

---

## **Broadband diffusion dynamics: a systemic analysis**

---

**Enrico Ferro**

Technology to Business Intelligence Unit,  
Istituto Superiore Mario Boella,  
Via P. Boggio 61, 10138, Turin, Italy, Europe  
Fax: +39-011-2276-299  
E-mail: enrico.ferro@ismb.it

**Abstract:** The paper analyses broadband diffusion from a multitude of angles. The main objective of the analysis is thus to investigate the reasons behind an adoption delay present in certain Southern European countries. The paper presents the situation of an Italian region named Piedmont. Results show that a lack of de facto competition, together with an immature level of Internet usage, is the main cause of the adoption delay. Findings also suggest that the creation of policies aimed at fostering the use of telework could contribute to increasing bandwidth needs for different users' categories, thus accelerating the diffusion process.

**Keywords:** broadband diffusion; broadband policies; e-government; e-business.

**Reference** to this paper should be made as follows: Ferro, E. (xxxx) 'Broadband diffusion dynamics: a systemic analysis', *Int. J. Electronic Business*, Vol. x, No. x, pp.xxx-xxx.

**Biographical notes:** Enrico Ferro is a Senior Researcher at the Istituto Superiore Mario Boella. He received his Honors Bachelor of Science degree from Brighton University, UK and his MSc in Technology Management from the Catholic University of Piacenza. He is a PhD candidate at the Management, Economics and Industrial Engineering Department of the Polytechnic of Milan. He was a Visiting Scholar at the School of Information Management and Systems at UC Berkeley (CA) and at the Center for Technology in Government University of Albany (NY). His teaching and research interests lie at the intersection of a number of knowledge domains such as Information Technology, Management and Public Policy. He has published papers in the proceedings of conferences such as the *eChallenges 2003*, *eGov 2004/05*, *TCGOV05* and *AMCIS05*.

---

### **1 Introduction**

In March 2000, the European Council met in Lisbon and set the following goal, 'Europe will have to become the most competitive and dynamic knowledge economy by 2010.' This is a bold statement and has been followed by the creation of a series of action plans labelled e-Europe. e-Europe is responsible for laying out the intermediate steps necessary to meet the 2010 deadline.

The e-Europe action plans published repeatedly stress the importance of fostering the availability of broadband connections in member states. Broadband plays a strategic role in the overall achievement of the Lisbon target and, therefore, in Europe's future. A widespread diffusion of broadband infrastructures may become a necessary foundation from which to build any kind of e-government and e-business activities.

The high costs related to the implementation of broadband infrastructures, coupled with the liberalisation of telecommunication markets, have resulted in a slow and heterogeneous diffusion of such infrastructures. The large number of bankruptcies experienced by the telecommunication industry after the burst of the internet bubble wiped out an unconditioned faith in the World Wide Web. The unchallenged faith, until that time, represented one of the main driving forces behind most infrastructure related investments. At present, telecom carriers are more wary and tend to have a higher degree of risk aversion towards the allocation of financial resources in the extension of their network infrastructures.

Recently published data, by the European Commission (Eurostat Yearbook, 2004), on the diffusion of broadband shows an increase in the average rate of adoption of broadband services. However, by looking at the disaggregated data, a very heterogeneous situation is found among the different states. Nordic countries seem to have higher rates of penetration compared with Southern countries. This disparity has been a cause of great concern for policy makers, since access to broadband is widely recognised as a prerequisite for a community's economic welfare and the delivery of government services (Clark et al., 2002). The main objective of this paper will be to investigate the main causes of the current diffusion delay and determine what actions may be taken in order to prevent the creation of an ever increasing digital, as well as, economic divide. In order to do this, a thorough and detailed case study was carried out in an Italian region named Piedmont.

This paper has two main intellectual merits. The first is theoretical and relates to its contribution to a deeper and more complete understanding of the factors influencing complex diffusion phenomena such as broadband connections and services. The second is methodological and relates to the systemic approach used in the analysis. By using this approach, a methodological gap in the literature is addressed (Gillett et al., 2003), and a multi-perspective view of the phenomenon is provided.

## 2 Methodology

An important methodological question in the analysis of broadband diffusion is the definition of the object of study. As technology advances, the definition of broadband is considered as a moving target. Thus, finding a widely accepted and durable definition may result in an arduous task. In the literature, three main interpretations are found with respect to the definition of broadband. The first defines broadband through nominal bandwidth and is expressed in terms of kilobits per second ([http://hraunfoss.fcc.gov/edocs\\_public/attachmatch/FCC-02-33A1.pdf](http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-02-33A1.pdf)). The second defines broadband by providing a detailed list of supported applications (<http://largebande.gc.ca/pub/program/NBTF/summary.html>). Finally, the third approach defines broadband as 'the technological environment that enables the use of digital technologies at their highest level of interactivity' ([http://www.innovazione.gov.it/ita/intervento/banda\\_larga/task\\_force/definizione.htm](http://www.innovazione.gov.it/ita/intervento/banda_larga/task_force/definizione.htm)).

None of the definitions listed above may be considered, in principle, as optimal. Each carries both advantages and disadvantages. The first definition is an unambiguous definition, but becomes obsolete very fast. The last definition, in contrast, does not require to be continually updated, but leaves room for interpretation, and thus renders comparative analyses very inaccurate, if not impossible. For the purposes of this study, the first approach was preferred because it allowed a higher level of methodological homogeneity in the treatment of the data collected from different sources. In this paper broadband will be referred to as internet connections with a downstream nominal speed equal to, or greater than, 640 kb/s.

In order to have a good grasp of both offer and demand related aspects, a systemic approach to data collection was adopted. This methodological approach, in addition to providing us with a multifaceted picture, represents the phenomenon's complexity and allowed grounded conclusions based on solid qualitative as well quantitative data.

The adoption of this methodological choice entailed a considerable effort in terms of both data collection and analysis. As far as demand related data are concerned, three main socio-economic actors were surveyed:

- government users (municipalities)
- residential users
- business users.

In all surveys, stratified samples were adopted. The stratification variables used were: municipality size (expressed as number of inhabitants) for municipalities; age and gender for resident users; activity sector and size (expressed as number of employees) for business users. Further information concerning the samples used is detailed in Table 1.

**Table 1** Samples for the collection of demand related data

<i>Survey</i>	<i>Sample</i>	<i>Population</i>	<i>Data collection methodology</i>
Government users	275	1,206	Written questionnaire
Residential users > 16 years old	1512	4,214,677	Computer aided telephone interviews
Enterprises > 10 employees	294	6,324,567	Written questionnaire

For supply related data, face-to-face interviews were conducted with the regional managers of the major telecom couriers operating on the territory. During such interviews, both qualitative and quantitative data were collected.

For data analysis, the following tools and techniques were used: log-linear models, survival analysis and geographical information systems.

### **3 Background information**

It is important to provide some background information on the present situation in the region in terms of policies implemented, competition levels and major players operating on the territory.

In Piedmont, the regional government designs and executes all the IT related policies through a public consortium named Consorzio Sistema Informativo (CSI) that aggregates

more than fifty state owned organisations, among municipalities, provincial governments, universities and state owned hospitals.

In 2000, CSI implemented a project named RUPAR and offered a connection through an integrated service digital network (ISDN) to all government organisations in the region. Recently, CSI announced the launch of a follow-up project named RUPAR2 whose aim is to upgrade the current integrated service digital network to a broadband network by 2007. Moreover, a distributed neutral access point named TopIX was created as a complementary measure. This was done in order to stimulate the growth of peripheral areas through the presence of a number of GigaPoPs scattered around the region. The goal was to provide easier access to international carriers as well as laying the foundation for an excellent test bed in the development of new interactive multimedia services.

As far as competition is concerned, it must be reported that Telecom Italia – the incumbent courier – continues to play a major role among residential users and in rural areas. While no data are available for the specific region, national figures show that, on average, Telecom Italia may still count on a market share of over 70%. This figure obviously increases as we move outside metropolitan areas.

Finally, there is only a single player present in the region that provides high-end residential broadband connections (up to 10 Mbit/s). This lack of competition in the environment contributes to the dynamics of the specific market segment in important ways.

## 4 Offer analysis

In this section of the paper, the analysis of the data related to the supply of broadband services will be presented. The aim of this section is threefold. The first objective is to understand to what extent the diffusion of broadband networks has been a phenomenon driven by a demand pull or technology push. The second purpose is to investigate the influence of a competitive market situation on the diffusion process. In other words, to understand what percentage of the territory has been left uncovered due to a lack of economic appeal. Finally, the last objective is to test the impact of variables such as municipality size and proximity to covered municipalities on the presence of broadband networks.

### 4.1 Coverage

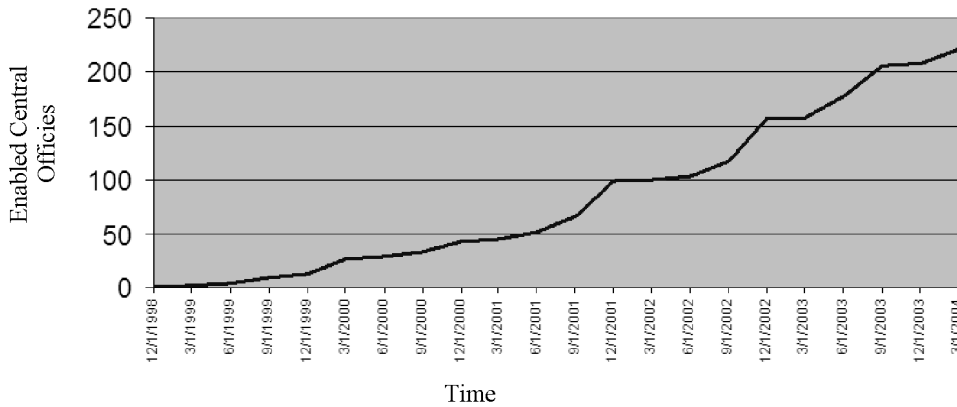
Technological progress permits the provision of broadband services through a variety of channels. Thus, if we consider coverage *tout-court* we could say that – theoretically – broadband services are available to the entire region. But, as a matter of fact, satellite services may be provided everywhere. Nevertheless, we believe that just stopping at this consideration would not render justice to the problem studied. Satellite connections require investments considerably higher, in terms of customer premises equipment (CPE). Moreover, they cannot guarantee the same level of service quality due to the sensitivity of their signal in atmospheric conditions and the higher degree of latency (especially important for highly interactive applications such as VoIP).

With regard to other wireless options, such as WiMAX, they are still not offered by any major operator in the region.

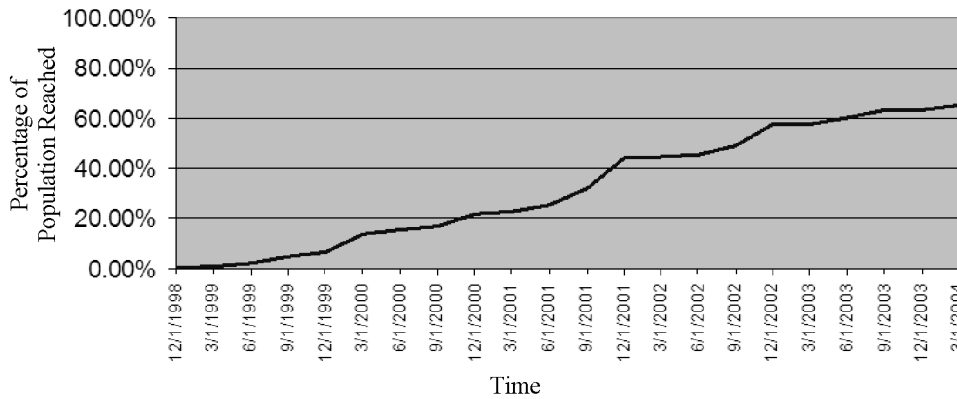
In light of what was said above, the attention was focused on wired access networks and, in particular, on the most widespread technology (i.e., digital subscriber line (xDSL)).

To understand the dynamics of the investments in xDSL infrastructure, a diffusion curve was created with the data collected from the different telecommunication carriers. Figure 1 covers a six year period and shows how the number of DSL enabled central offices has increased overtime. The first thing that may be noted is that periods of large infrastructure expansion were followed by periods of stagnation. Overall, the curve has not yet reached the plateau that characterises the final part of the typical ‘s’ shaped diffusion curve. Nevertheless, if we look at Figure 2, where the same data are plotted against the percentage of population, the curve seems to be increasing at a decreasing rate.

**Figure 1** Diffusion curve in terms of number of DSL enabled central offices



**Figure 2** Diffusion curve in terms of percentage of population reached



If we interpret this same data from a government point of view, it emerges that, out of the 1206 municipalities present in the region, only 17% of them are reached by xDSL services. This represents a serious barrier to the development of e-government services at local level.

It is interesting to note how, by looking at the same data from a multitude of angles, different pictures emerge. From a TLC carrier point of view, reaching nearly 70% of the population may seem to them like a good result. While from government’s standpoint,

having only 17% of its locations covered by broadband represents a serious hurdle in the e-government implementation process.

This is a clear example of one of the underlying differences in the development of e-business and e-government. While businesses may decide to serve only the more profitable segments of the market, governments do not enjoy the same privilege. Thus, they have to intervene where market fails. Many studies have shown how the implementation of e-government initiatives has resulted in an incentive for TLC operators to expand the coverage of their offer (Choudrie et al., 2003; Clark et al., 2002; Gillett et al., 2003; King et al., 1994; Lee et al., 2003). Regional and local public administrations may help to raise and aggregate demand, thus increasing the economic appeal to TLC operators in certain areas otherwise unattractive.

Public policies, though, should be driven by a subsidiary principle; that is, not to anticipate or replace private intervention but simply act in areas where private intervention is unlikely to happen in order to stimulate subsequent private actions. For this reason, it is of paramount importance to have a deep understanding of the factors driving the diffusion process in order to be able to identify where public intervention is required.

Survival analysis was used to investigate some of the determinants that characterised the diffusion of broadband in the region. Figure 3 represents the cumulative survival functions of municipalities with less than 10,000 inhabitants (small) and municipalities with a population over 10,000 units (medium-large). The coverage of the municipality by broadband services has been set as the death event. The two functions clearly show a situation in which small municipalities have been disregarded completely for a very long period of time. Only recently, small municipalities have been considered by TLC carriers. Nevertheless, the diffusion patterns among them appear to be far slower than the patterns experienced by medium-large municipalities. Figure 3 also seems to suggest the presence of positive externalities enjoyed by small municipalities in close physical proximity to municipalities already reached.

**Figure 3** Cumulative survival functions for small and medium-large municipalities

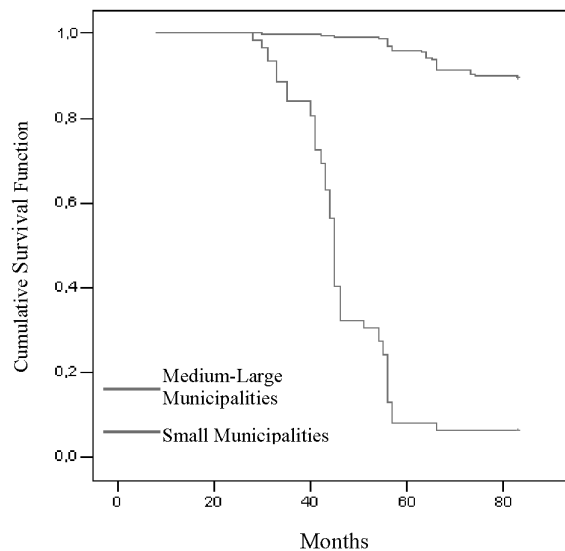
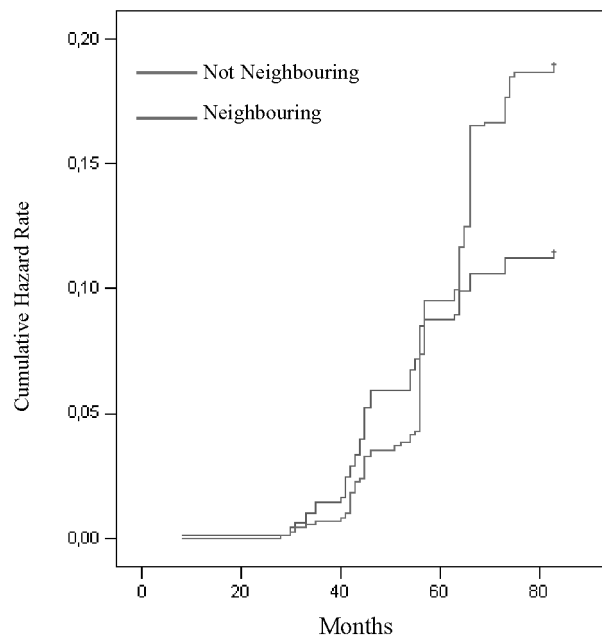


Figure 4 shows the hazard rate function for municipalities neighbouring other municipalities which are covered by broadband infrastructure, compared with those municipalities not neighbouring other municipalities already reached by broadband services. Although at the beginning of the diffusion process this variable did not seem to play a significant role, once it reached a certain point, its impact increased drastically. What may be interesting to note is that the first sudden increase in the value of the red function in Figure 4 roughly corresponds to the same point in which small municipalities started being considered by TLC carriers in Figure 3. This somehow reinforces the evidence for the thesis of positive externalities.

**Figure 4** Impact of proximity to a municipality already reached by broadband services



From a policy maker's point of view, it would be interesting to understand to what extent the presence of positive externalities may lead to a total coverage of the territory and/or more importantly, total coverage over what period of time. As a matter of fact, given the strategic role of broadband connections in the economic development process of a community, policy makers may decide to intervene in order to speed up the coverage process.

#### 4.2 The TLC carriers' point of view

The interviews conducted with the main TLC couriers operating in the territory had two main objectives. The first was to collect data about the regional infrastructure coverage. Secondly, it was to capture the TLCs' point of view on the diffusion dynamics of broadband. In particular, we wanted the TLCs' views about the main diffusion barriers and the consequential and most effective measures that could be taken in order to overcome such barriers.

In residential markets, all couriers shared the opinion that the availability of broadband services did not represent the principal issue. In their opinion, the main barrier to adoption was that service costs are still too high for the average household budget. In this respect, competitive players see the high influence that the ex-monopolist still exerts on the industry cost structure, and considers this a limiting factor. All main national operators serve the metropolitan area; however, market segmentation has considerably dampened the effect of price competition. The only courier operating on proprietary networks has positioned itself in a high-end user niche, thus not invading the incumbent's mainstream market. All other players targeting middle or low-end users do not own a proprietary network. As a consequence, the ex-monopolist exerts a deep influence on its real competitor's cost structure, can maintain higher prices levels and avoid a fierce price reduction competition. Many competitive players thus viewed the role of the regulatory authority as key to a decrease in retail prices. Although this may be true, it should not be forgotten that a reduction of retail prices may also be obtained by competitive players through the acquisition of efficiency gains.

Another barrier to the diffusion of broadband among residential users was the immature use of the technology due to limited computer literacy, on the one hand, and to lack of multimedia content, on the other. To overcome these barriers, investments to guarantee a wide availability of Internet connections within all levels of education were reported as important factors, as well as the switch in the distribution of the television programmes from analog to a digital mode.

For business users, operators still perceived high infrastructure investments as a hurdle and demonstrated very cautious attitudes towards the profitability assessment of infrastructure expansions aimed at acquiring new business customers. In this respect, an interesting business model was adopted by a utility company that recently entered the business segment in the main metropolitan area. This company, by bundling its fibre to the building offer with the applications provided by other operators, eliminated the risks related to infrastructure related investments. In fact, if a client decided to change providers, they would simply need to change the courier they were bundling their offer with.

Although this business model represents an interesting method to foster infrastructure diffusion, further research should be conducted in order to investigate whether it could be extended on a nation-wide scale and across all market segments.

Couriers also reported a lack of an innovative culture and, more generally, a feeling of distrust towards technology among the microfirms. In their opinion, the difference encountered was mainly due to intangibility of the contribution that the adoption of broadband connections would make to the company's performance. To solve these problems some operators reverted to local trusted intermediaries with a good knowledge of the territory. This helped to overcome distrust and allowed operators to bundle their offer with higher-level and more complex services, thus making it more attractive to business users.

Finally, all operators shared the belief that policy makers should design policies to encourage the use of telework. As a matter of fact, this practice would significantly contribute to boost broadband needs of both residential and business users. Moreover, it would help in reducing mobility's aggregated costs and the costs due to the negative externalities that mobility entails (i.e., environmental, social and health related costs).



## **5 Demand analysis**

In this section the data analysed regarding the demand of broadband services will be presented. The following stakeholders are taken into consideration: residential users, business users and government users (municipalities). The aim of the following analysis is twofold. The first is to investigate the main variables driving the adoption of broadband connections among different user segments and whether these drivers exert the same influence in different contexts (i.e., metropolitan vs. rural areas). The second is to identify the possible presence of heterogeneous levels of adoption/usage maturity across user segments.

### *5.1 Residential users*

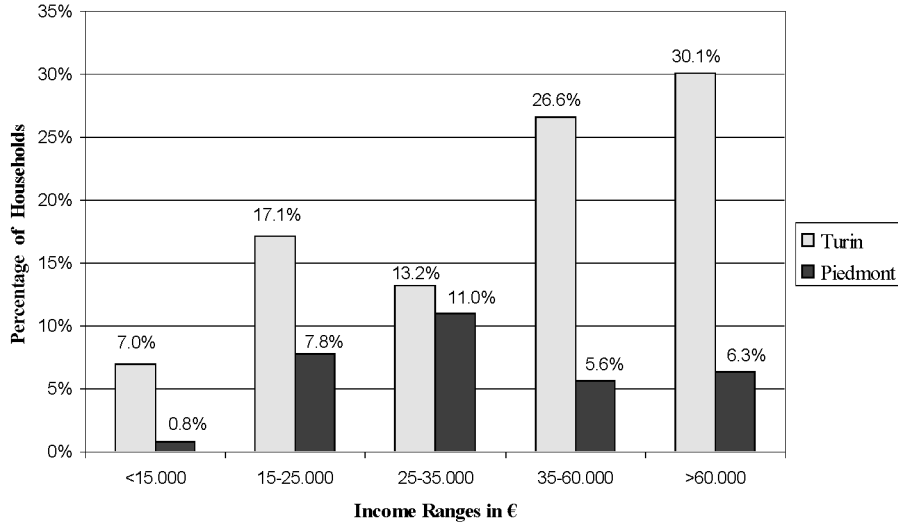
The analysis of residential demand for diffusion of broadband services in the main metropolitan area (Turin), as well as in the entire the region, was assessed. Data show respectively, a 15.3% and a 9.3% penetration compared to a service availability of nearly 70% of the population. This contrast represents an interesting starting point. First of all, the data confirms the hypothesis that the delay in the diffusion of broadband is not due to a lack of infrastructure availability and that a policy aimed at simply providing coverage to the remaining 30% of the region would not result in a major improvement of the current situation. Secondly, the presence of a similar situation in both the metropolitan area and the rest of the region suggests that even in a more competitive environment, policies did not seem to lead to higher levels of adoption. This may be explained by a number of factors. First, a still dominant position of the incumbent player. Second, the widespread lack of computer literacy or, to be more precise, the presence of digital gap between a small portion of the population that may be defined as technology savvy and the rest of it.

Figures 5 and 6 show the breakdown of broadband adoption in Turin and Piedmont, respectively, by net household annual income ranges and household size (in terms of number of people). The descriptive statistics seem to suggest clearer trends in the main metropolitan area rather than in the region as a whole. In order to investigate the impact of these variables further, a multivariate analysis was conducted in order to isolate the effect of each segmentation variable.

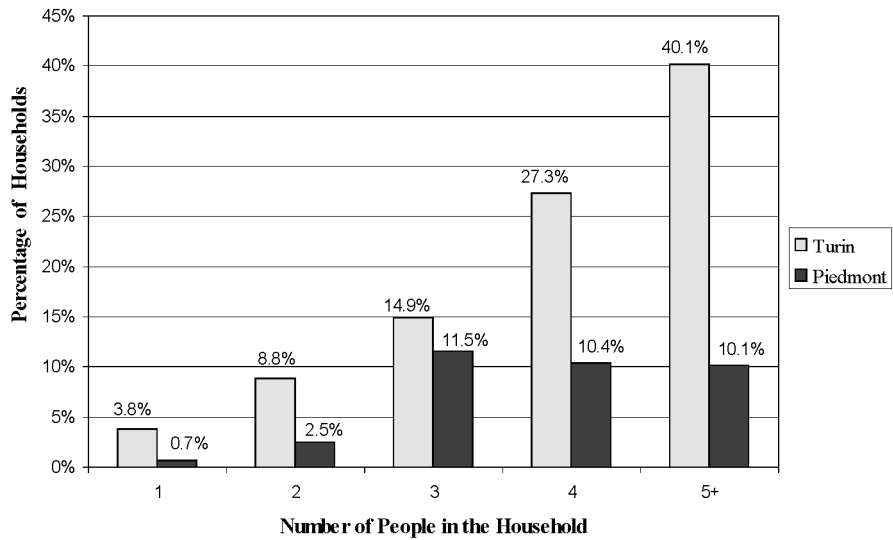
A log-linear model was designed, where income and household size were set as independent variables, while broadband adoption was set as a dependent variable. The results obtained showed that income has a statistically significant influence on broadband adoption only in Turin while household size exerts its influence in the metropolitan area as well as in the entire region.

The influence of household size on adoption could be linked to the amount of total traffic generated. As a matter of fact the higher the number of people living in a household the higher the likelihood of having one or more internet users generating traffic. From both the descriptive statistics and the multivariate analysis, the presence of three to four people in the household seems to be the minimum threshold for making the adoption of a broadband connection economical. To further test this hypothesis, data concerning offer prices and internet usage were analysed.

**Figure 5** Households with broadband connection by income range



**Figure 6** Households with broadband connection by size



A break-even analysis was carried out (see Figure 7) in order to identify the following switching points:

- from a dial-up to a pay-as-you-go broadband scheme (45 megabytes)
- from a pay-as-you-go to a flat broadband scheme (95 megabytes).

Subsequently, data concerning the distribution of internet usage, in terms of time and applications, were utilised to create household typologies representing the average internet usage of households with two, three and four internet users. It is important to stress the fact that the size of the household typologies refers to the number of people using the internet; thus, the actual total size of those households could be equal or greater.

**Figure 7** Breakeven analysis

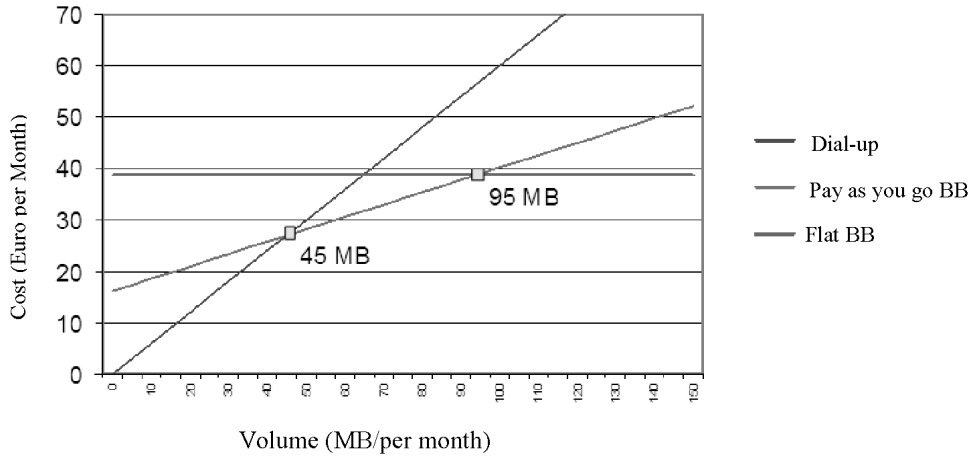
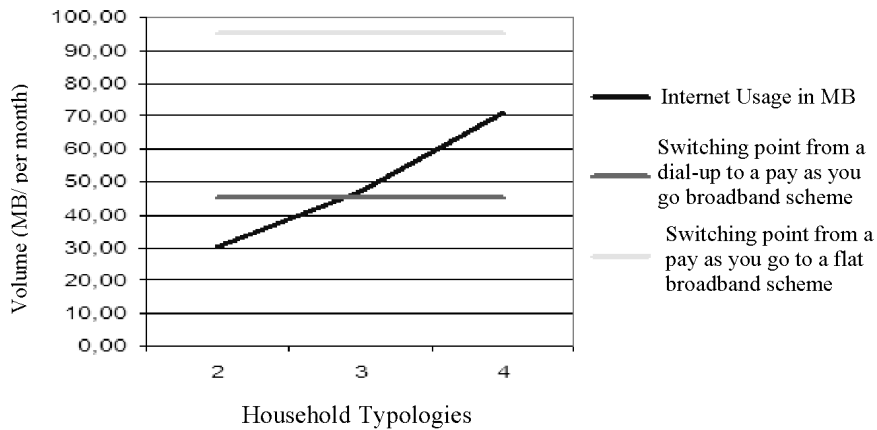


Figure 8 shows the combination of the results obtained from the breakeven analysis and the monthly megabytes consumption of each of the household typology considered.

**Figure 8** Internet usage against connection switching thresholds



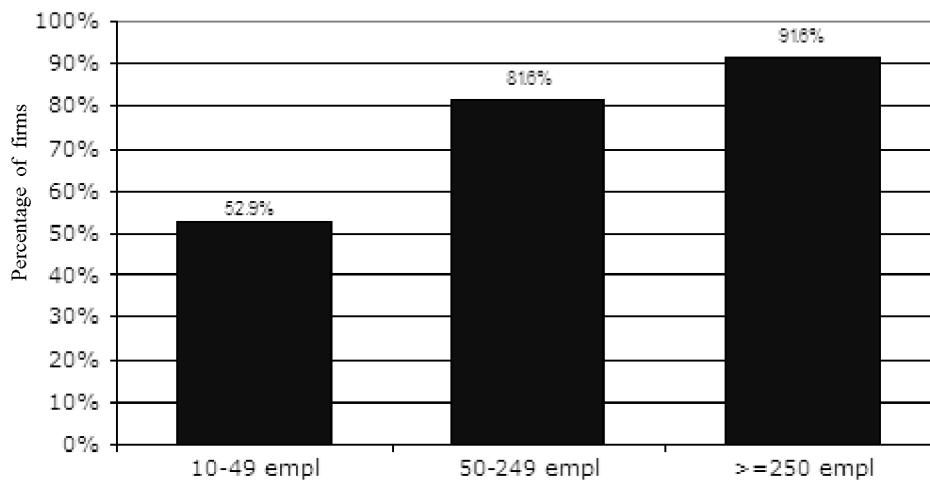
As the number of internet users in a household increases, it becomes more economical to switch from a dial-up to a pay-as-you-go broadband scheme. This happens when at least three users are present. An even more important, the result that emerges from this analysis is the fact that with current average usage patterns, even the presence of four internet users in a household does not justify an upgrade to a flat broadband plan. This does not mean that these connection plans may not be adopted by anyone. It simply means that households that do sign up for these types of connections represent the far end of the usage distribution, and thus, a meagre percentage of the total. It follows that, in order to make use of broadband connections as a mainstream phenomenon, progress along the usage evolution path must be made by society in order to raise the volume of traffic produced. This, coupled with a physiological reduction of bandwidth prices, should allow usage patterns and connection costs to meet, thus resulting in higher penetration levels.

## 5.2 Business users

The analysis of business users' demand has been carried out on data from a sample of 294 enterprises with ten or more employees. The data were collected through a web-based questionnaire.

Results show that 87% of firms have an internet connection and that 63% of the business users surveyed adopted broadband connections. The graph in Figure 9 suggests that a firm's size is an important adoption driver. A clear ascending trend in penetration may be found as a firm's size increases.

**Figure 9** Adoption of broadband by firm's size



Although no data are available for microfirms (<10 employees), given the trend presented in Figure 9 and the information collected during the interviews with the couriers, it seems sensible to expect a significant drop in penetration for that category of business users. From a policy maker's stand point this represents an important issue, since microfirms are an essential part of the regional as well as the national economy. For example, Italian firms have often been very small and family owned businesses and the average size of an Italian company is four employees, two units below the European average.

During the interviews conducted with TLC operators, their nationwide experience revealed that in some regions, hotels played a key role in the diffusion of broadband among business users. Having hotels' distribution over the larger territory, in fact, helped to create a more homogenous level of demand. This resulted in a more widespread availability of infrastructures. From the break down of broadband penetration by activity sector, we observe that the hotels present in the region are lagging behind. The penetration level in that activity sector is 45%, about twenty points below the average. Tourism plays an important role in Piedmont's economy and a policy package aimed at stimulating the adoption of broadband by hotels may lead to the creation of positive externalities for other sectors with respect to adoption and possibly also for other stakeholders.

### 5.3 Government users

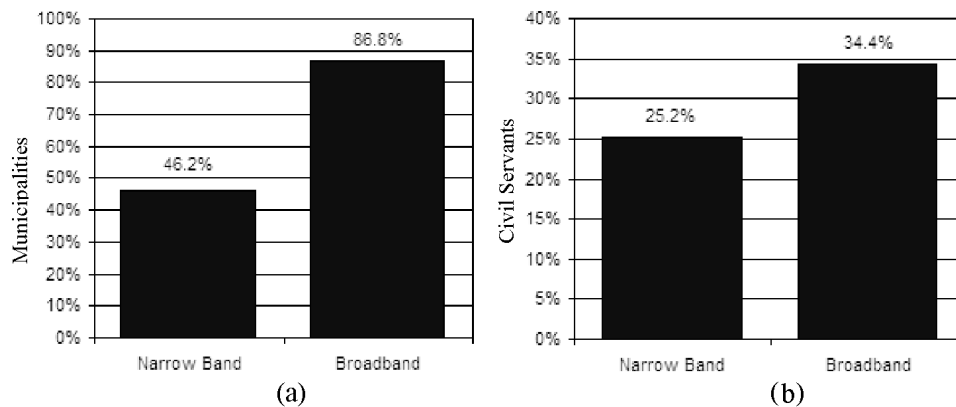
The results of municipalities' demand for broadband in the region will be presented. Municipalities were chosen as representatives of government usage because they are the prime means through which e-government services are rendered. Moreover, their spread throughout the territory results in a higher dependency on a widespread diffusion of the broadband infrastructures.

As stated in Section 4, broadband services are currently available in 17% of municipalities. This represents a serious hurdle for the diffusion of e-government services and contributes to the migration of businesses to metropolitan areas. The RUPAR2 plan, recently launched by the regional government (see Section 3), is an attempt to remedy this situation. Thus, from a policy maker's point of view, the availability of broadband infrastructure among municipalities should not represent an issue in the long term; according to the plan schedule, all municipalities should reach the goal by 2007. What instead should be of concern for policy makers is the adoption process. The current data about broadband adoption in municipalities shows an 11% penetration. This means that demand, at present, is so scarce that it does not even saturate even the small supply available.

In order to investigate to what extent municipalities adopting broadband connections differed from those still relying on narrow band connections the following analysis was carried out.

From the graphs showed in Figure 10, a clear gap emerges among adopters and non-adopters in terms of importance placed on information and communication technologies. To confirm this hypothesis, we looked at the percentage of services provided via the web and concluded that municipalities with broadband, on average, provide 53% of their service via internet vs. 24% average of municipalities with a narrow band connection. These data represent using clear signal. This should not be overlooked by policy makers. Simply investing in infrastructure will not guarantee a more homogeneous level of adoption. It will be necessary to design policies aimed at stimulating the acquisition of skills contributing to the creation of an innovation prone culture among those municipalities currently lagging behind.

**Figure 10** (a) Municipalities with website and (b) percentage of civil servants with ICT training



## 6 Limitations of the study

Although the analysis conducted presents the diffusion of broadband phenomenon from a multitude of angles, a number of limitations must be acknowledged. First of all, no provision was made for possible interactions with different technologies as complementary or substitute options. Secondly, organisations were considered as broadband adopters regardless of their size. Thus, the actual level of bandwidth available per employee was not considered as a variable. This could have led to some distortions due to the fact that a two megabit connection may be considered as broadband for small businesses or municipalities but not for larger organisations. Nevertheless, it is felt that the robustness of the conclusions drawn should not be significantly impacted by the limitations presented above.

## 7 Conclusions

From the systemic analysis carried out, the diffusion of broadband can be characterised as a very complex phenomenon in which context specific factors play an important role. Also, we found that the problem definition process – far from being unambiguous – should attempt to balance a multitude of forces often heading in different directions. In other words, it should be a formulation that takes into account the interaction of the heterogeneous interests and objectives that involve different stakeholders.

For residential users, the study shows that infrastructure coverage does not represent the main reason for the adoption delay. The wide gap present between coverage and adoption may be attributed mainly to the combination of high prices and immature usage patterns. From the supply side, the presence of a similar situation between metropolitan and rural areas suggests the lack of a *de facto* competition. Although the metropolitan area is served by all the main national operators, a segmentation of the market has considerably dampened the effect of competition on prices. As a matter of fact, the only courier operating on proprietary networks has positioned itself in a high-end user niche, thus has not invaded the incumbent's mainstream market. All other players targeting middle or low-end users do not own a proprietary network and as a consequence, the ex-monopolist, by exerting a deep influence on its real competitors cost structure, can maintain higher prices levels and avoid a fierce price reduction from competition.

From the demand side, the breakeven analysis showed that current average usage patterns require the presence of three or more active internet users. If we consider the shrinking family trend present in most Western countries, this means that in most families all members must be internet users in order to justify the monthly expense. From a policy maker's standpoint, it will be necessary to devise policies aimed at both raising the individual bandwidth need as well as fostering the diffusion of internet usage across different age groups in order to increase the percentage of internet users present in each household.

For business users, although the average penetration level among medium and large firms may be considered satisfactory, microfirms may not have the same level of satisfaction. In fact, from interviews with TLC operators and from the descriptive statistics, business size seems to be an important adoption driver. In this market segment, infrastructure coverage is still perceived as an issue by couriers who showed a very risk adverse attitude towards infrastructure related investments. In this respect, an interesting

business model has been adopted by a utility company recently entering this market segment in the main metropolitan area. This company, by bundling its fibre to the building offer with applications provided by other operators, eliminated the risks related to infrastructure related investments. Although this business model represents an interesting method to foster infrastructure diffusion, further research should be conducted in order to investigate whether it could be extended to a nation wide scale and across all market segments.

Finally, as far as government users are concerned, the current lack of coverage surely represents an important barrier for over 80% of municipalities. In this market segment, policy makers have decided to intervene with an allocation of financial resources aimed at providing a region with broadband access to all government users. Nevertheless, the comparative analysis conducted between broadband adopters and non-adopters has shown a significant gap in the importance placed on information communication technologies (ICT). In order to bridge this gap, infrastructure investments should be accompanied with complementary measures aimed at creating a more homogeneous level of IT literacy among government users. For instance, from a policy maker stand point, encouraging a wide diffusion of telework appears to be an advisable choice. The presence of remote workers will, in fact, contribute to raise both business and residential users' bandwidth needs, thus leading to a faster diffusion of broadband connections across different market segments.

Concluding, from a theoretical point of view, the systemic analysis carried out allows us to draw a number of conclusions. First of all, it shows the diffusion of broadband networks to be a technology pushed and highly heterogeneous phenomenon. Secondly, it reveals the existence of positive externalities for small municipalities due to physical proximity to areas with a higher economic appeal for TLC couriers. Finally, it suggests that adoption drivers vary in terms of nature and impact intensity among local areas within the same region.

## **Acknowledgement**

An earlier version of this paper was presented to the TCGOV05 Conference, Bozen, Italy.

## **References**

- Canadian Report of the National Broadband Task Force (2001) <http://largebande.gc.ca/pub/program/NBTF/summary.html>.
- Choudrie, J., Papazafeiropoulou, A. and Lee H. (2003) 'A web of stakeholders and strategies: a case of broadband diffusion in South Korea', *Journal of Information Technology*, No. 18, pp.281–290, ISSN 0268-3962.
- Clark, D., Gillet, S., Lehr, W., Sirbu, M. and Fountaine, J. (2002) *Local Government Stimulation of Broadband: Effectiveness, E-Government, and Economic Development*, MIT Press, <http://itel.mit.edu/>.
- Eurostat Yearbook (2004) Available at [http://epp.eurostat.cec.eu.int/portal/page?\\_pageid=1334\\_1457135,1334\\_1457140&\\_dad=portal&\\_schema=PORTAL](http://epp.eurostat.cec.eu.int/portal/page?_pageid=1334_1457135,1334_1457140&_dad=portal&_schema=PORTAL).
- Gillett, S., Lehr W. and Osorio, C. (2003) *Local Government Broadband Initiatives*, MIT Press, <http://itel.mit.edu/>.

- King, J., Gurbaxani, V., Kraemer, K., McFarlan, F., Raman, K. and Yap, C. (1994) 'Institutional factors in information technology innovation', *Information Systems Research*, Vol. 5, No. 2, pp.139–169.
- Lee, H., O'Keefe, R.M. and Yun, K. (2003) 'The growth of broadband and electronic commerce in South Korea: contributing factors', *The Information Society*, No. 19, pp.81–93.

### Websites

- Rapporto sulla Banda Larga del Ministero Italiano dell'Innovazione e della Tecnologia*, [http://www.innovazione.gov.it/ita/intervento/banda\\_larga/task\\_force/definizione.htm](http://www.innovazione.gov.it/ita/intervento/banda_larga/task_force/definizione.htm).
- FCC Report on the Availability of High-Speed and Advanced Telecommunications Capability*, [http://hraunfoss.fcc.gov/edocs\\_public/attachmatch/FCC-02-33A1.pdf](http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-02-33A1.pdf).

### Bibliography

- European Commission (2005) *E-Inclusion Revisited: The Local Dimension of the Information Society*, Commission Staff Working Document SEC(2005)206, [http://europa.eu.int/comm/employment\\_social/knowledge\\_society/library\\_en.htm](http://europa.eu.int/comm/employment_social/knowledge_society/library_en.htm).
- Ferguson, C.H. (2002) *The United States Broadband Problem: Analysis and Policy Recommendations*, Retrieved October 27, [http://www.brook.edu/dybdocroot/views/papers/ferguson/working\\_paper\\_20020531.pdf](http://www.brook.edu/dybdocroot/views/papers/ferguson/working_paper_20020531.pdf).
- Fowler, D. (2000) 'The last mile: making the broadband connections', *Networker*, Vol. 4, No. 1, pp.26–32.
- Gillett, S. and Lehr, W. (1999) 'Availability of broadband internet access: empirical evidence', Paper presented to the *Twenty-Seventh Annual Telecommunications Policy Research Conference*, September 25–27, Alexandria, VA.
- International Telecommunications Union (2001a) 'The economic and regulatory implications of broadband', *Briefing Paper, Regulatory Implications of Broadband Workshop*, 2–4 May, <http://www.itu.int/osg/spu/ni/broadband/workshop/briefingpaperfinal.pdf>.
- Kim, H., Moon, Y. and Yang, S. (2004) 'Broadband penetration and participatory politics: South Korea case', *Proceedings of the Hawaii International Conference on Systems Sciences (HICSS-37)*, Maui, Hawaii, 3–6 January.
- Leighton, W.A. (2001) 'Broadband deployment and the digital divide: a primer', *Policy Analysis*, No. 410. Cato Institute, <http://www.cato.org/pubs/pas/pa-410es.html>.
- Loges, W.E. and Jung, J.-Y. (2001) 'Exploring the digital divide: internet connectedness and age', *Communication Research Special Issue: Communication Technology and Community*, Vol. 28, No. 4, pp.536–565.
- Michalis, M. (2001) 'Local competition and the role of regulation: the EU debate and Britain's experience', *Telecommunications Policy*, Vol. 25, pp.759–776.
- Press, L., Burkhart, G., Foster, W., Goodman, S., Wolcott, P. and Woodard, J. (1998) 'An internet diffusion framework', *Communications of the ACM*, Vol. 41, No. 10, pp.21–26.
- Stanton, L. (2004) 'Factors influencing the adoption of residential broadband connections to the internet', *Proceedings of the Hawaii International Conference on Systems Sciences (HICSS-37)*, Maui, Hawaii, 3–6 January.
- Szabo, C., Chlamtac, I. and Bedo, E. (2004) 'Design considerations for broadband community area networks', *Proceedings of the Hawaii International Conference on Systems Sciences (HICSS-37)*, Maui, Hawaii, 3–6 January.
- Yun, K. and Lim, S. (2002) 'Market structure and competition between cable modems and DSL in Korea', Paper presented at *ISOneWorld*, Las Vegas, NV.