in 2005, the effect of having a high education was two times stronger than that of high income availability, in 2008; their effects are almost the same.

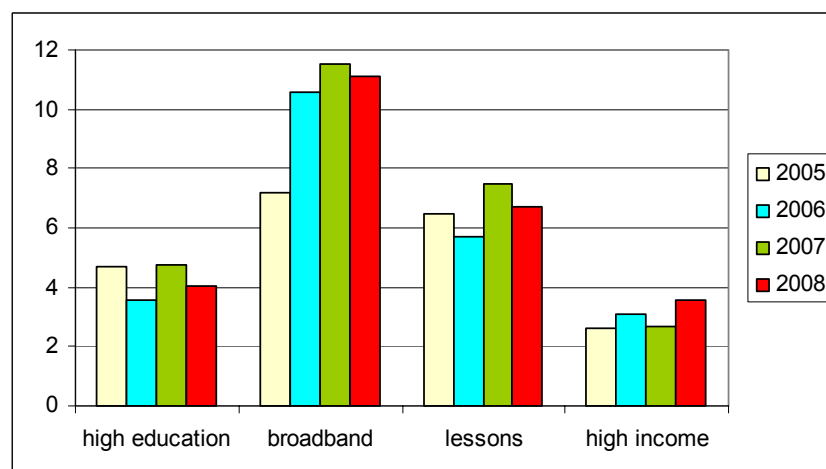


Figure 5 – 2005-2008 effects of some predictor variables on the use of the Internet in Piedmont

For the age variable, which is not binary, its effect on the Internet usage (that is on the log odd use/no use) is shown in Fig.6, for 5 year age classes. The curves clearly show that: a) compared with that of the other variables, the effect of age is very weak; b) an increase in age negatively affects Internet usage; c) compared with that observed in the previous years, in 2008 the contribution of age diminishes, thus suggesting the influence of a cohort effect.

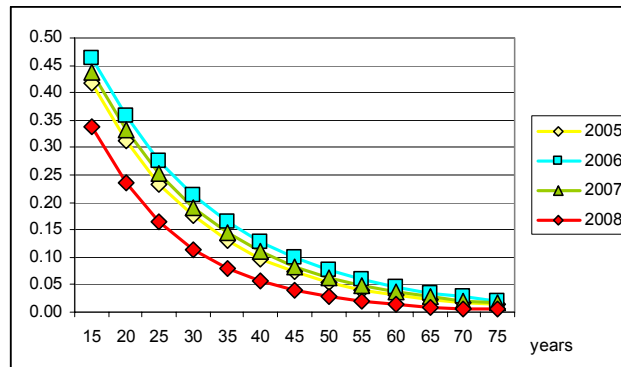
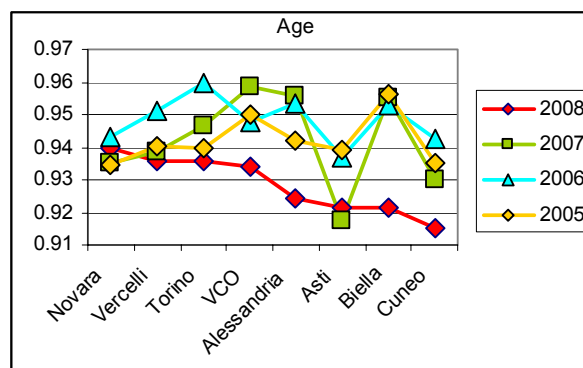


Figure 6 – 2005-2008 effects of age on the use of the Internet in Piedmont

Results at provincial levels are summarized in Fig. 7, where only the values which are statistically significant are shown. From their analysis, the following comments can be put forward:

- although it has a limited effect, age is always significant in all the Piedmont areas. Its reduced influence in 2008 is clearly evident in all the provinces;
- the influence of broadband access turns out to be pervasive in all the sub-regional areas. Results also indicate that its impact was particularly noticeable in some underserved areas, like for example that of Asti where, before the completion of the broadband regional policy in 2008, connectivity was low the digital gap most deep;
- for the other variables a greater variability is observed across the sub-regional areas. Attending ICT lessons has a role in almost all the provinces, although its relevance has been changing over the study period. The impact of education and income becomes stronger in 2008, although only certain areas (such as the province of Asti and VCO) are mostly affected.



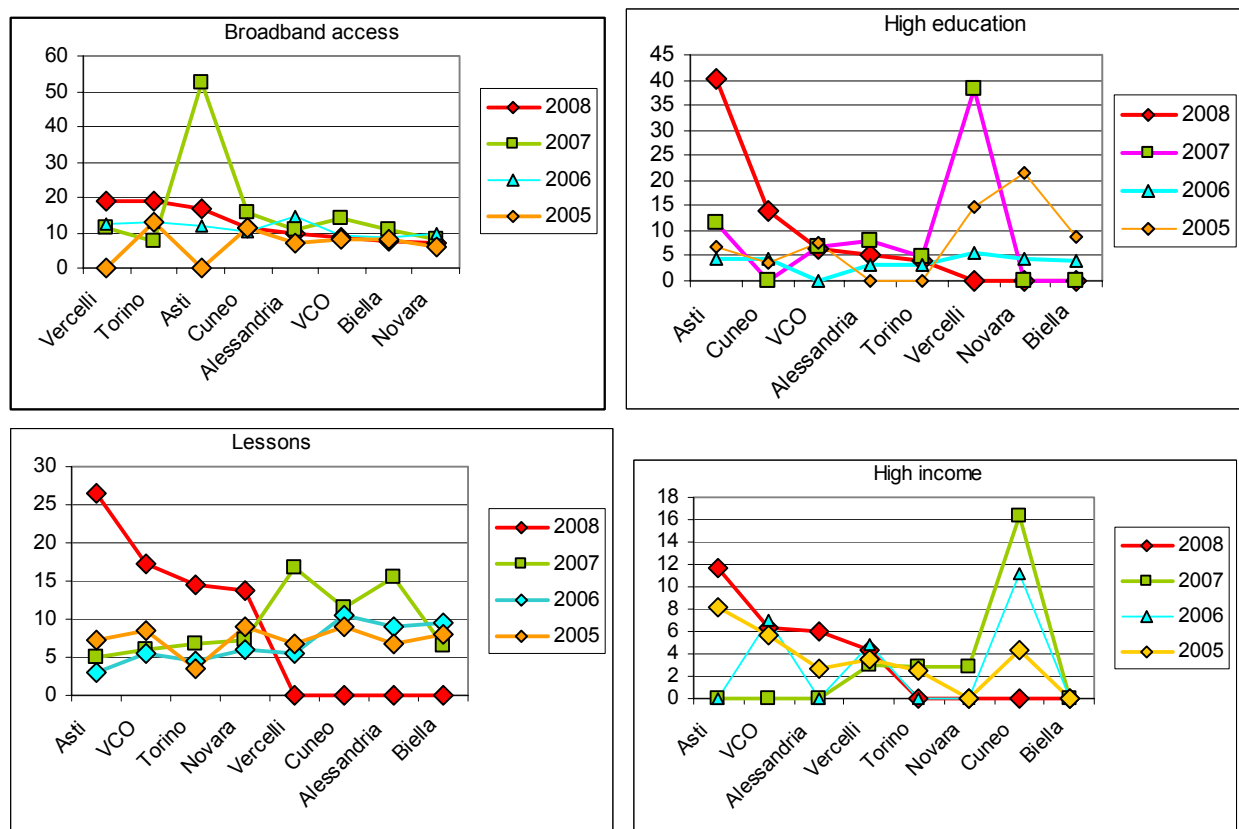


Figure 8 2005-2008 effects of the predictor variables on the use of the Internet in the Provinces (*)

(*) Provinces are ranked by decreasing values in 2008.

5. CONCLUDING REMARKS

The aim of this study was to contribute to the formulation of interpretive keys by which Internet diffusion may be appreciated, measured and monitored at regional and sub-regional levels. To this end, a conceptual scheme was outlined and the results of an empirical investigation for a household sample discussed. This was based on a relatively large database which has been built in the 2005-2008 period, as a result of yearly surveys carried out by the Piedmont ICT Observatory, in order to monitor the penetration of ICT's in the region.

In particular, an effort was made to achieve a balance between breadth and depth (see Press et al., 1998), although the results do not yet provide a fully satisfactory understanding of the Internet spreading.

Apart from the relevance of the statistical exercise which has been undertaken, two general results can be appreciated.

First, the analytical application allowed us to empirically investigate the relative importance of a number of factors, some of which are highly policy sensitive, in fostering the adoption of the Internet in a regional area. Actually, such an investigation served a twofold purpose: a) it made it possible to verify for Piedmont a few general hypotheses about the role played by certain determinants in Internet diffusion, such as the relevance of broadband access; b) it increased

awareness about the fact that, in an area, a bundle of different factors do play a role in the usage of the Internet and that this bundle can change, or be differently tuned, over time.

Second, the results of the analysis clearly indicate that the mix and level of factors having a responsibility in the Internet uptakes also vary according to the areas.

The last remark makes it evident that to fully understand its developmental path, the investigation of the Internet should be extended to include both the context in which this path occurs and the impacts it would produce on its hosting, social, economic and organizational environment.

In this respects, as already contented in the PICTO's studies (see, Pollone and Occelli, 2007, Gehringer and Occelli, 2008), developing the notion of information-wired-environment and innovation kernel could be helpful in sharpening the research questions to be addressed in future research, i.e:

- how the deployment of the systemic nature of ICT connectivity network (broadband) can put in place novel forms of socio-technical networks that may produce innovative learning environments and creative components in regional (local area) organizations?;
- which kind of adaptation process a socioeconomic system (local area) should undertake in order to get the highest benefits from the penetration of the whole range of Internet based services broadband technologies will deliver?

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RIASSUNTO

Un aspetto più volte sottolineato negli studi sulla diffusione di Internet, riguarda il fatto che l'uso della Rete risulta una prerogativa di una popolazione giovane, caratterizzata da livelli di istruzione e di reddito mediamente più elevati, ed appartenente ad una famiglia collocabile in una posizione intermedia nel ciclo di vita familiare (ovvero in una famiglia di dimensione medio grande con figli ancora adolescenti). L'esistenza di queste caratteristiche, tuttavia, non paiono di per sé sufficienti a

spiegare l'accesso alla rete. Altri fattori, legati a caratteristiche strutturali degli insediamenti ed ai percorsi di familiarizzazione/apprendimento nei confronti delle ICT intrapresi dagli individui giocano un ruolo importante.

Questo lavoro si propone di investigare alcuni di questi aspetti rivolgendo l'attenzione al Piemonte, dove ormai da alcuni anni l'Osservatorio ICT (del Piemonte) svolge delle indagini specifiche sulla diffusione delle ICT presso i cittadini, le imprese e la pubblica amministrazione.

Il lavoro si articola in tre parti. La prima presenta un quadro concettuale di analisi dell'adozione di Internet, quale, progressivamente, si sta sviluppando anche alla luce dei lavori dell'Osservatorio.

Esso si basa sull'idea che la decisione di adozione di Internet si collochi in un contesto (socio-culturale ed insediativo), nel quale sia i livelli di dotazione tecnologica (l'infrastrutturazione delle reti telematiche, e in particolare la presenza della banda larga) sia i processi di apprendimento degli individui hanno un ruolo importante nell'influenzare l'esito del processo decisionale.

La seconda parte presenta i risultati di un'analisi empirica che cerca di esplorare le ipotesi interpretative avanzate. A partire dalle informazioni raccolte nell'indagine sulla diffusione delle ICT presso i cittadini è stato utilizzato un modello di regressione logistica, attraverso il quale è stato possibile investigare il ruolo che un certo mix di fattori (caratteristiche individuali/familiari e di contesto) possono avere nel determinare l'adozione di Internet:

Il modello è stato applicato (a livello regionale e provinciale) sui dati raccolti in serie storica per il periodo 2005-2008. L'applicazione condotta pertanto consente di cogliere se nei quattro anni considerati si siano verificati dei cambiamenti nel ruolo dei diversi fattori e se questi abbiano interessato certe aree della regione piuttosto che altre. In sintesi i risultati ottenuti indicano che:

a) in primo luogo, con riferimento al mix di variabili considerate, l'uso di banda larga rappresenta la variabile più significativa nel contribuire all'uso di Internet, seguita dalla partecipazione ai corsi, dal livello di istruzione, dalla disponibilità di un reddito elevato e dall'età. Con riferimento all'età è da sottolineare che questa interviene con un segno negativo, e riflette il fatto che l'uso della Rete tende ad essere una prerogativa di una popolazione giovane;

b) in secondo luogo, il confronto negli anni, pur limitato ad un arco di tempo assai limitato, mostra che il contributo dell'uso della banda larga si rafforza, così come quello della partecipazione ad un corso di formazione;

c) infine, un aspetto da non trascurare è che i fattori che motivano l'uso di Internet, non sono omogenei in tutto il territorio regionale. L'analisi condotta, infatti, suggerisce che i diversi fattori potrebbero combinarsi in mix compositi e, a seconda dei contesti locali, avere un'incisività più o meno rilevante nel motivare la popolazione di un'area ad usare la Rete.

L'ultima parte del lavoro, infine, contiene alcune considerazioni generali sullo studio condotto. In particolare si argomenta come i risultati dell'analisi: a) contribuiscano positivamente allo sviluppo del quadro interpretativo ipotizzato; b) possano offrire indicazioni utili nella realizzazione di interventi di diffusione della banda larga.