Consumer Price Indexes for Telecommunication Services in Italy: Work in Progress

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Contents

1 – Introduction

In the last few years, the telecommunication sector in Italy has gradually changed from a monopoly situation to market competition. The transition has come late compared to other industrialised countries and much work is yet to be done.

Many factors have had a deep impact on this process: technological and product innovation, the increasing share of consumption, the fast-pace growth of the mobile market, and the globalisation of the economy.

This new scenario is decided by a Commission Guarantee Authority whose main goal is to define a regulatory framework consistent with the principles of market deregulation.

In this situation the compilation of CPI for service telecommunication is not an easy task. A large number of variables of different kind have an active role in price dynamics. The model used to represent the pattern of final consumption is complex and it needs to be continuously fed with new information.

The first part of the document deals with the evolution of the telecommunication market in Italy in the second half of the '90s (chapter 2), focusing on the complexity of the sector and its increasing importance. After this general introduction the document provides an overview of the price measurement problems encountered in CPI construction.

The difference in the characteristics of supply and demand services suggests a separate treatment of the methods used for fixed line network and mobile phone.

The market of fixed line network in Italy is still characterised by a dominant role of the former public Company. Other operators represent a negligible share of consumption and only one of them can now be considered significant. According to the chain index methodology, the sample and the associated weights are updated every year in order to consider new companies and services (chapter 3).

On the other hand mobile phones are a fast-moving and aggressive market. The traditional approach of CPI doesn't seem adequate to follow the continual change of products introduced to satisfy different consumer profiles and demand of new services (chapter 4).

In the last chapter some preliminary conclusions are drawn.

2. An overview of the telecommunication sector in Italy

2.1 Evolution of the telecommunication market

In the past five years the convergence between telecommunications, informatics and consumer electronics has revolutionised the institutional roles of the companies coming from these sectors, most particularly those of the telecommunication world. Today companies identified in the past by a monothematic core business have, by virtue of the convergence between telephone, computer and television, new development possibilities and may play roles which were unthinkable up to just a few years ago.

In Italy, a fundamental step in the telecommunication sector is the start-up of the process of liberalisation of the telephone service, by now completed, which took place following the legal abolition of the monopoly.

Starting in 1996-1997, the telecommunication sector appears to be undergoing a full transformation following the occurrence of two important phenomena:

⇒ the expansion of mobile telephony and the success of new telephony operators after the deregulation of the sector;

⇒ a greater organisation of the resources by the national telephony operators, the effects of which are evident in the two-year period, 1998-1999.

In fact, in 1998 a series of facts, which were important for the development of the sector, occurred in the telecommunications market. The list of interconnection of the operators to the fixed network was defined. The rate rebalancing process continued, with a progressive increase of the local rates to make up for the reduction in the costs of the long-distance and international calls. The right to define the cost of the calls from fixed-network phones to cellular phones was conceded. This right was granted to the fixed network operators, who must pay the mobile operators a price for interconnection to the cellular network on the basis of the list approved by the Communications Guarantee Authority[1].

1999 marked a fundamental stage in the history of Italian telecommunications. This is the year when the bases for the complete deregulation of the telecommunications services were laid with the opening to the competition of local switched network calls starting on 1 January 2000.

The actual opening of the telecommunication market in Italy required the precise definition of the regulatory context of reference. The most important decisions made by the Authority in recent years have been:

1) the rate rebalancing course through the price-cap mechanism[2];
2) the interconnection terms and rates of the new fixed network operators (Telecom Italia)[3];
3) the elimination of the concession fee paid by Telecom Italia to the Government as a consequence of the fact that the legal basis for exclusive concession no longer exists;
4) the opening of the network to encourage the entrance of new operators;
5) a greater distribution of the few resources through the issuing of Universal Mobile Telecommunications System (UMTS)[4] licences by the end of December 2000;
6) the promotion and development of new technologies.

Today these are topical matters that must be solved in order to catch up in the application of the Community directives dating from the early 1990s.

Numerous steps have been taken for the rebalancing of rates, which have increased subscription fees, reduced the costs of long-distance calls, and in general simplified the rate structure: the elimination of several time brackets and the introduction of new geographical contexts of reference. The criterion for setting rates used by the fixed telephony operator was changed, abandoning the logic based on units in favour of the currently more widespread system of *time* calculation[5].

The rate revision has also involved calls from fixed network to mobile network: the Communications Authority saw to regulating the costs of traffic to cellular phones in a rebalancing logic aiming to bring the prices closer to the costs. Lastly, service formulas without subscription fees have been introduced for Web access also, thus fostering the development of the Internet.

As for the segmentation of the market, there is a trend among new operators to focus their activity on specific customer targets (only business or only consumer/SOHO), rather than adopt a *generalist* approach typical of the first deregulation phases.

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[1] The Communications Guarantee Authority is the body in charge of carrying out regulating functions, legally separate from and functionally independent of the telecommunications organisations.

[2] Starting on 9 July 1999, the administered rating system ended and a price-cap mechanism was applied. This latter system makes it possible to rebalance rates at costs and productivity (essentially increasing the subscription fees and local traffic and reducing long-distance rates). The price-cap system regulates the dominant operator's rates, setting a ceiling for the total average variation of the price of a group of series for a period of several years, but allowing the operator to define the price of each of them.

[3] The interconnection list represents the costs that an operator must incur for using the network of another operator.

[4] Wideband transmission system that constitutes the mobile radio universal standard for high-speed communication.

[5] Even if the rate policy adopted by the various operators is complex and not always foreseeable.

The definition of the interconnection contracts and the related rates has allowed the launching of services with carrier selection codes; this has considerably increased the turnover of the new operators, but to the prejudice of the end consumers.

End users complain of an excess of regulation, which has characterised this phase of transition and has prevented the beneficial aspects of a dynamic and competitive market from being fully seen (in price terms).

2.2 The operators and the market

The telecommunication sector has always been subject to regulation such that any operator, in order to provide a type of service, even in a system of deregulation, must have a special licence[6] setting contexts and limits. Each licence allows the operators to provide the following services:
- network installation + telephony service
- service provider
- network supplier
- supplier of cashless services (reseller, phone center).

According to this logic, even operators that do not supply exactly telecommunication services, but provide services for connection to the Internet, or transmit data or supply telephony services for closed groups of users, must have authorisation. These licenses, considered "second level", are held by over 700 operators, two thirds of which operate in the Internet services sector. For example, if we focus our attention only on the licences issued for fixed network telecommunication services at the national and regional scale, in May 2000 a total of 104 licences[7] had been issued in Italy for fixed telephony, out of 81 legal parties. Of the 104 licences, 52 are national and 52 regional licences. The licences are of various kinds:

Licence A+B: installation of a TLC network for the purpose of providing a vocal telephony service;
Licence A: providing of the vocal telephony service
Licence B: installation and supply of TLC networks open to the public;
Licence B*: installation and supply of TLS networks open to the public through the use of DECT standard.
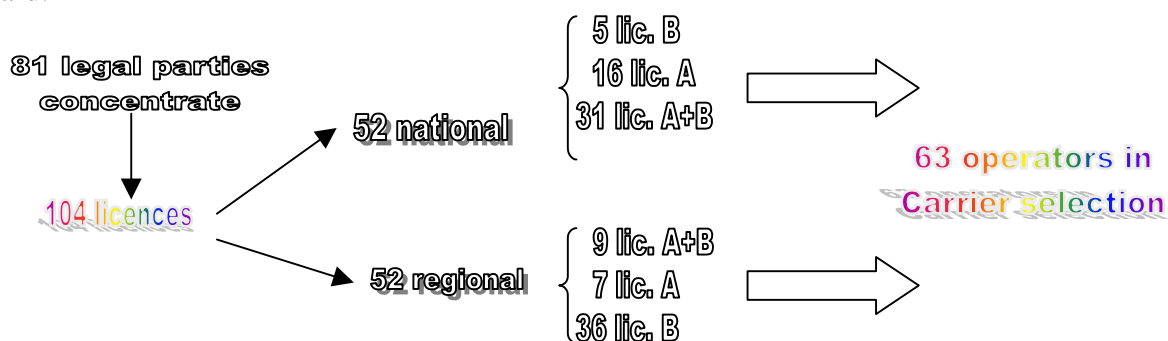
To the authorisations for fixed network services must be added the licences for mobile radio services. The Italian market features the presence of four national mobile radio operators[8], which will be joined in the future, after the assignment of the UMTS licences, by a fifth operator.

There are numerous transformation processes which, in recent years, have involved the TLC sector in Italy. The process of liberalisation of the sector has led to the appearance of new parties on the

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[6] The licence makes it possible to sign interconnection agreements with the infrastructure operators on the basis of the price lists approved by the Ministry of Communications.

[7] Regulating of the licences issued by the Ministry of Communications; it must be emphasised that the number of licences is indicatory of the period of reference since it is subject to change in time.

[8] Telecom Italia Mobile (TIM), Omnitel, Wind and Blu.

market, determining substantial changes in the universe of reference and a reduction of the degree of concentration of the market. The presence of a number of operators active in diverse ways over the territory has complicated the system of relations existing among the various market components. In fact, cross relations have been established among national and local operators, both in the collection and in the transit and terminations of traffic.

The definition of the various operators active on the Italian market has, in fact, become more complex and structured. The operators of telecommunication services provide Internet connection services, or they transmit data or supply telephony services for closed user groups. According to this logic, the operators active at the moment are classified in Italy as follows: *infrastructure operators*[9]; *carrier services*[10]; *value added services*[11]; *contents*[12].

The composition of the active operators in Italy
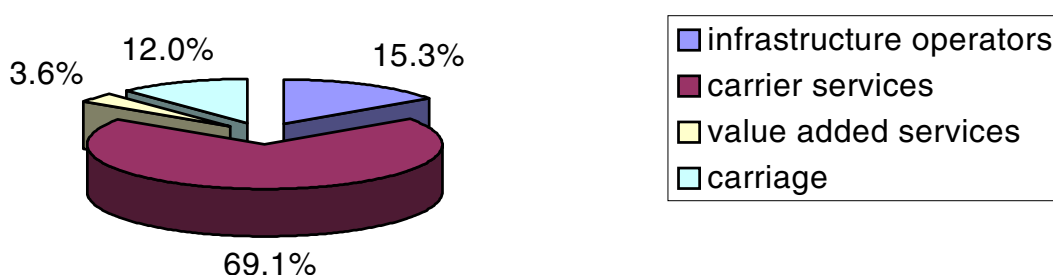
The operators of advanced services and traditional services are a propelling force of the mobile network market and act as catalysts of the new potentials offered by mobile technologies. In order to favour the competition in the access networks and infrastructure market, the incoming new operators had and have the right to national roaming under terms regulated for a certain period of time. The purpose of this transitory measure was to foster competition in the market of access

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[9] Intending the ownership and operational management of telecommunication networks (land, cellular and satellite) for the purpose of supplying transmission capacity (shared among *associated* operators) to the operator and the other service providers on the basis of interconnection agreements.

[10] Intending the supply to third parties of switching and transmission services (telephony, data and image) by means of own infrastructure or that owned by the infrastructure operators. The carriage services are broken down into: fixed network telephony (national and international), mobile network telephony (national and international), national data transmission, international data transmission.

[11] Intending the supply to third parties of transmission services (telephony, data and other) enriched with value added components which go beyond mere carriage, by means of own infrastructure or that owned by the infrastructure operators. These are: *Toll-free number* (national and international), *call center/contact center services* (software and call center applications), *EDI and messaging* (proprietary fax, broadcasting, e-mail), *TLC outsourcing services* (facility management, application support, technical assistance and servicing, etc. [except for basic services]), *Internet services* (access/subscriptions, hosting, housing, Web sites, Intranet, portals, etc.), *other services* (calling card, callback, video communication, satellite services, maintenance and servicing).

[12] Intending the supply to third parties of services that provide for the direct production of informational or entertainment material (thus excluding the sole carriage of material produced by third parties) distributed using own infrastructure or that owned by the infrastructure operators.

networks and mobile infrastructure where the market is characterised by the presence of one or two strong already-existing operators. In fact, within the framework of the mobile network services, the TACS and GSM systems operate, while the tender for the issuing of the five UMTS (Universal Mobile Telecommunications System) technology licences was held only at the end of the year 2000. The *third generation mobile network system*, the experimentation of which started in 2000, will make available multimedia applications even in the mobile context, revolutionising the mobile network market scene in the near future. In fact, the new wideband network will be able to handle data transmission at such a speed that it permits even sending moving images and hi-fi sound. With UMTS, the cellular phone will become a multimedia terminal capable of receiving communication, voice, data, and moving images. For the long term, the presence of several competing networks should be an incentive towards having greater effects on consumers in terms of prices, service quality and innovation.

2.3 Importance of the telecommunication sector in the economy

An initial economic indicator that shows the importance of the sector of the Italian economy in terms of growth is the share of the value added on the GDP at constant prices generated by the telecommunication sector. This share amounted to 2.0% in 2000.

The national accounts data show that the telecommunication sector has achieved excellent results in the past 5 years: between 1995 and 1999 output increased by more than 60% in nominal terms and 50% in real terms.

In particular, Table 2.1 shows how these dynamics have appeared in the various years. In 1999, the production at current prices increased by 15.3% and that at constant prices by 18.9%, confirming the positive trend in progress in this sector. The value added to the market prices in real terms also registered a double-digit growth (19.6%), higher than the average yearly increase at current prices (13.5%).

In 1996, the entrance into the telecommunications sector of a new telephony operator[13] justifies the increase in production in real terms by 11.5%.

Table 2.1 – Average yearly rates of production of the telecommunications sector at market prices and related deflators

Years	Current values	Values at 1995 prices	Deflator
1995	10.0	8.0	1.8
1996	13.8	11.5	2.1
1997	10.5	6.3	3.9
1998	10.8	6.3	4.2
1999	15.3	18.9	-3.1

The overall growth of the sector is undoubtedly supported and led by the cellular communication services: in 1999 the number of active users[14] stood at 30 million, with an increase of 47.8% over 1998. It is not by chance that the share of fixed network services is gradually falling to the

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[13] In 1996 Omnitel gained renown as a new telecommunications operator.

[14] Expressed in mobile network numbers reachable as of 31 December 1999 (source: ASSINFORM)

advantage of cellular telephony; as of today, fixed telephony services account for slightly more than 60% of the telecommunication services, while mobile telephony has a share of 40%.

The distribution of the shares in Italy is less balanced than in other countries, especially because of the different entrance times of the other operators. As of 31 March 2000, the top two mobile network operators, Tim and Omnitel[15], hold 94% of the market share[16], compared to a share of the top two operators of 84% for France, 79.7% for Germany, and 59% for the United Kingdom. The fourth operator, where present, already holds 4.1% of the market share (Germany) and reaches 23% in the United Kingdom; in Italy the telecommunication company Blu[17] only began commercial service in May 2000.

Confirming what emerges from the national economic accounts, the analysis of further information produced by ISTAT only for the telephony sector[18] also shows a strong positive dynamics: during the 1995-99 period the increase in turnover amounted to 82.3%, while in 1999 alone the increase was 12.9% over the previous year, aided by the lively demand in the mobile telephony and satellite network segments.

Also in 1999, the increase in turnover is considerably differentiated depending on the type of operator. In fact, the main fixed telephony operator (Telecom Italia) registered a 1.4% increase in turnover in 1999. Clearly higher were the growth performances of the other telephony operators[19] with 93.6% (in 1999), mainly attributable to the effect of the deregulation that had been in progress since 1996. Following with 37.0% is mobile telephony, which reached the maximum levels in terms of variations in 1996 with a growth of 195.7%. But what makes it possible to understand how the sector of telephony alone has really changed is the analysis of the fixed-base indexes (1995=100) of the turnover produced in 1995-1999. In the forefront with a growth in turnover of 802% is the mobile telephony sector, followed by the other operators with 404.4%.

With regard to the inflation dynamics characterising the telecommunication sector, also in Table 2.1 it is possible to see the annual variations attributed to the sector deflator. Up until 1998 the sector contributed to the increase in the prices of the entire economy, reaching the highest variation in 1998 with a deflator increase of 4.2%; in the last year, following the greater competitiveness of the market 3.1%, the companies implemented decreasing rate strategies, bringing about a 3.1% price reduction.

2.4 Summary of the analysis of the demand: information with regard to households

In recent years the impact of the consumer segment compared to the total market[20] of the telecommunication sector was decisive for the economic growth of the entire sector. In 1998 the turnover share generated by consumers was 49.9%, for a value of 27.39 trillion lire, registering an increase of about 23% over 1997. In 1999, the turnover share of business customers increased by one percentage point, and in absolute terms goes past 32.3 trillion lire, compared to the consumer sector turnover of approximately 31 trillion. Consumer customers for fixed telephony represented 63.2% in 1998, while in 1999 this percentage rose slightly to 63.3%.

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[15] The companies Telecom Italia Mobile and Omnitel entered the market following the assignment of their concessions, issued directly to the company Telecom (December 1993) and to the company Omnitel following an auction (March 1994).

[16] In Italy there has been a delay in the entrance of the third operator on the Italian market compared to the other European countries similar to Italy in size and position. The only situation similar to Italy is Spain, where the third operator began service starting in 1999.

[17] The company Blu entered the market following the award of the tender and the issuing of the licence in August 1999.

[18] Braca et al. (1999).

[19] Mostly new fixed telephony operators: Tiscali, Albacom, Infostrada and Tele2.

[20] Total market means both the equipment and the services markets taken together.

The spread of cellular phones has increased rapidly and extended to the entire population. In 1997 only 27.3% of the families had one; in 1998 this share rises to 43%, reaching 55.9% in 1999.

Also in 1999, around 2,600,000 families were not connected to the fixed telephony network, benefiting the replacement of fixed with mobile telephony. On the whole, in 1999 there were around 1,340,000 families without a fixed phone but with a cellular phone, corresponding to 6.2% of the total and 51.7% of the families without fixed phones. On the other hand, in 1998 there were 693,000, equal to 3.3% of the total families and 36.1% of the families without fixed phones.

Specifically with regard to the Italian market of GSM mobile networks, it is possible to grasp the substantial differences from other countries of the European single market similar in size and position to the Italian system. The countries considered are: Spain, United Kingdom, France, and Germany. An emerging aspect can be seen in the dimension of the market and the growth rates that have characterised the market of mobile phone services in Italy compared to the above-mentioned countries.

In 1999 Italy, with 30 million users, developed the highest number of mobile service users. Following is the United Kingdom with fewer than 24 million, Germany with 23 million, France with 21 million, and Spain with 15 million.

From the standpoint of prices offered to users, the acceleration of the competition on the mobile market has led to a great reduction in the prices of mobile telephony services, starting with the entrance of the third operator in the second-generation market. The prices of the services in Italy are on the average lower than the European average and tend to decrease: the average rate pressure fell in 1999 by 10%, also thanks to the greater competitiveness brought by the take-off of Wind and the entrance of Blu. The price options offered to customers, as well as promotional offers that, in certain periods of the year, are fiercely competitive, have increased considerably. But for a greater analysis of the price system the reader is referred to chapter 4.

3 – Consumer price indexes for fixed phone services

3.1 – The fixed telephony rating systems

As stated previously, with the opening of the telecommunications sector to free market competition, officially started on 1 January 1998, in Italy each user is formally guaranteed the possibility to choose from among various suppliers of fixed telephony services.

Only starting in January 1999 did the option for an alternative operator become possible, in *Call by Call* mode, for all kinds of calls, including local and local long-distance calls; while at least until the coming September the Telecom Italia monopoly will remain in effect – until the start-up of the *Carrier preselection* – for the management of the local loop (last mile of the network)[21].

Thus the second half of 2001 will be for all purposes the period during which the most important effects of the market liberalisation will definitively begin to be seen, with an ever-growing number of operators available and a growing competition in the conception of the services and management of the rate plans.

What emerges, therefore, is a picture of a market characterised by a growing and uncontrolled complexity, from which the end users have drawn considerable advantages in terms of availability of services and reduction of costs, but which has at the same time generated a difficulty in monitoring the different rates offered by operators to their customers.

During this rapid market evolution the National Statistics Institute has adopted different procedures for elaborating and calculating consumer price indexes for fixed telephony, trying to follow as completely and rigorously as possible the trend of the rate policies of the monopolistic company first, and of the competitors later.

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[21] Up to then users, even though they can make calls with other operators, must in any case have a service contract with Telecom Italia, and pay a monthly fee.

Up until the mid 1970s, the fixed telephony basket provided for only the presence of the monthly subscription fees to the telephone service supplied by the monopolistic company SIP (later Telecom Italia).

These included the subscription to the service, the fixed expenses, and a congruous number of telephone units free of charge.

There were two kinds of subscription offered for *residential consumers*: *single*, which provided for the supply of a single dedicated telephone line for the customer, and *duplex*, which provided for the alternative use of a line between two subscribing customers with two different, consecutive numbers.

During this period the consumer price index followed the trend of the rate variations of these two subscription fees weighed according to the number of residential subscribers for each of them.

With the calculation of the 1990-base index, a new type of measure was introduced which envisaged a small sub-basket for fixed telephony.

It included a sample of expense items concerning the kind of call and the different rating present in the subscribers' phone bill.

The sub-basket was thus made up of two subscription fees as described previously, and two items for the telephone traffic, broken down into local and long-distance calls.

Each single value was weighed according to a national consumption average per subscriber supplied directly by the company running the system.

In practice, there was an average bill of the expenditure per subscriber that produced a variation of the index only with the price variation of the units during the fixed-base period.

With the calculation of the 1995-base index a more complex, structured sub-basket, corresponding to the changed rating reality, was introduced.

In it, thanks to the results of a sample survey of the two main companies providing fixed telephone services, are most of the rates for local, long-distance and international calls broken down by time of call, distance covered by the call, and receiver of the call, broken down by fixed phone, mobile phone, and receiver's operator.

3.2 – Construction of the price index for fixed telephony services

In the same way as for other services, the price index for fixed telephony is a composite index. This means that, once its weight in relation to the totality of end consumers is defined, it is further broken down to take into account the complexity of the rate structure.

The price index of fixed telephony has always been followed at the centralised level and with particular attention by Istat, both because it was an administered price, and for its importance in households consumption.

In recent years, while the first reason has partly fallen (see note 2), the sector's importance has increased considerably.

In the meantime, with the deregulation of the market the problem of broadening the sample, introducing the new sector operators as well, was posed.

The advantage of a yearly revision of the basket, allowed by the adoption of a chain index[22], lies in being able to follow the sector dynamics with a certain caution. The new operators[23] or new services offered are considered in the calculation of the index only when their revenues (referring to residential traffic) become significant[24]. On the other hand, as has emerged previously, the

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[22] In Italy the calculation of a yearly chain CPI was adopted starting in January 1999. The basis of reference is the year 1995. The basis of calculation is the month of December of each year preceding that for which the indexes are calculated.

[23] Starting in January 2001, Infostrada was also included in the sample, together with Telecom Italia.

[24] Even the operators not included in the sample show their contribution indirectly, to the extent that they succeed in influencing the rates applied by the operators present.

deregulation process is still in the initial stage and the ex-monopolistic operator alone holds about 90% of the market.

The index calculation structure is made on the basis of a division of the turnover of each operator, detailed with respect to all the possible rate arrangements that concern residential users. This division is based on estimates made by the operators themselves and deriving from a continuing monitoring of the traffic. Residential use is considered a proxy of private consumption, even if it is evident that part of the residential traffic is made for business reasons and vice versa.

The fixed telephony services consumed by households consist of two kinds of expenditure: service access costs and costs regarding actual traffic.

The costs for access to the fixed telephony service consist of the monthly fee and the occasional accessory services (activation, transfer or termination of service) or continuing services (call waiting, call transfer, detailed statement of traffic, etc.). Only the monthly subscription fee is considered in the calculation structure, since the other services are of a marginal importance.

Indicating with $R_{i1,t}$ gross revenue at time t, with $P_{i1,t}$ the net subscription fee, with V_t the tax[25], with $T_{i,t}$ the average number of subscribers for operator I in year t, it is possible to write:

$$(3.1) \quad R_{i1,t} = P_{i1,t}(1+V_t) \times T_{i,t}$$

On the other hand, the monitoring of the traffic feels the effects of the complexity of the rate structure. The elements identifying the type of call are:

- receiver (fixed, mobile network);
- distance (local, local long-distance, long-distance, international);
- time bracket (peak, off-peak, weekend);
- length of call (short, long).

For each kind of call each operator supplies the information for the most recent year available[26], which regards the average monthly number of calls made for the kind of call k with operator I at time t $C_{ik,t}$, the average length of the calls $D_{ik,t}$, the amount of the unit on answer $S_{ik,t}$, the price per time unit $P_{ik,t}$.

For each type of call k (with k>1, since for k=1 we have indicated the revenues from fixed costs) and for each operator the average monthly gross revenue is calculated:

$$(3.2) \quad R_{ik,t} = (S_{ik,t} + D_{ik,t} \times P_{ik,t}) \times C_{ik,t} \times (1+V_t) \times T_{i,t}.$$

The weight of time t for the type of call k from operator I is equal to:

$$(3.3) \quad W_{ik,t} = \frac{R_{ik,t}}{\sum_i \sum_k R_{ik,t}}.$$

At time t+1, keeping fixed the quantity data $C_{ik,t}$, $D_{ik,t \text{ and }} T_{i,t}$, and considering the prices $S_{ik,t+1}$, $P_{ik,t+1}$ and V_{t+1}, from (3.1) and (3.2) the following values are subtracted:

$$(3.4) \quad \hat{R}_{i1,t+1} = P_{i1,t+1}(1+V_{t+1}) \times T_{i,t}$$

$$(3.5) \quad \hat{R}_{ik,t+1} = (S_{ik,t+1} + D_{ik,t} \times P_{ik,t+1}) \times C_{ik,t} \times (1 + V_{t+1}) \times T_{i,t} \quad \text{for } k>1;$$

which represent the average revenues for each type of expense, at prices t+1 in the hypothesis that the quantities remain unchanged at time t.
The price index for fixed telephony services is equal to:

$$I_{t+1} = \sum_i \sum_k I_{ik,t+1} W_{ik,t} = \sum_i \sum_k \frac{\hat{R}_{ik,t+1}}{R_{ik,t}} W_{ik,t} \quad .$$

The construction and the management of the index do not present excessive difficulties at the present time. Up to today, operators have always supplied precise, sufficient information[27].
Because of the rebalancing of the rates, the competitive policies and the Authority's decisions, some of the components of the consumption structure fixed in the base period may vary during the year[28]. In order to make the replacement it is necessary to revise the structure of the base period, keeping the quantities unchanged and redistributing them with respect to the new situation. In this case, also, the information supplied makes it possible now to deal with the situation.

4 – Consumer price indexes for mobile phone services

4.1 – The mobile telephony market: analysis and measurement problems of the price indexes

In 1999 the number of mobile phones in Italy passed the mark of fixed phone users and, according to reliable forecasts, the number of mobile users will reach 50 million in 2004. This will mean that almost every Italian citizen will be reachable by means of a mobile phone.
But mobile telephony is not only verbal communication; in fact the functionality of GSM has been increased even further. In about one year the UMTS will be available and the new use of cellular telecommunications is already represented by the VAMS. Among these, the most interesting are the prepaid services, mobile Internet, mobile Commerce, localisation services, unified messaging, information services and personal number with roaming. In short, a single means for many differentiated uses, many of which are of a commercial nature.
In this context and in these perspectives the work of analysing the mobile phone service rates, for the purposes of calculating the consumer price indexes, appeared immediately extremely complex and of increasingly difficult management with the increase in the number of operators, the types of contracts offered, their characteristics, and the types and number of paid services possible and available.
For the mobile phone services – as for fixed telephony – ISTAT considered it advisable to create a sub-basket which envisages, for each major operator, the most widespread types of contract with the respective services offered – weighed according to the average consumption data registered at the base year.
This method showed in the years great difficulties in making the index effectively representative of the trend of the rates applied by the management companies.
There are various main causes for this complexity.
The first is attributable to the fact that the operators have never changed in time the process of the services offered in the contracts signed with their customers.

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[27] It is, however, presumable that in the future, with a full implementation of the competitive system, the operators will want to keep reserved information that is available today, also because of the price-cap mechanism that provides for a control over the rates applied.

[28] As of February 2001, for example, Telecom Italia inserted a weekend rate for national calls and made district (local long-distance) calls equal to local calls, introducing in the first case long calls (connections to the Internet).

In fact, the marketing policy of all the operators provides for the offering on the market not of new rates, but of new contracts with service characteristics different from the preceding ones, to which any customers who may be interested may adhere, abandoning the initial contract.

It is still very difficult, if not impossible, to succeed in comparing the quality and types of these offerings, establishing their value, and consequently evaluate the actual price variation between what is offered in a contract put on the market during the year and what is offered in the most similar contract chosen in the basket of the base year.

The second difficulty concerns the weight to be attributed to each new contract – and within it to each service – put on the market.

In fact, at the moment of the launch of each offering, and in the following months, there are no measurable data concerning the migrations from one to the other offering and/or from one to the other operator.

The third difficulty concerns the possibility offered by the operators to be able to recharge the credit purchased by customers with prepaid cards by means of calls received from other subscribers (with the increase in the calls received, the credit available for other calls to be made increases).

It is a fairly common offering that creates problems in monitoring the actual rate paid by the subscriber.

The fourth difficulty concerns the free-of-charge offering of prepaid cards included in the sale price of mobile phones. In fact, all the operating companies offer phones of various brands with very interesting discounts and with prepaid phone cards included, in order to win over consumers for their services.

We are faced with a limit of representativeness of the fixed base consumer price index and of the possibility to measure the many variables of the phenomenon.

Mobile phone services were introduced into the Italian consumer price index starting in 1996. Their weight has progressively increased, as has that for the purchase of the telephones, as can be seen in the following table:

	Mobile telephony services	Var. %	Purchase of cellular phones	Var. %
1994	0.1124		0.0733	
1995	0.1146	+2.0	0.0491	-33.0
1996	0.1209	+5.5	0.0497	+1.2
1997	0.4792	+296.4	0.5560	+1018.7
1998	0.6153	+28.4	0.8726	+56.9
1999	0.7214	+17.2	0.8411	-3.6

Mobile phone services have shown a growing trend, while the expenditure for the purchase of cellular phones seems to have reached the saturation level.

4.2 Methods of constructing a CPI for mobile phone services

Unlike fixed telephony, the construction of a consumer price index for mobile phone services is characterised by several problematic aspects that are not easily solved. As has already been seen previously, the market has had a rapid development in recent years. The commercial policy adopted by the companies has been that of frequently changing the offering, with the purpose of capturing new customers or of attracting them away from competitors. The technological innovations that continuously characterise the evolution of the market make it possible to offer increasingly complex and diversified products at lower and lower prices.

At first subscription contracts, similar to those found in the fixed telephony sector, characterised by a fixed component (fee for access to the service) and a variable component proportional to the actual calling traffic, were offered. Payment was made periodically, on the basis of a phone bill sent to the customer and referring to the actual consumption.

Later this kind of contract was replaced with rechargeable cards, which have no additional fixed costs, except for the recharging expenses. The customer chooses the amount he wishes to charge his card with, and call costs are progressively subtracted from it[29]. The life of a card is unlimited, but normally it is envisaged for a minimum usage to be made during a year.

Each operator provides a certain number of rate profiles, which are diversified by cost and the mode of access to each service[30]. A new customer has the opportunity to choose both the operator, from among those currently present on the market, and the rate profile from among those offered by each operator.

For the purposes of the consumer price indexes, whose population of reference are households, it is necessary to exclude the entire business market and concentrate the analysis on residential traffic only.

This distinction can be made in a sufficiently precise way in the case of subscriptions, where the kind of customer is an element that determines contractual differences that concern the fixed expenses (periodic fee), the rates applied, and the special terms offered.

In the case of rechargeable cards, it is not always simple to distinguish the business traffic from residential traffic. Any professional person uses his cellular phone for both work and private purposes and the only approximations, which are not always reliable, can be made with reference to the receiver of the call and the time when it is made.

Later, for the purposes of explanation of the theory, reference will be made only to private consumer, who represents a subset of the total consumers, supposing that there is information available on that kind of traffic.

Indicating the nth operator with **i**, the rate profile with **j**, the service possible with **k**, and the time unit with **t**, the amount of the revenues of the mobile phone service for the residential consumers in year t is equal to:

$$(4.1) \quad R_t = \sum_i \sum_j \sum_k P_{ijk,t} Q_{ijk,t} = \sum_i \sum_j \sum_{k=1}^{k_1} P_{ijk,t} Q_{ijk,t} + \sum_i \sum_j \sum_{k=k_1+1}^{k_2} (S_{ijk,t} + P_{ijk,t} \times D_{ijk,t}) \times C_{ijk,t} \quad ,$$

where the second part has been divided between fixed expenses (the first k_1 services) and variable expenses (the services from k_1+1 to k_2) .

In the part concerning the fixed expenses, $P_{ijk,t}$ is the price for the k-th fixed expense in the j-th rate profile of the i-th operator at time t and $Q_{ijk,t}$ is the relative quantity[31].

In the part concerning the variable expenses[32]:

$S_{ijk,t}$ represents the call set-up applied to the k-th type of traffic (service) in the j-th rate profile of the i-th operator at time t[33];

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[29] With several rate profiles currently in force, the card recharges automatically by a certain number of lire for each minute of traffic, either received or made. In this case these are incentives that must be dealt with in the more general aspects of the treatment of discounts in the consumer price indexes.

[30] Several rate profiles privilege calls made to the same operator or in a certain time bracket or to a predefined telephone district. Others allow calling one or more preselected numbers at a lower rate. There are also profiles with a flat rate, regardless of the kind of call.

[31] The fixed services considered are the monthly subscription fee, the card recharging costs, and the costs for service activation, changeover to another rate profile, and termination.

[32] The services considered in the variable part are the outgoing traffic from operator i in its various forms that depend on the characteristics of the call made. The outgoing traffic may be internal (national) or international. The internal traffic may refer to the local, regional or national fixed network or to the mobile network of the same operator or another. Special rates may refer to the calls made to one or more preselected numbers of the fixed or mobile network. Normally the rate applied for each call is differentiated also with respect to the time or the day when it is made.

[33] Not all rates necessarily precede a call set-up. In this case we use $S_{ijk,t}=0$.

$P_{ijk,t}$ is the price per minute (second) for the k-th type of traffic in the j-th rate profile of the i-th operator at time t;

$D_{ijk,t}$ is the average length in minutes (seconds) of the calls made for the k-th type of traffic in the j-th rate profile of the i-th operator at time t;

$C_{ijk,t}$ is the number of calls made for the k-th type of traffic in the j-th rate profile of the i-th operator at time t.

If we have:

$$(4.2) \quad D_{ijk,t} = \frac{M_{ijk,t}}{C_{ijk,t}} \quad ,$$

where $M_{ijk,t}$ is the total length in minutes (seconds) of the calls made for the k-th type of traffic in the j-th rate profile of the i-th operator at time t, (4.1) can be rewritten in the equivalent form:

$$(4.3) \quad R_t = \sum_i \sum_j \sum_{k=1}^{k_1} P_{ijk,t} Q_{ijk,t} + \sum_i \sum_j \sum_{k=k_1+1}^{k_2} (S_{ijk,t} \times C_{ijk,t} + P_{ijk,t} \times M_{ijk,t})$$

In order to be able to construct a price index, it is necessary to be able to have all the information concerning the revenues, the number of calls, and the total or average length for each component, i.e. for each service offered in a certain profile by a company and referring to a yearly period chosen as the base.

Indicating with $R_{ijk,t}$ the revenue for each single component, we can write:

$$(4.4) \quad R_t = \sum_i \sum_j \sum_k R_{ijk,t}$$

and

$$(4.5) \quad W_{ijk,t} = \frac{R_{ijk,t}}{R_t} \quad ,$$

where $W_{ijk,t}$ is the relative weight in terms of revenues for the k-th service of the j-th rate profile of the i-th operator calculated with reference to the base year t.

According to the classic approach, the price index of mobile phone services for the year t+1 (or even for each month of the year t+1) is equal to:

$$(4.6) \quad I_{t+1} = \sum_i \sum_j \sum_k I_{ijk,t+1} W_{ijk,t}$$

where

$$(4.7) \quad I_{ijk,t+1} = \frac{P_{ijk,t+1}}{P_{ijk,t}} \quad ,$$

is the price index for the k-th service of the j-th rate profile of the i-th operator.

In mobile phone services the price index cannot be calculated with (4.6) and (4.7) for the following interconnected reasons:

a) the indexes $I_{ijk,t+1}$ remains equal to 100 over time, for each i, j, k, i.e. in time no price change is registered;

b) between time t and time t+1 the situation changes substantially: the number of operators changes and each of them changes the set of rate profiles offered.

In fact, since the operators try to gain greater market shares and the market itself is expanding continuously, the prices of a rate profile, once fixed, are never changed again. The market policy adopted by the sector's companies is that of proposing newer and newer options, giving customers

the possibility to switch from a previous rate, if they decide it is more convenient to do so. The new customers can sign contracts with the offers available at that particular time. Over a period of time there is a replacement of the rate profiles offered.

Let us suppose, for example, that operator i at time t offers the rate profiles A and B and at time t+1 profiles B and C. Each profile is made up of a certain number of rates and contractual conditions depending on the services possible.

Table 4.1 – Operator i

Profile	T	t+1
A	$n_{i,A}^{t}$	$n_{i,A}^{t+1}$
B	$n_{i,B}^{t}$	$n_{i,B}^{t+1}$
C	0	$n_{i,C}^{t+1}$
total	n_{i}^{t}	n_{i}^{t+1}

$n_{i,A}^{t}$ represents the number of subscriptions to rate profile A of operator i at time t, likewise for the other values of the boxes.

At time t the rate profile C did not exist and the total number of customers is equal to n_{i}^{t}.

At time t+1 several customers of profile A may have shifted to profile B or to the new profile C or to another operator. Since it is no longer possible to subscribe to profile A, we have the relation $n_{i,A}^{t+1}$ ≤ $n_{i,A}^{t}$. After a certain number x of years, we will have $n_{i,A}^{t+x}$=0.

The number of subscriptions to profile C is given by the sum of the new subscriptions plus the changeovers from A, B or another operator.

Since the market is rapidly expanding, normally we have: $n_{i}^{t+1} > n_{i}^{t}$.

Because of the strong competition, prices are decreasing, in the sense that profile C has prices that on the whole are more convenient than A. The comparison is not immediate, in the sense that C could be more advantageous for a certain service (for example the calls towards a mobile operator) and less so for another (the calls towards a fixed operator). The comparison is complicated by the fact that the *call set-up* may or may not be present, the rate may be calculated on the basis of periodic units or seconds, or the difference between the two profiles may concern other contractual conditions.

It is evident that the consumer's choice is not simple and, while admitting a rational behaviour (immediate switch to the best profile) it is not necessarily true that all customers consider it convenient to change from profile A to profile C.

The consumer's decision is based only on a subjective evaluation of the convenience of the prices of a profile and not on an expectation of savings on the overall expense. The experience of sector operators indicates that if a customer changes to a new profile considered more convenient, he will tend to use it more and, although the unit price is lower, the total expense will be higher than before. In the decision to switch from one profile to another it is also necessary to take into account the fixed expense to be paid to the operator at the time of the change. In general, if a customer no longer considers it advantageous to switch to a new profile, he will maintain a tendentially conservative behaviour.

The difficulty in constructing a price index for mobile phone services according to the Laspeyres approach lies in the impossibility to compare to temporal situations because of the continuous replacement and invariance of the prices offered during the base period.

The calculation according to the current approach – At present, the following calculation method is followed in Italy: each year the most representative profiles of the main sector operators are selected. The index of the mobile phone services is a weighted average of the indexes of each operator, with weights equal to the revenues for the outgoing traffic, obtained from the financial statements of the previous year, appropriately adjusted, in order to take into account only the residential traffic. In accordance with the yearly chain calculation method, each year the weight of the mobile phone services on the families' total end consumption is also updated.

Since the price index of each component remains equal to 100 for the entire year, the average index also equals 100. Since the prices tend to decrease, the current method causes an overestimate of the index of the mobile phone services, which is reflected on the general index to an extent proportional to its weight, which has been growing in recent years.

The table below shows the impact of possible distortions of the CPI due to an overestimate of the index of mobile phone services.

Table 4.2 – Overestimate of the price index

	1996-98	1999	2000
2%	0,002	0,010	0,011
4%	0,004	0,019	0,023
6%	0,006	0,028	0,033
8%	0,009	0,036	0,043
10%	0,010	0,043	0,052

What are the possible alternative approaches to the problem?

Exclusion from the consumer price index – If we acknowledge the impossibility to measure the price variation for mobile phone services, a possible solution is to eliminate the item from the consumer price index (or, in an equivalent manner, attribute to the mobile phone services item the same variation as registered by the goods and services in the basket as a whole). Since the consumer price index has a tendency to grow with time, the use of this method would cause an overestimate even higher than the current method.

Use of the index of a similar item – Also in the hypothesis that it is not possible to measure directly a mobile telephony index, it is possible to apply to that item the price variation registered in a similar item or, in an equivalent manner, shift the weight of the mobile telephony item to another item, for example the fixed telephony services. In Italy this solution does not seem to be applicable. In particular, although fixed telephony has also had a decreasing trend in recent years, the differences in the market structure and the price fixing methods are such that it would be arbitrary to connect the variation in the prices of mobile phone services to those of fixed telephony. In this case, it may be presumed that the distortion is reduced in absolute value, but its sign remains uncertain.

The index based on the average rate pressure – The operators periodically calculate a measurement of the price trend of the services offered, called average tariff pressure (ATP).
The ATP is defined as the ratio of the amount of revenue to the minutes of traffic used:

(4.8) $\quad ATP_{i,t} = \dfrac{R_{i,t}}{M_{i,t}}$

where

(4.9) $R_{i,t} = \sum_j \sum_k R_{ijk,t}$

are the revenues earned at time t by operator i, concerning all the rate profiles j and the single services k, including both fixed and variable costs, and

(4.10) $M_{i,t} = \sum_j \sum_k M_{ijk,t}$

are the minutes of traffic used at time t for each kind of call made with operator i, concerning only the variable costs.

Since the market is rapidly expanding in terms of both customers and quantities used by each customer, we generally have the following relations:

(4.11) $R_{i,t+1} > R_{i,t}$ and $M_{i,t+1} > M_{i,t}$.

The offering of increasingly convenient rate profiles in terms of unit prices also leads to:

(4.12) $\Delta R_i = \dfrac{R_{i,t+1}}{R_{i,t}} < \Delta M_i = \dfrac{M_{i,t+1}}{M_{i,t}}$

and therefore

(4.13) $\Delta ATP_i = \dfrac{ATP_{i,t+1}}{ATP_{i,t}} < 1$.

The consumer price index for mobile phone services obtained using the ATP:

(4.14) $I_{t+1} = \sum_i \dfrac{ATP_{i,t+1}}{ATP_{i,t}} \times W_{i,t}$

where

(4.15) $W_{i,t} = \dfrac{R_{i,t}}{R_t}$

is the relative weight of the i-th operator evaluated in terms of revenues at time t.

In practice the index calculated with (4.13) cannot be used for numerous reasons.
First of all, it is not a price index, since between time t and time t+1 both the prices and the quantities used vary.
In the second place, the ATP refers to the totality of the services used, while for the purposes of a CPI, the measurement should refer only to private consumption.
The ATP also has the defect of not being calculated with monthly frequency and it is also produced directly by the operators as a concise datum, without the possibility to analyse its components. It follows that an official index, used for institutional purposes, cannot be even partially entrusted to a calculation method on which it is not possible to make a conformity check.
Nevertheless, an indicator based on the ATP may be used as a control value with respect to the estimate that may be made with another method.

An alternative approach – As has been seen earlier, the construction of a Laspeyres index presupposes a detailed knowledge of the information referring to a period chosen as the base and of an instrument for dealing with the continuous replacements.

Let us consider the following subdivision of the revenues at time t for the totality of the mobile phone service operators:

Table 4.3 – Mobile phone services at time t

	Revenues	Quantity	Total Duration	Average Duration	Price
Fixed expenses					
-Subscription fee	$R_{1,t}$	$Q_{1,t}$			$P_{1,t}$
-Recharges	$R_{2,t}$	$Q_{2,t}$			$P_{2,t}$
-Activations + changeovers	$R_{3,t}$	$Q_{3,t}$			$P_{3,t}$
Outgoing traffic					
-Internal	$R_{4,t}$	$C_{4,t}$	$M_{4,t}$	$D_{4,t}$	
--towards local fixed network	$R_{5,t}$	$C_{5,t}$	$M_{5,t}$	$D_{5,t}$	
--towards national fixed network	$R_{6,t}$	$C_{6,t}$	$M_{6,t}$	$D_{6,t}$	
--towards mobile network, same operator	$R_{7,t}$	$C_{7,t}$	$M_{7,t}$	$D_{7,t}$	
-- towards mobile network, other operator	$R_{8,t}$	$C_{8,t}$	$M_{8,t}$	$D_{8,t}$	
-International	$R_{9,t}$	$C_{9,t}$	$M_{9,t}$	$D_{9,t}$	
	$R_t = \sum_k R_{k,t}$		$M_t = \sum_k M_{k,t}$		

For the fixed expenses the revenues are given by the product of the quantities times the relative price.

For the outgoing traffic, the quantities consist of the number of calls. For each service k (for example, the calls towards the local fixed network), the number of calls made is given by the sum of the calls for the service k of each rate profile of each operator:

(4.16) $C_{k,t} = \sum_i \sum_j C_{ijk,t}$, for k = 4,5,…,9.

Likewise for the total lengths:

(4.17) $M_{k,t} = \sum_i \sum_j M_{ijk,t}$, for k = 4,5,…,9.

From (4.16) and (4.17) results:

(4.18) $R_{ijk,t} = f(C_{ijk,t}; M_{ijk,t}; P_{ijk,t})$, for k = 4,5,…,9 ,

where $P_{ijk,t}$ is the price to pay at time t to use the service k of operator i, using the rate profile j.
The price indicated with $P_{ijk,t}$ includes all the rate components (manner of rating with respect to time, call set-up, taxes) and varies according to the profile considered $P_{ij_1k,t} \neq P_{ij_2k,t}$ for $j_1 \neq j_2$.

From (4.18) it is possible to determine the total revenue for the traffic k:

(4.19) $R_{k,t} = \sum_i \sum_j R_{ijk,t}$

and

$$(4.20) \quad W_{k,t} = \frac{R_{k,t}}{\sum_k R_{k,t}}$$

which represents the weight, in terms of revenues, of the service k with respect to the totality of the mobile phone services used in year t.

At time t+1 the rate profiles j and the operators i present on the market change.

Indicating with $T_{i,j}$ the number of subscribers to operator i who have chosen profile j, it is possible to construct for each service k a system of equations in (i x j)+2 equations:

$$(4.21) \quad \begin{cases} \hat{M}_{ijk,t+1} = f(\alpha, \beta, T_{i,j}, \frac{1}{P_{ijk,t.1}}); \forall i, \forall j \\ M_{k,t} = \sum_i \sum_j \hat{M}_{ijk,t+1} \\ C_{k,t} = \sum_i \sum_j \hat{C}_{ijk,t+1} = \sum_i \sum_j \frac{\hat{M}_{ijk,t+1}}{D_{k,t}} \end{cases}$$

where $D_{k,t}$ is the average length at time t specified in Table 4.3.

The first (i x j) equations of the system (4.21) express the $\hat{M}_{ijk,t+1}$, total lengths unknown at time t+1 depending on the number of subscribers, of the inverse of the rate, and of the two parameters α and β^{34}.

The first constraint of the system states that the sum of the total lengths estimated at time t+1 is equal to the total length of the calls made for the service k at time t.

The second constraint of the system states that the sum of the $\hat{C}_{ijk,t+1}$, number of calls estimated at time t+1 is equal to the number $C_{k,t}$ of calls made for the service k at time t. The $\hat{C}_{ijk,t+1}$ are calculated in the hypothesis of an average length equal to that registered at time t.

The system has a total of (i x j)+2 unknowns and its solution makes it possible to determine the total lengths and the number of calls for each profile j of each operator i at time t+1, taking into account the new profiles and/or operators, but leaving the quantities at time t unchanged.

Using (4.17) it is possible to write:

$$(4.21) \quad \hat{R}_{ijk,t+1} = f(\hat{C}_{ijk,t+1}; \hat{M}_{ijk,t+1}; P_{ijk,t+1}) \text{ , for k = 4,5,...,9 ,}$$

from which

$$(4.22) \quad \hat{R}_{k,t+1} = \sum_i \sum_j \hat{R}_{ijk,t} \quad .$$

From (4.18), (4.19) and (4.21) it is possible to derive a price index for mobile phone services:

$$(4.23) \quad I_{t+1} = \sum_k \frac{\hat{R}_{k,t+1}}{R_{k,t}} \times W_{k,t} \; .$$

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[34] The best functional form that ties the unknown variables to the known ones is not defined at the moment and must be determined in an experimental manner on the basis of the information possessed. A working hypothesis could be:

$$\hat{M}_{ijk,t+1} = T_{ij}(\alpha + \frac{\beta}{P_{ijk,t+1}}) \; .$$

The construction of a system of equations for each service j presupposes the knowledge of all the information present in Table 4.3 and of a periodic update during the year t+1 of the number of subscribers for each profile of each operator. The ideal situation would be to be able to have monthly information, the same frequency of calculation as the consumer price index, but even a lower frequency may be accepted.

The feasibility of the method has not yet been tested, since the sector operators do not supply sufficient information for the construction of the system of equations. In particular, the data of Table 4.3 are supplied at a very aggregate level, while the number of subscriptions for each available profile is considered strategic information to be kept confidential.

In order to be able to continue in the approach, there remains only the possibility of constructing a sample survey on users in order to know in detail the structure of consumption. The costs of such a survey are not, however, justifiable for a National Statistics Institute only for the construction of a consumer price index for mobile phone services[35].

5 – **Conclusions**

Telecommunication services are a critical sector in the construction of consumer price indexes. The complexity of the rate structures offered grows with the passing of time, because of technological innovations, the deregulation process in progress, the globalisation of the markets, and the growing demand for new services.

In these conditions a measurement of price dynamics is not simple and, with the passing of time, it will be complicated even more by the fact that there will be multimedia applications that will lead to a convergence among information, communication and technology sectors that appear distinct and separate today (fixed and mobile telephony, Internet, television).

On the other hand, the consumer price index must never lose sight of its main objectives, of a prompt, transparent and reliable measurement of consumer inflation.

The solutions to be sought for telecommunication services must thus combine the need for precision with that for clarity and applicability of the chosen method.

For this purpose, solutions should be privileged that, even approximately, make possible a monthly calculation of a price index, evaluating the effects of the replacements in course, without absorbing resources greater than the relative importance of the item in the total basket.

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[35] An alternative could be that of a cooperation with consumer associations, which might be interested in a greater understanding of the market, and support or share the survey management costs.