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## Conference Paper

# Next Generation Access and Digital Divide: Opposite Sides of the Same Coin?

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**JEL codes: L51, L96**

### **Key words**

**Infrastructural Digital divide, Cultural Digital Divide, Geographical cross-subsidies, Efficient bypass, Critical mass of services**

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# Next Generation Access and Digital Divide: Opposite Sides of the Same Coin?

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## Abstract

Geographical averaging of retail and wholesale prices could distort incentives for bypass entry in both the metropolitan and the high-cost areas. The two-instrument approach to universal service support, proposed in (Armstrong, 2001), could enhance efficiency, through competitive and technological neutrality. Alternatively, the industry support to high cost areas could be substituted by redistributive fiscal measures or public subsidies. Using evidence from Italy we suggest that tackling demographic, educational, and income inequalities is necessary, even in low cost areas, to support further broadband penetration. We estimate logistic regressions of Internet and broadband use at home, and show that a substantial increase of broadband penetration is possible in Italy only if specific platforms and applications are made available to older and less educated households. Therefore, a critical mass of services could help reaching the critical mass of users that make Next Generation Access Networks viable.

## 1. Introduction

The two traditional issues faced by PSTN universal service policies, i.e. support to low income users and support to high cost areas - see for example (Cremer et al., 2001), (Crandall and Waverman, 2000), (Gasmi et al., 2000), (Panzar, 2000), (Riordan, 2001), (Valletti et al., 2002) - pose difficult problems also with respect to the development of high speed data services.

Geographical differences in cost will dictate the choices of coverage, technology, and market structure. The gap between rural and urban unit costs is bound to increase as the quality of broadband services supplied in low density areas improves, even if less capital intensive and less performing technologies than Fiber to the Premises (FTTP) are deployed there.

Moreover, unit costs of FTTP strongly decrease with actual diffusion. Therefore, even in urban areas, affordable prices, in addition to other favorable demand conditions, are necessary to sustain a diffusion sufficient to break-even.

In other words, differences in cost of providing service and social inequalities pose difficult and interrelated problems of coverage and pricing to regulators and service providers: how wide and geographically uniform should coverage be, how high and geographically uniform should prices be, and where is infrastructural or service competition viable and desirable?

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Traditional policies conceived to support Universal Service of voice and narrowband services, such as industry funded subsidies and geographical averaging of prices, could be too expensive and distortive to apply to support high speed service diffusion. In particular, they either wouldn't be sufficient to promote ubiquitous availability and universal adoption of broadband, or would increase the price of new generation services supplied to denser areas, hindering their diffusion or even their sustainability.

On the other side, public funds are invoked to support at least five different (intermediate) social goals: the development of NGA in urban areas; bridging infrastructural digital divide; improving quality and efficiency of government and public service provision through ICT; addressing cultural barriers to adoption and utilization; assuring the affordability of services. These goals are not contradictory and could be part of an integrated effort that addresses coordination market failures and network externalities. However budget constraints and the high opportunity cost of public funds impose a careful selection of priorities and instruments in order to maximize the effects of a feasible program. So, promotion of new generation access networks in metropolitan areas and digital divide policies appear opposite sides of the same coin for policy makers and regulators.

## 2. PSTN Universal Service Obligations and Digital Divide policies: similarities and differences

Technical progress and pro-competitive regulation created, in many countries, the conditions for phasing-out Universal Service Obligations for voice and narrowband data services (in the following USO). However, in the same years Digital Divide Policies (in the following DDP) were proposed with similar motivations and instruments.

While convergence of voice and data services and the distributive goals of public policies suggest an integrated approach, the effectiveness of DPP could be enhanced if the differences in demand factors, the economic motivations of regulatory and public intervention, and the available technological solutions were pointed out.

### *2.1 Obligations for voice and narrowband services: a problem of the past?*

Cross subsidies from urban areas, business customers, long distance and international calls towards access and local calls of residential, especially rural, users were embedded in the rate structure in the monopoly era. The prevention of cream skimming forced the regulators of liberalized markets to make the subsidies explicit through the contribution of operators to redistributive funds. Moreover, the rebalancing of the rate structure toward costs was promoted, using incentive regulation. This process, almost completed in Europe, greatly reduced the amount of cross subsidies, and the number of unprofitable areas and customers. As a consequence, in most European countries, the operator in charge of USO doesn't receive anymore an explicit contribution to the universal service fund because the net costs deriving from the service provided to unprofitable users and areas is deemed negligible in comparison to the related commercial advantages.

It is worthwhile to compare the European case with USA, where, considering only the federal instruments, the Universal Service Fund will collect in 2010 \$8.7 billion, with a contribution rate of about 13% on interstate and international call revenues, and will disburse them to high cost (\$4.6 billion) and low income (\$1.2 billion) voice customers, Internet access for schools and libraries (\$2,7 billion), and rural health care (\$214 million), while additional funds are provided to local operator through above-cost intercarrier compensation. The federal support to voice services will be gradually substituted with the support to broadband capable infrastructures and services, whose life cycle net present value is estimated to be \$24.3 billion, for an universal availability target of actual 4Mb in download (FCC, 2010).

This comparison is useful to show some of the merits of the European regulatory framework, and to point out the remaining difficulties in making the consumer protection compatible with a level and technologically neutral competitive playing field.

In first place, the rebalancing of the fixed and traffic sensitive components of retail prices implemented after the European market liberalization in 1998 didn't result in a significant loss in subscriptions, i.e. it didn't have efficiency but, at most, distributive negative effects. For many residential customers, the fall of call prices obtained through regulation and competition was more than sufficient to compensate the increase of subscription prices. In subsequent years, the almost universal diffusion of mobile services, made possible by competition - and above-cost termination rates, ignited fixed-mobile substitution in low-income and low-volume customers.

In the second place, in the European Union termination rates are cost oriented (i.e. don't provide subsidies to access providers) and the monthly subscription (geographically uniform in most countries) is high enough to cover the average access costs in those areas that are considered potentially profitable. So, in particular, the estimated net cost doesn't include the funds transferred implicitly from lower than the average to higher than the average cost areas through uniform prices, but only the deficit that average price leaves uncovered.

The Finnish example shows that the European regulatory approach to universal service admits a flexible and differentiated implementation. In particular, from the 1st of July 2010, Finland is the first EU member state where the provision of broadband (1Mb/s in download) at fixed business or permanent residential locations has become an universal service obligation. The NRA will monitor the affordability requirement without any ex-ante price control. Secondly, from 2007, technological neutrality has been applied strictly: wireless and mobile technologies can fulfill the obligations, provided that adequate standards of quality, reliability, and safety are met (wireless service licenses of an universal service provider will be amended to include those constraints, in particular if an integrated operator proposes the switch-off of part of its copper network). Thirdly the Government expects that the cost savings deriving from meeting previous voice obligations with wireless technologies are sufficient to cover the incremental costs related to broadband provision, so that also in the future no public or industry fund will be necessary; however it is prepared to share with the industry any unreasonable net cost that could result from the new universal service obligation. Moreover, the second phase of the national broadband plan, whose target is to make available a fiber network within two kilometers from the 99% of permanent households and business places, will be promoted also with public funding in areas where a private business case is not viable (4% of potential end users). Fourthly, since residential density has significant variation among the local operating areas fixed subscription rates and LLU rates have been permitted to vary correspondingly (the LLU monthly fee, varies from 7.86€ to 33.70€, with a weighted average of 12.07€ - in May 2010). As a consequence of the country's geography, of a favorable regulatory context (very high fixed to mobile termination rates for calls made without carrier selection, soft price controls), of the integrated strategy of the three players that provide both fixed and mobile services, and of strong competition, mobile services are usually more convenient than fixed ones, and the share of 'mobile only' households is growing (61% at the end of 2007, for voice services (European Commission, 2008), while the number of fixed telephony subscriptions, including VOIP, dropped by a further 20% from 2007 to 2009 (FICORA, 2009)); in the meanwhile, the number of DSL connections is declining (but is still the 48% of broadband connections), and that of wireless broadband is booming (38% of the total) (FICORA, 2010).

## *2.2 Demographic and cultural digital divide*

Demography, education and other socio-economic factors besides income have been shown to be significant factors of the variance of telephone penetration rates (see (Riordan, 2001) for a discussion of the literature and estimates on US Census data and (Grilli, 2004) for an UK probit analysis). We expect that complementary skills (computer literacy, foreign language skills, professional background, and general education), that are correlated with age, play an important role in Internet and broadband adoption because act as barriers or modify the users' perception on the usefulness of the Internet (Rosston et al., 2010) (Savage and Waldman, 2009).

We will present in section 4 some evidence from Italy. Here it is useful to discuss how age, education, professional status and family structure interact, and suggest analyses based on microdata.

First note that the marginal effect of age on the adoption is less pronounced in countries such as those of Northern Europe that have a long history of highly diffused high education levels. In other countries, such as

the Mediterranean Europe ones, the mean education of senior citizens is much lower than for younger people, so that the higher marginal effect you measure results from the joint effect of both factors (Lewin, 2010) Second, the actual competences related to a given education level vary with time (in particular computer, scientific, and linguistic skills) and space (even within the same country: see the gap in mathematical competences between northern Italy and *Mezzogiorno* in the PISA tests (OECD, 2007). Third, the work experience can be a substitute of formal education.

Finally note that Internet and broadband adoption at home is at the same time a family and an individual decision. In particular, as the number of actual users increases, the demand for connection time and bandwidth increases (favoring fixed, high speed connections); however, pro-capita income could be lower and the poverty rate higher both in some small households (singles or couples, when retired or unemployed) and in larger families with three or more children.

These factors have an impact on the design of DDP and on the business case for NGA.

First, the scope of improving diffusion in the short term depends on the effectiveness of the proposed policies against the specific barrier that affects adoption. Given the present environment, the joint demographic and education barriers could be the more costly and lengthy to remove. However, clear opportunities for innovation exist both in technologies and business models (IPTV, Internet through television sets, pads with touch interfaces, etc.) and in public policies (e-health, for example).

Second, forecasting speed and extent of diffusion, and their effect on traffic density, has implications on the choice of an investment strategy (timing, technology, and adoption of transitory or future proof solutions).

### *2.3 Economic Motivations of DDP: externalities in the broadband era*

Direct externalities prevail in voice and narrowband services (e-mail), and could also have a role in broadband and ultra-broadband (high quality video-conferencing). However indirect externalities will have a far greater importance in the latter case. We can distinguish two broad cases.

We label the first, that is very similar to the application barrier to entry found in software markets, as *critical mass of users and services* (Castelli and Leporelli, 1993) the provision of a new application hosted on a platform increases, for some potential users, the willingness to pay for access to the platform. This may reduce the platform's access price and further increase the number of adopters and of viable applications. Therefore, the provision of an application may also benefit people that won't use it if it helps reaching the critical mass of users that make the platform viable; on the other hand, a critical mass of different applications may be necessary to reach a sufficient number of the platform adopters if their user sets are not coincident.

In the second case, that we label as *application providers' savings* from the new platform adoption (Castelli and Leporelli, 1993), we focus on the public policy implications of the externality. Our argument is that when a previous application exists, users' migration must be incentivized leaving them part of the surplus that derive from the innovation. When an application provider adapts a preexistent application to a new platform the coexistence of the versions or their phasing-out are planned taking into account the users' switching cost and the threat of competitors' substitute applications.

A radical treatment of excess inertia is the switch off of the older platforms (as in the case of analogue terrestrial television). A less drastic solution is leaving to the end user a differential surplus sufficient to cover the platform switching cost.

Public services enjoy almost monopolistic markets and their provision through ICT channels could result in huge budget savings (provided organizational and political problems are solved). However, their availability must be universal: the migration from face-to-face to Internet provision must necessarily be gradual before switch-off is considered, and technical assistance is required for less skilled people.

Therefore, in order to get the benefits of ICT, public service providers, such as health care and educational institutions, should not only promote and organize new ICT applications, but also devote part of the savings

they attain to the targeted technical assistance and financial support of less skilled and low income end-users.

The support should be limited to the households whose willingness to pay for private services would not be sufficient to justify the new platform adoption. Its effect would be efficiency enhancing because both the *critical mass* and the *provider's saving* mechanisms are activated.

#### *2.4 Infrastructural choices and DDP: the technological opportunities and costs*

In order to assess the business case for a given technology in a given local area we have to forecast the evolution of the geographic density of access lines and of traffic: at one end capital intensive technologies, such as FTTP, are justified if density is high or can grow rapidly; at the opposite end, mobile, wireless, and even satellite options could be the most cost-effective transitory solution, or also the only viable and efficient solution in the long term. The opportunities for the improvement of the infrastructure and its speed depend on the demographic structure of the population and on the effectiveness of the support policies.

In particular, in low density areas infrastructural digital divide poses additional problems to those related to narrowband universal service. One of them, backhaul capacity, is common to fixed and terrestrial wireless networks: second mile capacity has to be increased to connect the significant number of local areas where voice service is available but DSL or mobile broadband speed would be constrained by aggregated traffic volume. The quality and cost problems of the access network are technology specific: multiplexers in the access network and long loops preclude or degrade DSL service; cell size has to be reduced and the available spectrum has to be increased to provide sufficient traffic capacity and avoid congestion in areas where wireless network have to substitute rather than complement the fixed network.

Therefore, wireless technologies could be a cost effective substitute of the copper network in selected areas where upgrading the fixed access network is costly, the performance gap is limited, and the traffic density is within the reach of the available (3G) and future (LTE) technologies.

### 3. Geographically averaged prices and their effects on efficiency

In this, section, following the conceptual framework proposed in (Armstrong, 2001) we will discuss how technological neutrality and a level competitive field could reduce the social cost of USO and DDP.

#### *3.1 Access, pricing, bypass, and universal service: the scope for competition*

In (Armstrong, 2001) geographical averaging keeps incumbent's regulated retail price out of line with regional unit costs. Entrants can choose between access to the monopolist's network and bypass. Armstrong's paper discusses how regulation could align private and social incentives for entry (i.e. make entry profitable if and only if it is socially desirable) and finds that wholesale network access prices should be cost-oriented, while retail subsidies should be granted to all operators in high cost areas and retail taxes should be levied on all the operators in low cost areas, both equal to the incumbent's price-cost divergence in that area.

The combined effect of the wholesale and retail instruments would be equivalent to ECPR for access based entry (i.e. geographically averaged wholesale prices, if retail prices are averaged). Therefore, if bypass is unlikely, the proposed mechanism gives no practical advantage over a rule that is easier to implement and administer.

On the contrary, when bypass is possible, serious distortion could take place both in urban and in rural areas if urban taxes and rural subsidies are not implemented. In the low cost segment of the incumbent's network retail and wholesale prices are higher than costs and bypass, such as fixed-mobile substitution or overlay NGA could be excessive. On the other side, the radio access technologies would be disadvantaged in rural areas with respect to the fixed network, the only one enjoying geographical cross-subsidies.

Similarly, reverse auctions for awarding high cost support in the context of DDP would be distorted if the incumbent could combine the auction support and the geographical cross-subsidies.

### *3.2 Implementing the two-instrument approach*

The Armstrong's theoretical approach is simple, elegant, and clearly suggests adaptations, generalizations, and implementation strategies; however a number of issues could prevent its practical use.

First note that the amount of geographical subsidies depends on the difference between regional prices and costs and could be reduced, even to zero, moving prices towards costs. This would be the easiest and most efficient measure (leaving aside externalities) if the high-cost price could be accepted by the regulator as affordable, or the Government could use budget resources to support (at least the low-income) affected users.

Second, the geographical averaging could be at least partially preserved, and the industry transfers could be reduced and substituted with Government support to the high cost providers.

In both of these cases, the public support, although directly targeted to DDP in high cost areas, would indirectly promote also broadband diffusion and NGA investments in metropolitan areas, because both retail and wholesale prices of the legacy network, and taxes on the overlay NGA could be reduced.

The Armstrong's approach is compatible with the competitive provision of universal service (i.e. multiple designated providers in a given local area) that could be implemented issuing virtual vouchers that end-users in high cost areas could redeem with the provider of their choice, therefore only actual adoption would be supported and competition would be promoted.

Turning to the issues to be considered for the practical implementation of the approach, the first and most difficult question concerns the geographical tax collection: defining exactly which end user, or connection, or served fixed location should pay the tax will be difficult and highly controversial. PSTN, VOIP, and mobile voice services or fixed and mobile broadband provide imperfect substitute services that are jointly adopted by the many households; mobile connections are an individual more than an household service. In principle, if bypass is defined as the loss of a fixed connection at a permanent residential or business location, only mobile subscriptions that cause these losses should pay the tax. Identifying those subscriptions would be cumbersome and costly but not impossible: for example bundled household subscriptions should be subject to only one tax; moreover fixed subscribers could get tax waiver on mobile unbundled subscription. Alternatively the total amount of the burden on the mobile subscriptions could be estimated using statistics on the total number of 'mobile only' households and then allocated uniformly on all mobile subscriptions.

Secondly, the amount of the subsidy or tax for a given user should depend on the specific cost of providing her the service. A feasible methodology could be computing average costs for a small number of geotypes, defined on the basis of similar cost and market conditions. In particular, it could be useful to distinguish zones that could be interested by early deployments of NGA and areas where fixed voice and broadband services are currently considered unprofitable. A further distinction could be made between zones where local loop unbundling is actually used and those where only bitstream wholesale services are demanded: in the latter, in fact, infrastructure based competition could be precluded by higher unit costs of backhauling and co-location.

Thirdly, sharing the subsidies among multiple designated firms (using vouchers, i.e. proportionally to local market shares) could increase the total cost of universal service provision if those subsidies would also cover the duplication of indivisible network components such as fiber backhauling or base station sites. On the contrary, in high-cost areas wholesale access to indivisible infrastructures should be promoted. In particular, auctions could be used to find the least-cost wholesale provider of additional backhaul capacity needed to extend broadband coverage in a given local area. Public funds could be integrated in this framework in order to reduce the taxes levied on low cost areas. An additional problem is related to the transition management. If, initially, the PSTN incumbent is the only designated provider of universal service, and technological



neutrality is not guaranteed, its costs would probably overstate those of an efficient provision. Consequently, the regulator has to balance the risks of excessive remuneration to new entrants (if the switch to the new approach is immediate) with those of prolonging the incumbent's monopoly (if the transition is gradual and the incumbent can adjust its infrastructure to take advantage of technological neutrality). In the long run, for each geotype, the subsidies would be based on the costs of the most efficient technology deployed there by a designated service provider.

Finally note the competitive consequences of de-averaged prices and/or measured costs. With uniform regulated incumbent's prices the competition benefits are transmitted also to areas where entry hasn't occurred. On the contrary, in deregulated retail business markets incumbent's prices are usually lower in those areas where infrastructure based competitors are active; these areas are usually low-cost, but in the short term competitive conditions certainly have a greater impact on prices than long run costs. Reducing subsidies to high cost areas should result in more vigorous competition in low cost areas because competitors would enjoy lower wholesale rates or bypass taxes, while de-averaged regulatory costs would allow more aggressive incumbent's prices. Technological neutrality and symmetric subsidies could open high cost areas to inter-platform competition and reduce the cost of USO and DDP. Pricing below regulatory cost should remain feasible in areas labeled as unprofitable, at least if a single designated provider of last resort is active there.

#### 4. The dimensions of digital divide in Italy

In this section we analyze the Internet and broadband adoption factors in Italy, in order to evaluate the cost-effectiveness of different possible USO reforms and DDP. Our analysis is based on annual surveys carried out by the Italian Statistical Office (ISTAT) from 2005 through 2009. In each survey about 48.000 individuals, belonging to around 19.000 households, representative of the entire Italian population are interviewed on their use of ICT equipment and services. We focus on the use of Internet and broadband from home.

##### 4.1 *A logit model of Internet and broadband diffusion*

In fig. 2 and fig. 3 we present summary descriptive statistics of internet and broadband adoption. We classify households in the sample using five dichotomous factors: best grade of education in the household (high school or better vs. others), profession of the head of household (clerks, professionals and managers vs. blue collars and unemployed), presence of a child 14-24, town size (more or less than 10.000 inhabitants) and region of living (North and Centre vs. South and Main Islands).

Internet use shows a much more pronounced effect of education, profession and presence of children, while geographic factors (town size and region) have little influence. We must underline that in 2009, 52,3% of Italia households still didn't have an Internet connection at home and the adoption growth rate is quite low: should the CAGR of last four years continue, Italy will reach 90% adoption, i.e. Netherland adoption in 2008 (European Commission, 2008) in eight years. This issue appears difficult to solve in the short term, given the high incidence of households with only senior and less-educated components.

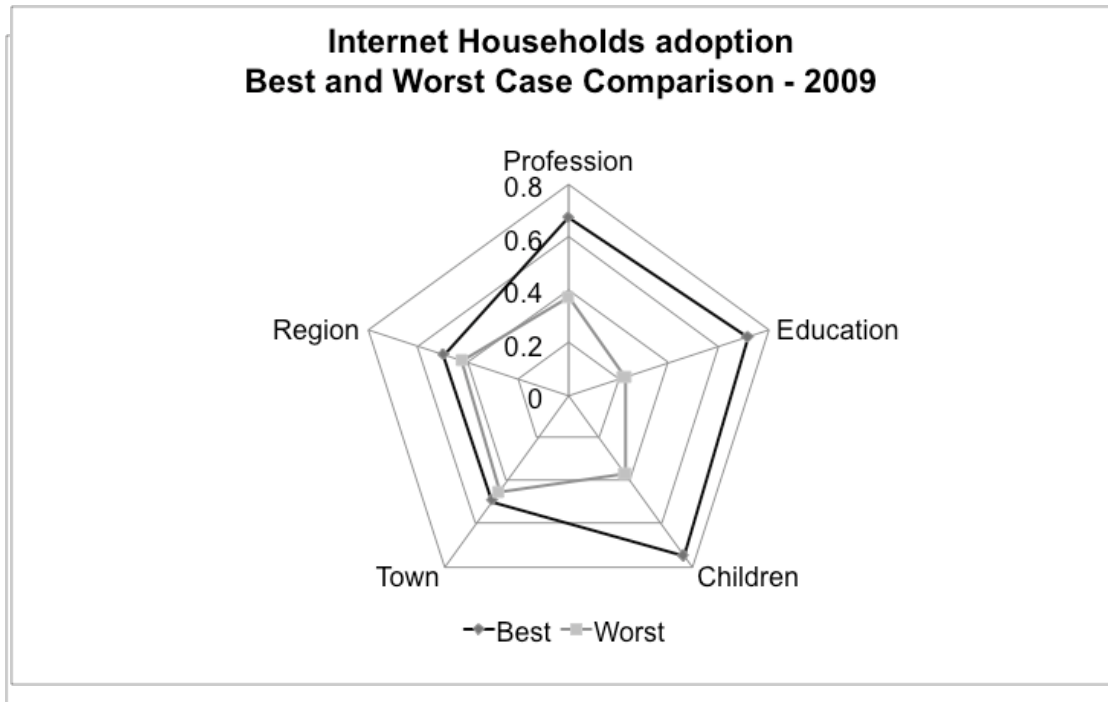


Figure 1- Evolution of internet and Broadband in Italy statistics on impact of factors on Internet adoption

Figure 2 - Descriptive statistics on impact of factors on Internet adoption

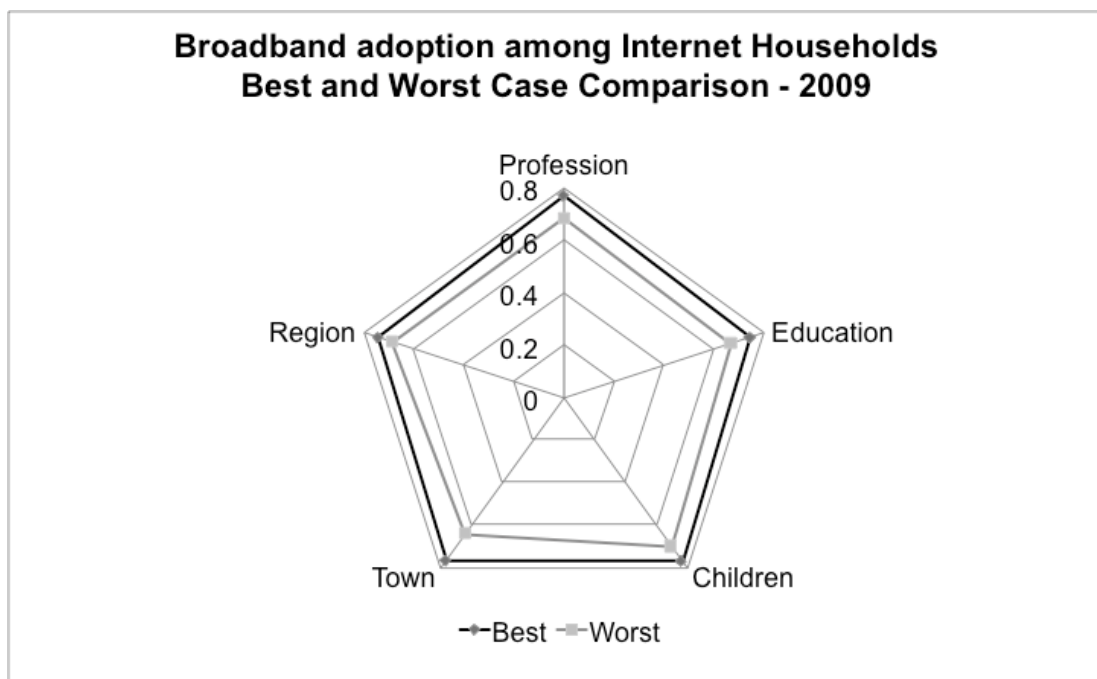


Figure 3 - Descriptive statistics on impact of factors on Broadband adoption

The broadband adoption among those households that use Internet, shows interesting differences with respect to Internet adoption. First note that broadband adoption has experienced a boost through the last five years, more than doubling penetration. While all the socio-economic factors that positively influence Internet adoption also have a positive effect on broadband adoption, suggesting both a greater willingness to pay and an influence of income, here the most important differential factor seems to be the size of the town. Apparently, in smaller towns infrastructural problems have constrained broadband diffusion. However, in the aggregate, the share of broadband households on Internet households has grown quite rapidly: the transition to broadband of the residual 30% of narrowband Internet users shouldn't require slow diffusion

and learning processes but the overcoming of existing barriers, that probably are essentially economic and infrastructural.

Some suggestions on the direct impact of income on fixed telephony and broadband penetration, that we couldn't analyze using ISTAT microdata, come from aggregate penetration data for the twenty Italian regions in the 2010 AGCOM annual report (Agcom, 2010) and the 2008 regional relative poverty incidence data (ISTAT, 2010). A negative correlation of penetration and poverty is evident in fig. 4 and, obviously, the variation of fixed voice penetration is not related to cultural or infrastructural factors.

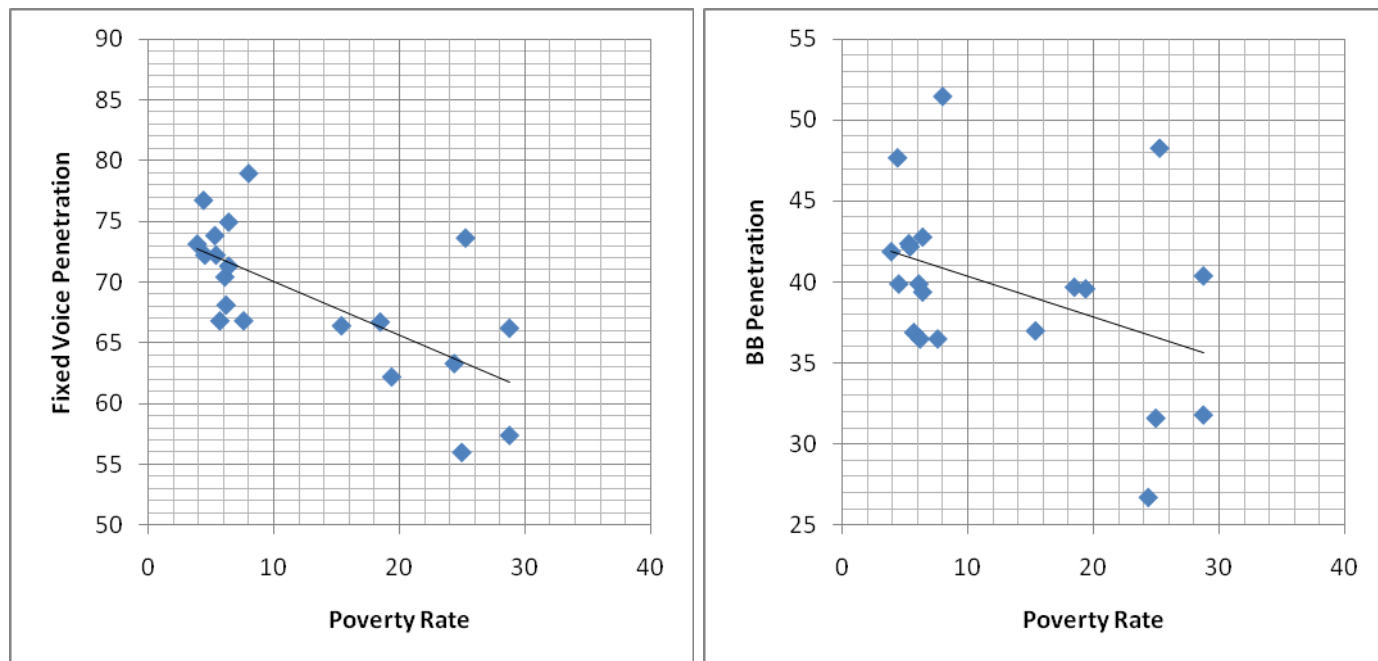


Figure 4 - Correlation between poverty and Fixed Voice and Broadband penetration

The data in (AGCOM, 2010) also suggest a complex interrelation between fixed telephony and broadband adoption: being still mobile broadband in its infancy, on one hand fixed telephony access is for most users a prerequisite of broadband adoption; on the other hand, the interest for broadband has weakened fixed-mobile substitution. Moreover, an interesting correlation, and a possible two-way causation, appears between competition and broadband diffusion (see fig. 5): from one side entry has privileged areas with higher broadband demand; from the other side, competition could have improved take-up.

Even with a complete transition to broadband of all present Italian Internet users, a broadband penetration gap of about 30% with respect to Netherland would result. Therefore, addressing the specific needs of those households that still don't use Internet at home will be eventually necessary if Italy wants to reach broadband penetration levels comparable to those of European best performing countries.

A structural model of telephone, Internet and broadband penetration, technology choice, and use is needed to explore this issue. As a first step we present here logistic regressions on the ISTAT microdata, respectively for internet adoption, and for broadband adoption among people that use internet at home.

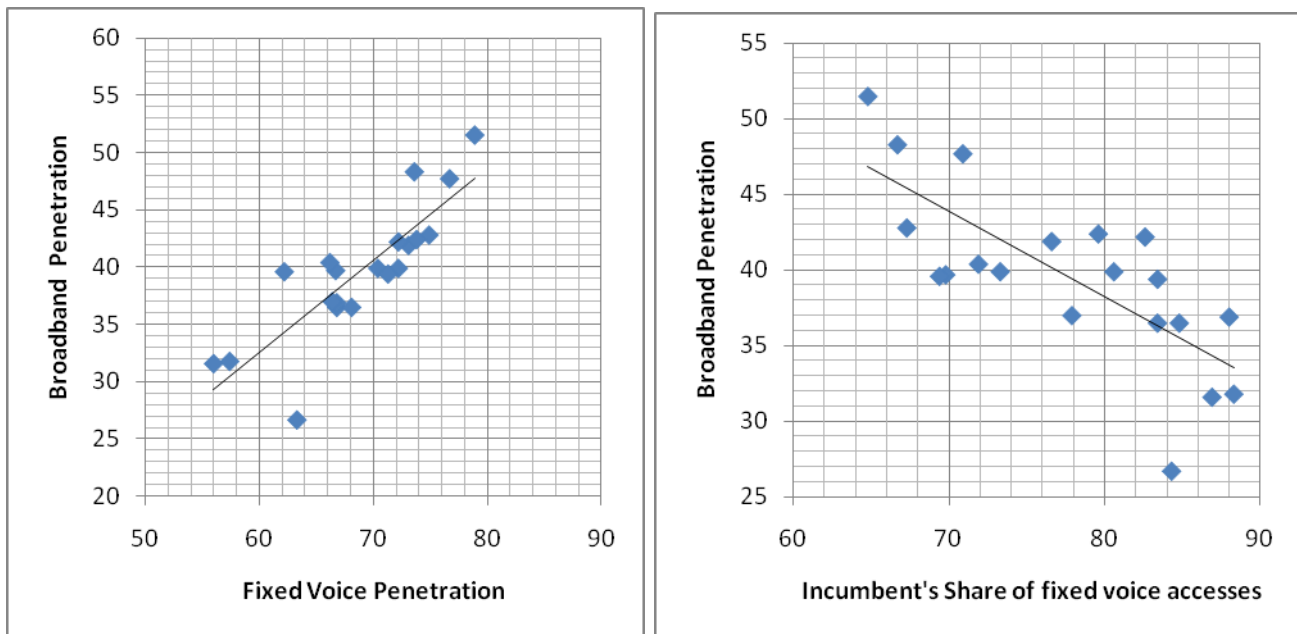


Figure 5 - Correlation between poverty and Fixed Voice and Broadband penetration

We are interested in verifying if a specific effect of town size is confirmed after controlling for the different incidence of education levels, age and professional status between large and small towns. Moreover, we are interested in verifying the specific effect of profession because we consider it a proxy of family income. A separate estimate for the Internet and Broadband adoption processes, is necessary in order to distinguish the effects of educational and demographic factors (that could influence Internet adoption) from those of infrastructural problems (that could affect broadband).

The independent variables taken into account are the following:

- best educational level in the family, in three categories: High (College & University), Medium (High School) and Low;
- best profession in the family, a proxy for the income (a variable that ISTAT, unfortunately, does not provide), again divided into three categories: High (Managers), Medium (Clerks) and Low (Blue collars, unemployed, or retired);
- minimum age in the family, divided into classes (0-13, 14-17, 18-25, 26-44, 45-54, 55-64, over 65)
- town size, in two categories: over and up to 10.000 inhabitants;
- region, divided in two categories: Center-North and South and Main Islands
- year of the survey: time trend from 2005 (0) to 2009 (4)

Regressions results are shown below, in terms of the usual  $\text{Exp}(\beta)$ s (all variables are highly significative).

#### 4.2 *Infrastructural and economic constraints to broadband adoption*

We have tried to evaluate the possible effects of two polar policies on broadband adoption:

- overcoming infrastructural digital divide: the availability gap that affects more severely towns under 10.000 inhabitants is supposed to be integrally closed by an infrastructural investment program;
- overcoming the economic constraint: we suppose that economic aid is given to the most disadvantaged households that have at least one child between 6 and 24 years, in order to increase their adoption propensity to the level of high-income households.

Variable		Internet	Broadband
Intercept		0,009	0,124
Best Educational level	High	5,533	1,232
	Medium	2,628	1,143
	Low	1,000	1,000
Best Profession	High	3,444	1,343
	Medium	2,289	1,128
	Low	1,000	1,000
Minimum age	0-13	18,059	1,504
	14-17	49,642	1,799
	18-25	28,704	1,553
	26-44	12,224	1,209
	45-54	6,551	1,387
	55-64	3,886	1,224
	over 65	1,000	1,000
Town size	over 10.000	0,931	2,145
	up to 10.000	1,000	1,000
Region	Centre-North	1,812	1,298
	South and Major Islands	1,000	1,000
Year		1,233	1,584

Figure 6 - Logistic Regressions results in terms of  $\text{Exp}(\beta)$ s

In order to estimate the effect of the former policy, we consider descriptive statistics from the 2009 ISTAT microdata: the broadband share of internet connections was equal to 63,9% in towns under 10.000 inhabitants, and equal to 72,4% in bigger cities. We assume that this difference is entirely due to a disparity in coverage. Using an average Italian availability of 92% (Confindustria, 2010) we find that, if full coverage was reached in both categories, the broadband adoption among Internet users would turn out to be of about 76,8% of the whole Internet users, which are 47,7% of the Italian households. So, in the short term, completing coverage would entail, at most, the incremental adoption of 1,8% of the households, i.e. about 438.000 new lines. They would be split in approximately 407.000 households in smaller cities, and the remaining part (31.000) in cities over 10.000 inhabitants. Consider that budget problems have delayed a Government plan aimed at achieving 100% coverage of Italian population with 2Mb/s broadband (fixed or mobile) service, that would require 1,4€ billion investments. Therefore the infrastructural divide explains only a small part of the Italian gap in broadband adoption.

In order to evaluate the effects of overcoming income constraints on families with children we simulate the Government support to this demand segment assuming that the Low Profession coefficient of the regression is substituted by the High Profession coefficient if at least a child lives in the household. The total increment in the broadband demand would be 2,3%, about 550.000 new lines.

The short term effects of a total coverage and of an economic incentive on broadband penetration are very similar in size, if we neglect the very important problem of broadband availability and adoption by small business. However the residential demand stimulus seems much more cost-effective than widespread coverage, considering that learning effects, that decrease price and income elasticity (Rosston et al., 2010), should be sufficient to obtain permanent effects even if the support is withdrawn after a few years; moreover the incremental cost for the providers would be limited, consequently, they could obtain a net positive effect even if they support in part the program.

In any case the overall effect of programs that accelerate the transition of Internet users to broadband would be modest on those households, more than half of the total in Italy, that still don't use Internet at home.

## 5. Regulatory and Policy Options and Conclusions

Our analysis shows that insufficient Internet use by older and less educated people is the most serious problem to be solved in Italy, both to harness the economic and social benefits of Information Society, and to create demand conditions that make universal availability of adequate broadband services and NGA investments in high-density areas viable.

Different policies are needed to promote broadband among Internet users and non-users. For the latter's case the diffusion of new access devices such as pads or television sets and the promotion of new services could be important. Moreover, technical assistance and financial aid could be provided in order to obtain savings and quality improvements through online provision of a number of public services.

In the former's case adoption could be constrained for both low-income households and high-cost residents, due to infrastructure availability. Public support should be targeted to those that need it most, considering its effect in term of incremental adoptions.

Regulatory reforms could promote the efficient use of public support and reduce technological and competitive distortions of entry and investment decisions.

First, the cost of voice USO could be greatly reduced removing barriers to the use of wireless technologies in low-density areas. Mobile services are often the cheapest choice for low-volume users, and the number of 'mobile only' households is booming (Hauge et al., 2009).

Second, the provision of broadband services requires additional resources for improving backhaul and possibly access network. Even here wireless networks could be a differentiated substitute (inferior in quality) or an important complement to fixed networks; in particular they could be the preferred transitory solution in areas where extensive investments in the fixed access network are necessary and short term traffic density is low. It is important that resources devoted to USO are progressively switched to support broadband capable investments (FCC, 2010) (Gabel, 2007).

Regulators and policy makers should consider geographical de-averaging of retail and access prices or a more rigorous, technologically and competitively neutral implementation of the Armstrong's two-instrument approach.

This market mechanism, conceived in an efficiency increasing and technologically neutral perspective, may incentive competition among providers, therefore reducing the network cost and increasing the effort provided to win customers and promote new services. On the other hand, de-averaging retail and access prices could simplify the attainment of technological and competitive neutrality: industry taxes and subsidies could be withdraw, while the protection of high cost customers and the promotion of universal (broadband) service could be left to competition and public support (redistributive and innovation policies).

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