FIXED AND MOBILE PHONING IN ITALIAN REGIONS

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ABSTRACT

The telecommunication diffusion and its interaction with the socio-economic environment was analysed both in terms of introduction of new technologies in the market and their diffusion/substitution process with respect to former technologies.

Nevertheless, the word "innovation" should be referred to products in a more general sense, so avoiding limitations to technology but also keeping track of all those characterising elements of products inside the market. Due to a similar approach, should be considered as innovative a product even if it does not contain technological components different with respect to pre-existing ones, but also if a former technology is sold using totally innovative formulas.

This modified viewpoint requires a more flexible approach to the diffusion process. This approach can enhance the interest on studying those different answers adopted by different socio-economic environments, to analyse the characteristic elements enabling the identification of categories with similar behaviour.

Keywords

Telecommunications
Innovation
Diffusion
Clustering

1 INTRODUCTION

Communications deeply evolved starting from the age of 80's, when the early applications of electronics and computer technologies introduced radical changes inside the communication process itself. The introduction of digital technologies for telecommunications management and the diffusion of Facsimile and Data Transmission systems seem to represent the early step of the growing communication process, characterised by a remarkable impact both in economic and in social environment.

Since from 1995, when Nicholas Negroponte published *Being Digital*, the forecast about the evolution of communication process and the analysis of induced effects on the socio-economic environment was included in the set of the most popular discussion arguments at international level, both for the scientific community and for mass media, with a special care for topics as technological update, diffusion and distribution.

The strength and the speed of transformation process involving the communication field can be easily perceived analysing two sensational phenomena: Internet and Mobile phoning. The main existing differences between these two communication concepts are related to the way of usage and the technological endowment. In the first case, Internet, we can access a very large amount of information sources using basically wired systems, while in the second case a direct communication between two individuals is obtained by mean of radio waves transmissions.

However, in both cases the revolutionary transformation is characterised by an high rate of technological innovation and a process of market liberalisation. Moreover, the technological change strongly reduced the costs for infrastructural investments needed, so enabling the entrance of new subjects, prompting a forceful push in the market deregulation.

In particular for mobile telecommunications case, the new technological investments are really less expensive with respect to those needed for the fixed communication. This factor enabled a large amount of enterprises to access the market under easier condition and was also crucial for mobile phoning success, including the partial substitution of conventional wired systems.

Further innovations pushed equipments and systems producers towards stronger integrations, leading to the so-call "third generation standard". With the purpose to

increase profits, market power and added value in their services, the main operators of the communication systems have been competing strongly in global markets.

In such a particular environment, the challenging European standard was defined as UMTS (Universal Mobile Telecommunication Service), a system that will enable, with respect to former one, an effective extension of conventional and innovative services provided by the fixed network to wireless mobile telephony.

This paper presents a study about the effects of the different innovation phases of telecommunications in the Italian case. In particular, we analyse the usage of mobile phones by mean of multi-logistic curves and operative flows for each region.

The multi-logistic curve is formed by the sum of "n" independent logistic curves, each one characterized by three independent parameters: the carrying capacity, the growth coefficient and the midpoint. This model allows analysing all those complex growth phenomena that are constituted by distinct processes both in succession or overlapped. In our case, this enables to determine the trend and pulses in the market connected to the dynamics of the technological innovation.

2 MODEL AND DATA

The correlation between technological innovation and economic development was used by Schumpeter (1939) to explain the long cycle of economy. The behaviour of the couple *technological innovation* and *market requirement* is substantially equivalent, even if formally opposite. As a matter of fact, increase of technological offer is strongly linked to an equivalent market demand development.

It is actually difficult to identify the role played by the technology or by the market, especially when the induced changes achieve a primary relevance. Thus, if similar conditions will take place, a complete redefinition of roles starting from the new existing reality becomes necessary.

Subsequently, in 1983 Rogers et al. showed how the time distribution of innovation adopters can be represented as a standard normal curve in the majority of cases, so the total number of adopters can be obtained by the mathematical integration of the distribution, called "diffusion curve".

Moreover, the Schumpeter model introduced also the difference between innovation and imitation, strongly linking the early stage of the diffusion process to “innovators” and leaving to a second phase the imitation effect, due to the diffusion of knowledge about the innovation.

2.1 The model

The more common representation of the dynamics of technological innovation is the well-known Pearl-Verhulst equation or logistic "S shaped" curve (Marchetti 1980). This curve starts with a light growth, then fast grows in the central part to reach an asymptotic behaviour at its final part.

In particular, from the two “historical” models (*Exponential* and *Coleman*) (Skiadas 1985), describing by mean of linear models the diffusion increase respectively at early and final stage of the process, can be derived the first logistic model defined by Fisher and Pry (1971), with an inflection point at f=1/2:

$$\text{Fisher-Pry:} \qquad df/dt = C_1 f (1 - f) \qquad (1)$$

Considering the total number of adopters instead of the percentage we can obtain the Blackman (1974) model, that is lightly different from the former one (with inflection point at f=F/2):

$$\text{Blackman:} \qquad df/dt = C_1 (f (F - f)/F) \qquad (2)$$

In both models, for f -> 1 (or to F) the result goes to zero, as in the case of Coleman’s model, while for f->0 their behaviour is equivalent to the Exponential model. Viceversa, in the central phase the models (1) and (2) represent the interaction process between real and potential adopters.

These two models were widely used to forecast the diffusion of technological innovation, using the market share achieved by the innovative product or technology as dependent variable with respect to an estimate of the whole global market.

A more useful formulation for the logistic function of growth can be represented as the solution of the following equation:

$$N(t) = N_* / (1 + e^{-a(t-t_m)}) \qquad (3)$$

where N_* represents the carrying capacity, that is the level at which the growth process saturates (and can also identify the potential market), t_m is the *midpoint* and **a** is the *growth rat*e.

Subsequently many other formulations was proposed by different authors, to obtain more generic models based on parameters supplying more insights (Skiadas, 1985). Finally the multi-logistic model (Meyer, 1994 e 1999) was proposed, a model that comprehend multifarious logistic curves representing the different *operative phases* of a unique diffusion process.

The multi-logistic model improve the simple logistic one since several growth processes experience more than one phases of logistic growth, either overlapping or sequentially. The carrying capacity of a system is often limited by the current level of technology, which is likely to change. If the carrying capacity changes during a period of logistic growth, then subsequently a second one with a different set of parameters can superimpose on the first growth pulse.

For that reason, a multi-logistic approach can be used to model the sequence of different innovation waves, since each innovation causes an upward translation of the current carrying capacity. Therefore the change of the carrying capacity in the time can be modelled by a series of independent logistic curves. The multi-logistic growth model is defined as the sum of *n* logistic curves based on 3 parameters:

$$N(t) = \sum_n N_{*i} / (1 + e^{-a(t-t_{mi})}) \qquad (4)$$

As in standard procedures we assume that the measurement errors are independently and normally distributed with constant standard deviation. The parameter estimates are then determined by minimizing the sum of the squares of the residuals by an ordinary non-linear regression technique.

In our analysis the Loglet Lab software has been used (Meyer, 1999b). It implements the Levemberg-Marquandt method of non-linear least square algorithm to fit the historical data series of fixed and mobile telephone utilization in Italy to the multi-logistic curve. This software enable also to evaluate the parameters using a set of sample estimations, so enabling the evaluation of confidence range for parameters values (and consequently on the designed curve) (Campisi, 2001).

2.2 The data set

Actually, the data related to telephone market are collected more frequently, precisely and carefully with respect to the past. Unfortunately, such a condition does not mean that their availability increased, also for those researchers involved in studies focused on phenomena totally different with respect to any commercial, financial and market share topic. The data collected by each provider are always considered as *classified* and the researcher who obtain those, is forced to present only specific results from which it is impossible to rebuild the original set.

To analyse the complex evolution of the Italian market, we used data about the total amount of communication flows both wired and mobile from 1996 up to 2000, the number of mobile phone contracts from 1993 up to 2002 and the wired-mobile flows (and viceversa) for each district from 1999 up to 2000. Figures and graphics are in normal scale, where traffic data are in millions of minutes and the contracts are in single unit.

3 THE OBTAINED RESULTS

3.1 Phone communication market

The first data set used (fixed and mobile communication flows) shows the communication demand behaviour in Italy during last years. Fig. 1 shows a small usage reduction of fixed communications for exclusive interpersonal purposes but also a remarkable growth of both flows involving fixed generic communications (the contribution of Internet connections) and mobile phones.

Moreover, fig. 2, supply a further confirmation of the described behaviour, showing the changes of market share of the three different products during last five years (voice; voice + Internet; mobile). The two innovative products (Internet and mobile), reached the 50% of the overall communication demand in the year 2000, instead of a percentage lower than 10% owned in 1996.

The behaviour of mobile telephone diffusion (Fig. 3 and following) shows that the changing process of the communication demand is still far from a steady level, as it happen for the demand of Internet communications (Tesauro, 2001).

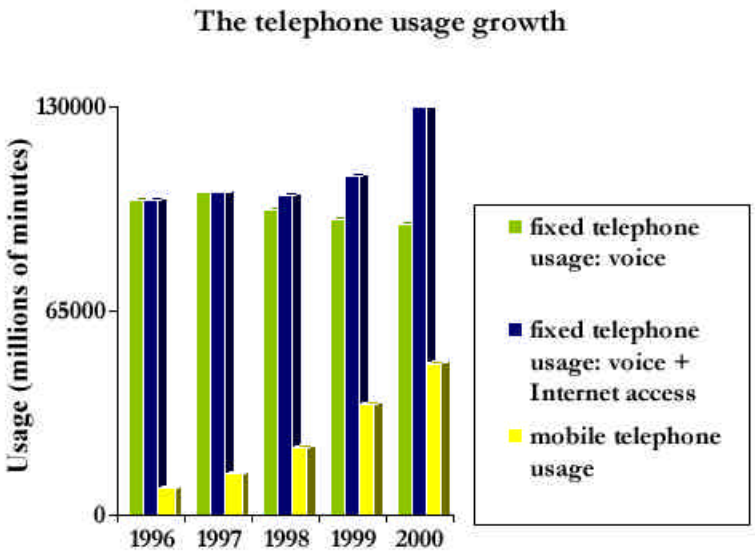


Fig. 1: The usage of phone communications (millions of minutes) from1996 up to 2000

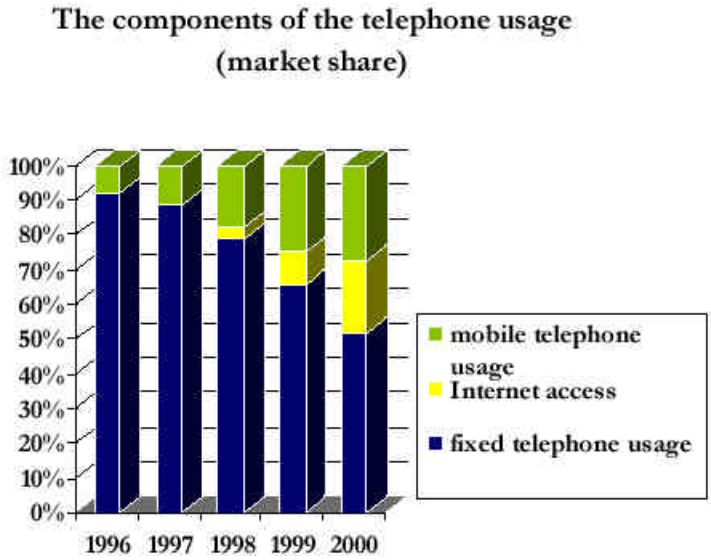


Fig. 2: Market shares in telephone usage from1996 up to 2000

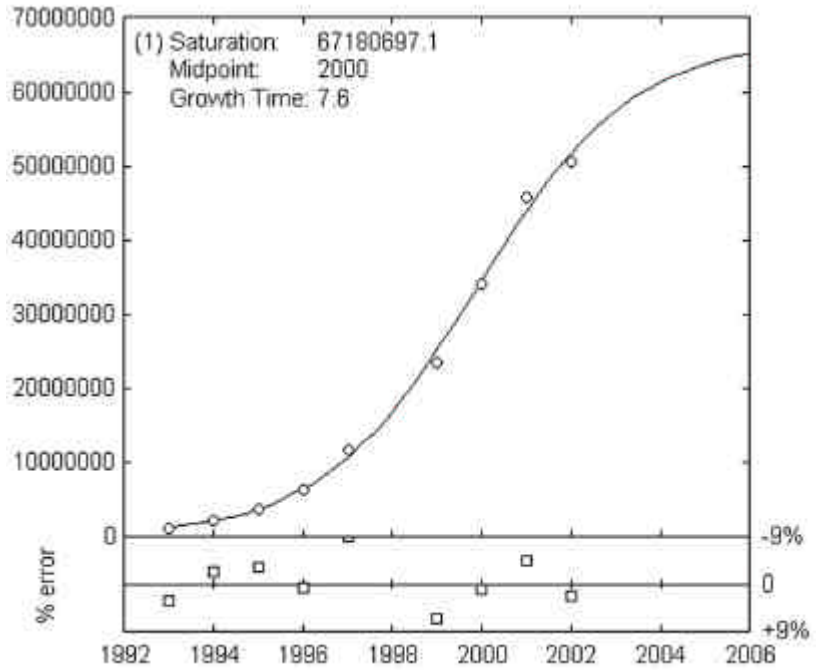


Fig. 3: Diffusion of mobile phoning from 1996 up to 2000

Source: Personal evaluation of data from *Mobile Communications* review

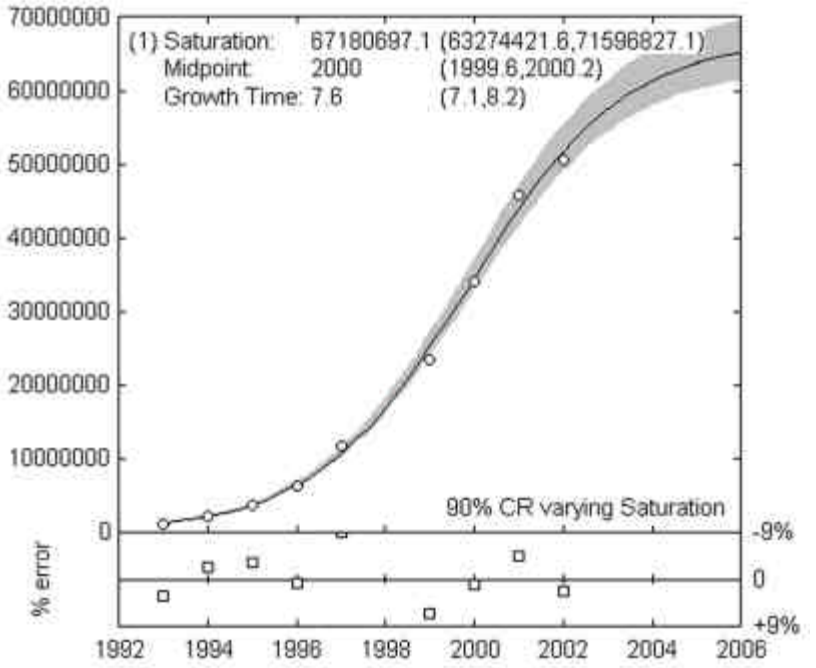


Fig. 4: The estimated diffusion with *bootstrap* method

Source: Personal evaluation of data from *Mobile Communications* review

3.2 Mobile phoning diffusion

The GSM system was the first common international standard in the market of mobile phones. It was adopted by all European countries and most of other continent countries (excluding North America and Japan) and introduced for the first time the concept of "free circulation" by mean of the so called *roaming* service. This function enabled the usage of any device linking services supplied by different providers, as in the case of reaching foreign countries.

The mobile phone market in Italy deeply changed in 1995 when the liberalization leaded to the entry of a second national provider, followed by a third one in 1998 and a fourth one (2000). This new market configuration introduced meaningful changes in terms of both rating policies and overall carrying capacity.

Moreover, the main influence introduced by these new providers was represented by both the growing speed of the carrying capacity and some very innovative and attractive rating policies, so activating a strong competition among themselves that leaded to a market configuration characterised by a high dynamic of the offer. These reasons drove us to choose the multi-logistic model for this analysis (4).

Figures 3 and 4 show the behaviour of mobile phones diffusion process starting from 1993, when the GSM system was introduced in the Italian market, until today. The behaviour is represented by a simple logistic curve (3).

The two results was obtained using totally different evaluation approaches, nevertheless they are absolutely analogous. In the first case a traditional process of result fit obtained by parameters estimation was used, while in the second case the same parameters was evaluated starting from the average of a 200 values sample.

In fig. 4 the confidence range estimation of parameters enable the graphical representation of a curve confidence interval. In this particular case, the curve represents also the carrying capacity, so the 90% estimated confidence range is a function of the real carrying capacity variation.

The obtained estimations indicates the market saturation for GSM system in Italy close to 67 millions of "subscriptions" (chip boards) and a midpoint at year 2000 reached in only 7 years, that is contemporarily the maximum growth rate and the curve inflection point.

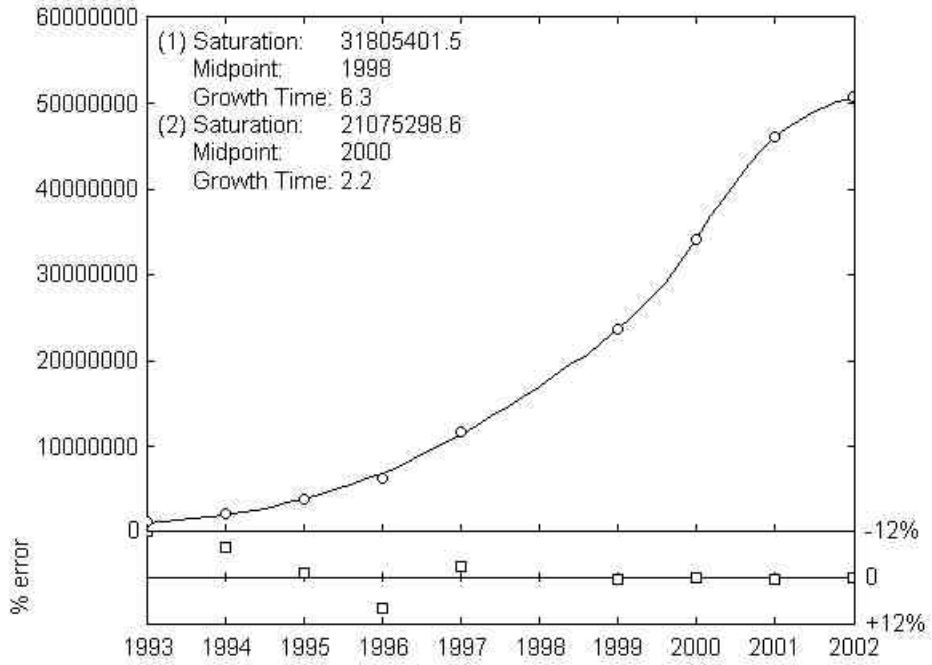


Fig. 5: Two-logistic analysis of mobile phones diffusion from 1996 up to 2000
Source: Personal evaluation of data from *Mobile Communications* review

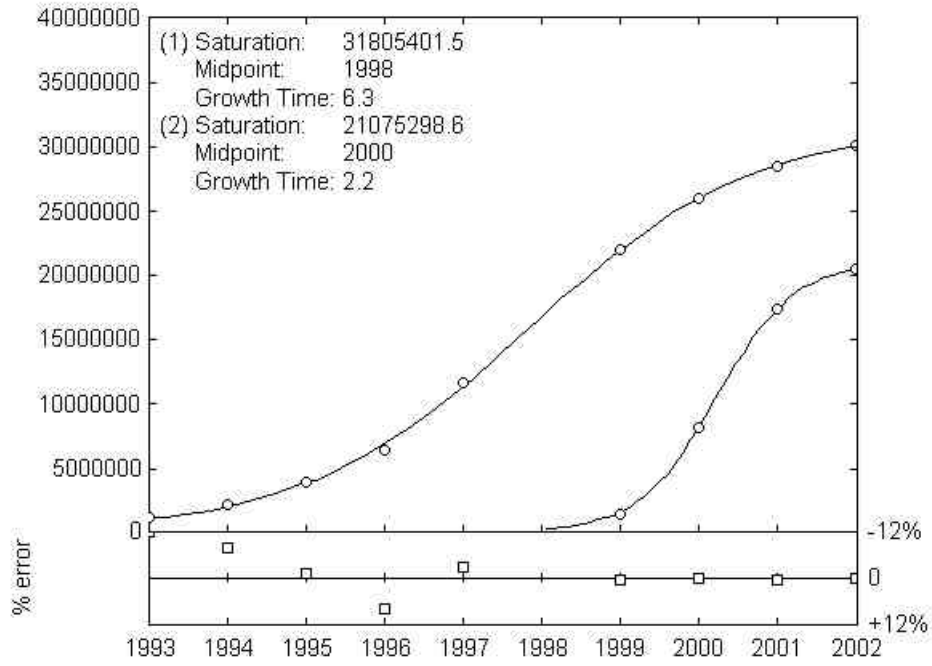


Fig. 6: Two-logistic components of mobile phones diffusion from 1996 up to 2000
Source: Personal evaluation of data from *Mobile Communications* review

The value forecasted by model is considerably high, but seems also consistent, because the sampled value showing about 51 millions of subscriptions in June 2002 is close to the estimation of 55 millions for the end of the year.

Figures 5 and 6 present the same analysis shown in figures 3 and 4, while obtained by mean of a two-logistic model, that is two partially overlapping logistic curves. It is easy to observe that the model introduces a second curve (starting from 1998) and substantially modifies both the overall carrying capacity (in this case close to 53 millions of units) and shifting the main curve midpoint at the end of year 1998.

Finally, in figures 7 and 8 the results obtained from the same analysis done using a three-logistic model are presented. The result of this attempt is defintely surprising, because the two added curves respectively start at the points corresponding to the meaningful market share achievement of the two main added providers. The estimation of the overall carrying capacity remains close to 53 millions of units, but the midpoints of the first two curves seem advanced with respect to former analysis.

3.3 The regional distribution

Figures 9 (A and B) show the usage of mobile phone system for each Italian Region in the 1999 and 2000, in terms of both the total amount of calls (sent or received) and the communications length. A first element to be considered is the absence of meaningful changes inside each regional sample set, in terms of ratio between number of calls and length. Viceversa, small variations can be observed comparing homogeneous data sampled in different years.

The existing differences among Regions can be immediately recognised: there is a group of five Regions (Piemonte, Lombardia, Veneto, Emilia-Romagna e Toscana) absorbing about 50% of mobile phones usage, with individual values between 8% and 14%.

A second group of five Regions (Trentino, Marche, Puglia, Calabria e Sicilia) represents a 25% of market share, with individual values between 4% and 8%, while the remaining 10 Regions cover only the 25% of market share, with individual values below 4%.

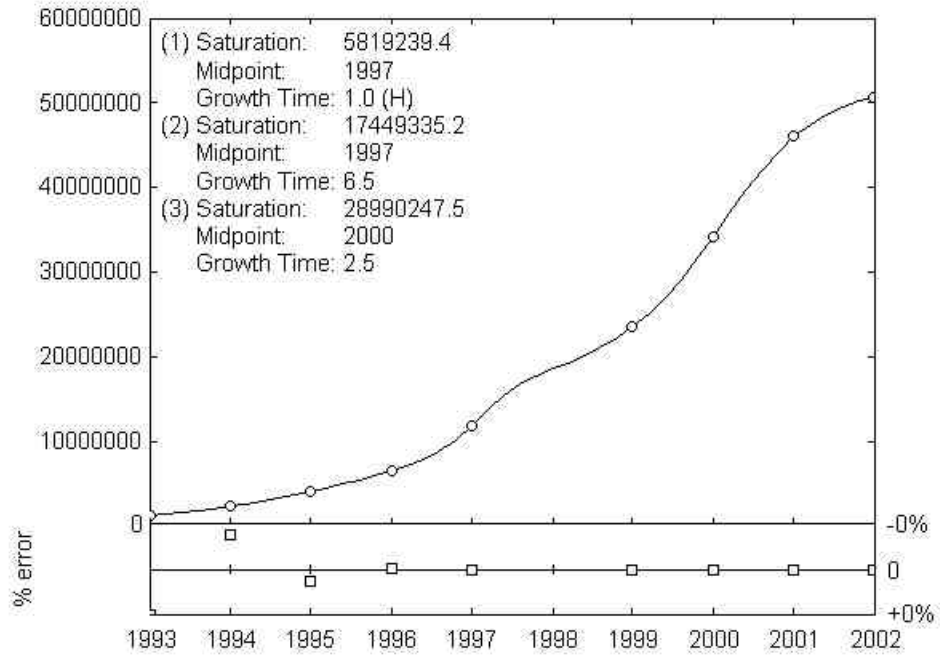


Fig. 7: Three-logistic analysis of mobile phones diffusion from 1996 up to 2000
Source: Personal evaluation of data from *Mobile Communications* review

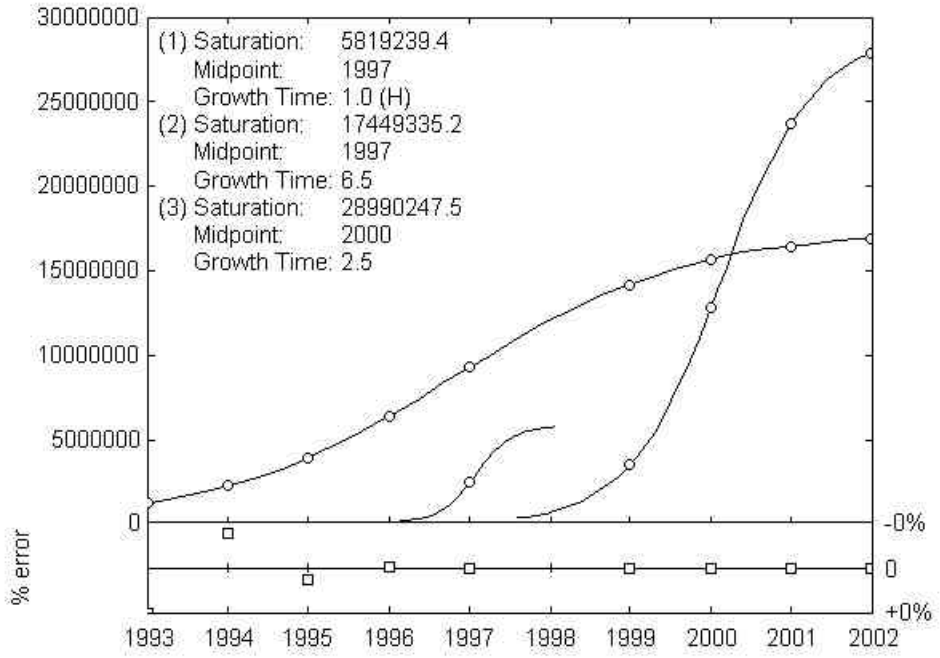
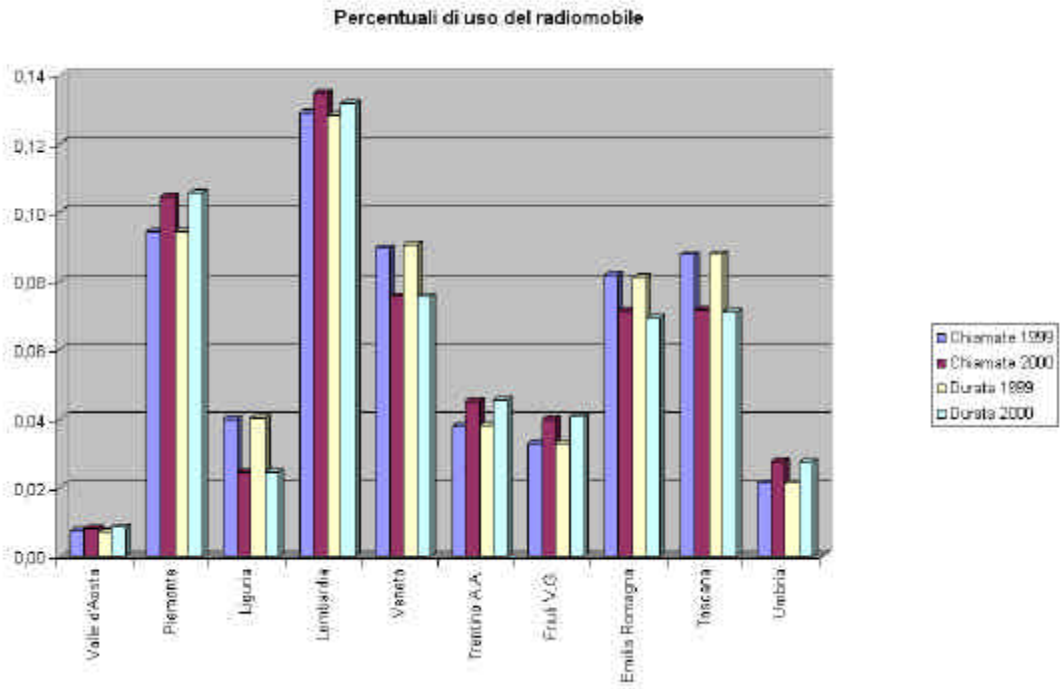
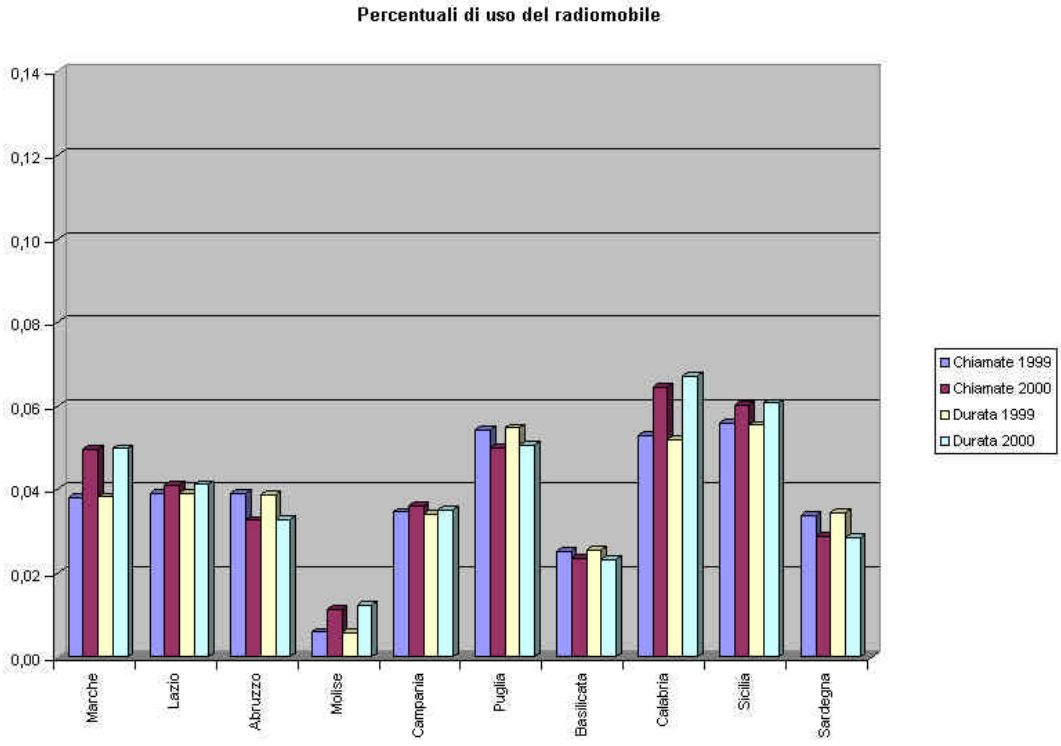


Fig. 8: Three -logistic components of mobile phones diffusion from 1996 up to 2000
Source: Personal evaluation of data from *Mobile Communications* review



(A)



(B)

Fig. 9: Usage percentages of mobile phones in 1999-2000 (calls and lengths) for each Region

The observed values for the Regions characterised by an high economic development (Piemonte, Lombardia, Veneto, Emilia-Romagna) seem definitely foreseen, while the data about Campania and Lazio are absolutely surprising, because some studies formerly done enhanced the special reactivity of these two Regions to highly innovative products. Viceversa, the actual sample includes these regions in the set of areas less involved by the mobile phone market.

Another interesting element is represented by the yearly change of each Region. The usage of mobile phone in the year 2000 increased for twelve Regions with respect to 1999, but only in four of these (Piemonte, Lombardia, Marche e Calabria) the difference is meaningful. Viceversa, the other Regions lowered the usage percentage and for five of these (Liguria, Veneto, Emilia-Romagna, Toscana e Abruzzo) the values are remarkable.

4 CONCLUSIONS

The communication market keep on with its growing process and seem basically addressed to the most developed systems in terms of technological endowment for both individual communications (mobile phones) or information retrieval (Internet). The growth rates and related spaces in terms of “units” remain remarkably high, even if the phase of maximum increase was exceeded, following current market configuration.

This general condition, due to current configuration, make the communication market still highly dynamic and consequently rich of attractions for further commercial initiatives. Moreover, the introduction of new initiatives can modify again the economic conditions, as during last years, and generate new pulses to the actual growing path creating new operative spaces.

The multi-logistic approach seems highly effective, especially while analysing the evolution process of phenomena. In particular, the two-logistic model seems to reach the experimental aim, even producing error percentages lightly greater than the simple logistic model (12% instead of 9%), because it started the second curve at the same point corresponding to the meaningful market share achievement of the second provider and shifted in the same position the midpoint of the first curve.

A first look at the three-logistic model seems to provide more meaningful insights, because this model highly reduces the error percentages of the estimates obtaining

negligible values, and shows a market behaviour mirroring the characteristic dynamic in a faithful way.

Nevertheless, the forecasting attitude of multi-logistic model seem less reliable of the simple logistic one, at least for the used software package. As a matter of fact, the sampled Italian value of about 51 millions active devices in 2002 is not compatible with the overall market dimension estimated by multi-logistic models at 53 millions of units.

Viceversa, the estimate obtained by the traditional model (about 67 millions) seems unreliable with respect to national population, but shows different market conditions where the amount of people owning more than one card will increase to cope the actual rating dynamics.

The market entry of the innovative UMTS systems that will occur in few years will surely introduce “changes” in the communications market, but will also have to cope the “substitution” competition with the pre-existent technology at a very large scale.

Finally, the regional analysis of mobile phones usage depicts an overall description substantially close to expectations. Only for a couple of Regions the obtained results was different with respect to a general perception of both their activity and influence on the national socio-economic environment.

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