Demand and Innovation in Services: the Case of Mobile Communications♦

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Abstract

This paper aims at analyzing the characteristics and the determinants of innovation in the mobile communication service industry, by emphasising in particular the role of demand. In a Schumpeterian spirit, we argue that competition in this sector crucially depends upon innovation, and that, given the specific characteristics of the industry, firms' innovative strategies are strongly affected by demand. Our main point is that in a context of uncertainty, demand affects firms' innovative strategies in two ways: first, by providing information on users' behaviour and by increasing the capability of market segmentation; second, by providing incentives to innovate. This argument is supported by an empirical analysis carried out on the basis of an original dataset including all the tariff plans offered in the history of the Italian market up to 2005. We find that both firms' installed base of customers and market saturation play a role in shaping firms' innovative activities, in terms of number and type of innovations.

JEL Classification:

KEYWORDS: service innovation, demand characteristics, mobile communications sector

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♦ We thank Roberto Fontana for useful comments and suggestions. Nicoletta Corrocher would like to acknowledge the financial support of the Research Council of Norway, Project n°172603/V10: "The Knowledge-based society").

1. Introduction

The mobile communication industry is one of the most flourishing sectors within the ICT industry and, in general, within the economy. In the last decade, the diffusion of mobile phones and the associated revenues have grown at an impressive rate. Between 1993 and 2003, mobile phones subscribers have grown at an annual compound growth rate of 38.3 (44.8% in the EU 15). In 1995 telecom service revenues represented 2.3% of GDP in the OECD, while in 2003 this had increased to 3.2%. In most OECD countries, more than 40% of these revenues come from mobile communications (OECD, 2005).

In this paper, we focus on the mobile communication service sector. For an economic theorist, this sector presents several interesting characteristics both in terms of supply and in terms of demand. On the supply side, firms compete by offering different kinds of services typically through proprietary networks, in which they invest in terms of capacity and coverage. The number of firms is constrained by the existence of a limited radio spectrum space, and entry is regulated through auctions or beauty contests. On the demand side, consumers are highly heterogeneous in terms of willingness to pay and modes of service usage, and switching costs are significant and limit the mobility of consumers across operators.

All the above mentioned features have been analysed by recent theoretical and empirical studies in the industrial organization literature. On the supply side, the literature on competition among networks and on network-based discrimination is of obvious relevance (Laffont et al., 1998; Gans and King, 2001; Berger, 2002). For the specific case of mobile phone industry, network coverage has been considered as a parameter of vertical differentiation by Valletti (1999). The limited number of firms and the key role of tariffs have led to empirical studies on tacit collusion in this industry, with a focus on the effects of multimarket contacts and entry (Valletti and Cave, 1998; Parker and Roller, 1997). On the demand side, the recent literature on price discrimination in oligopolistic industries (Stole, 1995) and the much larger

literature on switching costs (for a review see Farrell and Klemperer, 2002) naturally fit the sector.

Notwithstanding the growing interest in the topic, all these contributions focus on the more "static", purely strategic aspects of mobile service competition. Innovation, in its more general sense, is usually not considered. Some studies analyse the evolution of the sector and the changing role of different actors following the introduction of subsequent standards (Gruber and Verboven, 2001; Dalum and Pedersen, 2003; Gans et al., 2003), but do not examine in detail the role of service innovation in affecting competition among firms in the mobile communications industry. Even the appreciative literature on innovation in services (Miles, 1994; Howells, 2000; Metcalfe and Miles, 2000) has not discussed this sector in an extensive way.

This paper aims at analyzing the characteristics and the determinants of innovation in the mobile communication services industry and, in doing so, it puts particular attention on the role of demand. In a Schumpeterian spirit, we argue that competition in this sector crucially depends upon innovation, and that, given the specific characteristics of the industry, firms' innovative strategies are strongly affected by demand. Our contribution is both at the theoretical and at the empirical level. At the theoretical level, our main point is that in a context of uncertainty, demand affects firms' innovative strategies in two ways: first, by providing information on users' behaviour and increasing the capability of market segmentation; second, by providing incentives to innovate, which are related to market saturation. The empirical evidence available for Italy confirms the heterogeneity of innovative strategies of firms in this sector and supports our theoretical speculations on the role of demand upon innovation.

The analysis will proceed as follows. Section 2 provides a brief review of the theoretical contributions on demand and innovation, which are of interest for the present study. Section 3 and Section 4 constitute the core of our theoretical framework. The first illustrates our conceptualisation of innovation in the sector and

discusses its properties. In the second, we discuss the nature and the determinants of innovative strategies in terms of firm characteristics and stages of the industry life cycle, and we derive some implications for industrial dynamics. Section 5 briefly presents the evolution of the sector in Italy, which is the focus of our empirical analysis and provides empirical support to our theoretical hypotheses, by discussing descriptive statistics from an original dataset of all the tariff plans provided over time in the Italian market up to 2005. Section 6 concludes.

2. Literature review: demand and innovation in services

The aim of this section is to briefly review some of the existing contributions on the relationship between demand and innovation, in order to emphasise the importance of two factors that drive the innovative strategies of firms. On the one hand, demand represents a valuable source of information: by providing knowledge on their needs, users show firms the direction of their research activity. On the other hand, demand constitutes an incentive to innovate: in this respect, it is the size of the market that matters, as it determines the absolute need for a device. In light of our discussion of the role of demand on innovation in mobile communication, we will need to adapt the received arguments to our purposes. In particular, we will emphasise the passive role of consumers (i.e. consumers' behaviour as an object of observation) more than the interaction between users and producers, and we will add a role for uncertainty and cannibalisation in investigating the issue of incentives to innovation.

In elaborating the concept of demand as a source of information, some studies (Myers and Marquis, 1969, von Hippel, 1982, Lundvall, 1992, Rogers, 1995) start from the consideration that consumers are not always fully aware of the properties and uses of the new goods. In these conditions, their information is limited, and the process of choice is subject to a great uncertainty, which creates a barrier to the adoption of new goods and services. Such uncertainty is higher for radical innovations, than for incremental innovations. The barrier to the adoption of a new good can be overcome either by increasing consumer's knowledge or by redesigning the good so as to reduce the barrier. In whatever way knowledge is acquired,

demand formation takes places gradually and requires learning. The faster is the rate of qualitative change, the more new learning will have to take place as innovations emerge. The greater the novelty of a product, the less the potential consumer will be able to estimate how useful this new product will be. However, as users/consumers start using it, they will begin to learn the properties of the new product and how it can serve their purposes (Arrow, 1962).

From firms' perspective, successful innovations must be based on knowledge about the needs of potential users (Freeman, 1982), since once an innovation has been developed and introduced, it diffuses only if information about its value is transmitted to the potential users. In the literature, the role of interaction among users and producers has been extensively analysed by Lundvall (1992), who described the economy as a whole as a network of agents and organizations where the learning process takes places during the interactions. The learning process typically occurs in the interaction among different actors and the inventive activity takes place during the interactions among firms and users. In this context the innovating firms as well as the potential users operate under extreme uncertainty. Producers have no information about potential user needs and users have no knowledge about the use-value characteristics of new products. The uncertainty involved in this kind of transaction is considerable. Not only is the user buying a product with unknown characteristics, he is also buying the cooperation of a firm for a future period. This implies that trustworthiness becomes an important factor for competition.

The exchange of information between users and producers also involves uncertainty and room for cheating and disloyal behaviour. The user must disclose her/his needs to the producer in order to get workable solutions. The producer has an interest in disclosing the full capacity of his product and in giving the user insights into his technical competence as a potential co-operator. The producer will have a strong incentive to monitor what is going on in the market. The user, on the other hand, needs information about new products, in particular about how new characteristics

relate to her/his specific needs. When new users' needs develop, the user might be compelled to involve a producer in the analysis and solution of the problem. This can only be done successfully if the user has a detailed knowledge about the competence and reliability of different producers. The cooperation is not a single act but takes place at different stages of the process (Rothwell, 1986).

Eric von Hippel (1982 and 1986) introduced the concept of "lead users", *i.e.* users familiar with conditions that the rest of the demand will face in the future: "*consumers whose present strong needs will become general in a marketplace months or years in the future*" (von Hippel 1986, p.792). Since they expect to benefit more than others from the solution to a problem, lead users are both willing and able to interact with a firm, and, therefore, become an important source of innovation. Therefore, only those peculiar users, which are well aware of their own needs, are useful for producers. On the same line, Teubal (1979) suggested that the influence of demand upon innovation depends on "need determinateness, the extent to which preferences are specified (or need satisfaction is expressed) in terms of product classes, functions and features".

The role of demand in driving innovation is particularly emphasised in service sectors (Gallouj and Weinstein, 1997; Licht and Moch, 1999; Sundbo and Gallouj, 2000). This is because one of the most relevant characteristics of services is user's participation in the production phase, particularly for knowledge intensive services (Barras, 1990; Sundbo and Gallouj, 2000). The strong interaction between users and suppliers affects not only the production, but also and more remarkably the processes of services delivery and consumption.

A second mechanism through which demand affects innovation relates to the definition of incentives to innovate. In this respect, we can generally claim that as market grows, firms are more and more inclined to innovate. Schmookler (1962, 1966) found evidence that expected profits, and thus incentives, depend on market size. *Ceteris paribus,* a firm directs its efforts toward sectors with the largest market, which are the most profitable ones. Although relying upon some important

assumption, Schmookler's contributions gave rise to a large number of empirical studies analysing different sectors. From a theoretical point view, these studies root in those works that, since Nelson (1959) and Arrow (1962), have analysed incentives to innovate.

However, considering market size as an incentive to innovate is not enough, since the scale effect of growth, which is one of the side results of the new growth theories, has been empirically contradicted. Young (1998) addressed this problem by suggesting that an increase in market size might generate a greater variety of potential solutions. This increase in variety can raise the average level of consumers' utility, but it can also raise the equilibrium level of R&D without increasing the quality because resources are spread among a variety of solutions and, thus, can reduce scale effects on growth. In order to explain the persistent coexistence of many solutions, when each consumer buys only one of them, it is necessary to assume some degree of heterogeneity on the demand side, as for instance is the case of spatial competition models (Salop, 1979).

A composite demand structure is also the mechanism at work in Adner's models (Adner, 2002; Adner and Levinthal, 2001). A group of consumers may have its needs more than satisfied for some product characteristics and inadequately met for some others. This is the case when disruptive technologies can emerge. New technologies can introduce in the market a product design, which emphasises a different mix of characteristics that address the needs of a niche market (Christensen 1997, Adner, 2002, Adner and Levinthal, 2001). Also Windrum (2005) highlighted that users' with diverse preferences can drive innovation cycles in mature industries. Specifically, he showed that in some industries despite the late stage of the product life cycle, innovations could occur with the purpose of satisfying peculiar market niches[1].

[1] These studies root in the Lancaster approach where a good is conceived as a bundle of characteristics and consumers preferences are specified over the individual characteristic (Lancaster 1991).

In sum, Schmookler suggested that an increase in market size expands the pool of rents and creates more incentives to invention. Empirical evidence showed that it is true only for certain industries and, especially, for process innovation or incremental product innovation. The explanation relies on the fact that an increase in market size can call for a greater variety of solutions for the same problem and, therefore, it spreads profits and duplicates R&D efforts among heterogeneous submarkets. The extent of this effect depends on the degree of heterogeneity of consumers. Process or incremental product innovations are less influenced by consumers' heterogeneity, because they are likely to have a homogenous response from the market. The more heterogeneous the market is in terms of number of submarkets, the smaller the incentives to invention.

3. Measuring innovation in mobile communication services

The aim of this section is to operationalise the concept of innovation in our framework. We do this in stages. We initially introduce the notion of service, the notion of tariff plan and the notion of innovation as a new tariff plan, briefly illustrating its properties. Then, we discuss the nature of innovation in this sector based on the pattern of change in service characteristics.

3.1 Definition of innovation

In the spirit of Saviotti and Metcalfe (1984), we could think of any product as the combination of two sets of characteristics, technical characteristics and service characteristics, and by a pattern of mapping between the two. Technical characteristics describe the internal features of the technology, while service characteristics refer to the characteristics of the product as seen by the end user[2]. As acknowledged by the authors, innovation stems from different types of changes, e.g. introduction of a new technical or service characteristic, or change in the relative

[2] The authors mention also process characteristics, which refer to the methods of production, the technologies in use and the modes of organisation involved.

importance of existing characteristics, or even change in the combination of technical and service characteristics, and in the mapping between the two.

Since we are interested in understanding the nature of innovation in mobile communications services, our starting point is the seminal contribution of Gallouj and Weinstein (1997), who incorporate the specificities of services in the characteristics approach used by Saviotti and Metcalfe, and propose a conceptualisation of innovation in services. According to this view, a service can be defined as a set of process operations carried out by a service provider within a system on behalf of a customer, which aim at changing the characteristics of the system itself. Services include a set of technical and process characteristics, as well as a set of competences belonging both to the provider and to the user. In this framework, technical characteristics include tangible front office and back office technical characteristics, as well as intangible technical characteristics. The first two correspond to Saviotti and Metcalfe's technical characteristics and process characteristics, while the third ones refer to a system of codified and formalised competences ("routines")[3].

In mobile communications, services can be seen as sets of (tangible and intangible) technical and service characteristics. Services are voice calls, short message services, and multimedia services. Technical characteristics are, for example, standards for voice and data transmission, or software to write short text messages. Service characteristics refer to the main features of the service itself. In the case of voice services, for example, they are given by price components and the dimensions along which prices are made contingent, e.g. *geographical area* or *time zone*.

For the scope of the analysis, we focus on voice services, since for most of the history of the industry they have constituted by far the largest share of revenues[4]. We examine in particular changes in service characteristics and we consider innovation

[3] Examples of these characteristics are legal or financial expertise, consultants' methods, and standard contracts used by legal advisers.
[4] According to EITO (2003), the percentage of voice traffic over total traffic is around 91% in the GSM environment and around 85% in the UMTS environment.

as the provision of a new tariff plan. We do not take into account the determinants of innovation stemming from changes in technical characteristics, e.g. the definition of digital standards for mobile communications or the introduction of new software for value added services, nor do we consider the provision of non-voice services.
A tariff plan is defined as a list of service characteristics. In particular, we identified eleven service characteristics for voice services in mobile communications:

1) *pre-paid cards – subscriptions*: it indicates whether the tariff plan is designed for pre-paid cards or for subscriptions
2) *subscription fee*: it indicates whether the tariff plan includes a subscription fee
3) *price per unit / price per minute*: it indicates whether the price is calculated on the basis of units (e.g. one unit=30 seconds) or on the basis of actual minutes/seconds
4) *call connection fee*: it indicates whether the tariff plan includes a call connection fee
5) *time-based charges*: it indicates whether the tariff plan discriminates prices according to time (e.g. morning hours – evening hours)
6) *day-based charges*: it indicates whether the tariff plan discriminates prices according to days
7) *location-based charges*: it indicates whether the tariff plan discriminates prices according to the geographical location of the caller/receiver
8) *on-net vs. off-net charges*: it indicates whether the tariff plan discriminates prices between on-net and off-net calls
9) *rebate mechanism*: it indicates whether the tariff plan includes a rebate mechanism
10) *minutes for free/price related to total expenditure*: it indicates whether the tariff plan provides discounts on the basis of total monthly expenditure (e.g. 40% off on national calls if one spends more than 120 euro per two months)
11) *variable prices*: it indicates whether the tariff plan provides variable prices during the time span of the call (e.g. 30 cents for the first three minutes, 15 cents afterwards)

Formally, a tariff plan can be represented by a vector T_j (of dimension n=11) where the nth entry takes value 1 if the characteristic is present, 0 otherwise. For instance, the fourth entry of this vector (which is associated to the service characteristic *call connection fee*) takes value 1 if the call connection fee exists and 0 otherwise. [5] Except for characteristic 1, all the characteristics can be seen as categorical variables: for instance, if a tariff plan discriminates on the basis of time zones during the day, it can do so by defining time zones in different ways – e.g. distinguishing between night and day, or among morning, afternoon and evening. We call C_j the vector of categories identifying the service characteristics within a tariff plan. Innovation is defined as a new tariff plan. A tariff plan j is new if there is no previously introduced contract k such that T_j=T_k and C_j=C_k. It is important to underline that in the present framework we do not consider simple changes in prices for given characteristics and categories as innovations.

For the scope of this paper, two remarks are important. First, innovation (the introduction of a new tariff plan) cannot be reduced to the application of standard pricing techniques, such as textbook second-degree price discrimination. Demand in this sector is very heterogeneous: consumers vary greatly in terms of willingness to pay and modes of service usage, and consumption patterns and customer needs continuously evolve over time, due to economic but also social factors (e.g. fashion). Firms spend a considerable amount of resources when developing new tariff plans, to identify clusters of customers based upon life-styles and socio-demographic variables. In any case, firms can only imperfectly predict the success of a specific tariff plan. Things are made even more complex by the fact that firms in this sector are "multiproduct", i.e. they offer more than one tariff plan. Therefore, they need to take into account the effect of a new tariff plan on the demand for their existing tariff plans. As we will see, the risk of cannibalisation plays an important role in this environment. The existence of such *uncertainty* on the consumers' side implies that

[5] For characteristics 1 and 3 we assign value 1 if the tariff plan is designed for pre-paid cards and if the price is calculated on the basis of actual minutes/seconds.

analysing the introduction of new tariff plans through the lens of innovative studies can improve upon our knowledge of the phenomenon.

The second remark concerns the appropriability of innovation. The introduction of a new tariff plan is naturally characterized by a low degree of appropriability. Innovation cannot be patented, information about new tariff plans spreads very quickly in the market, and imitation of technical characteristics is easy. However, economic incentives to innovate are preserved because of the existence of *switching costs* for consumers, which create market power. Switching costs are both exogenous and endogenous (i.e. they emerge as a result of firms' strategy). *Exogenous* switching costs have been mainly associated to the lack of number portability, which has characterized the industry for a long period. If a customer has to change his phone number when he changes his mobile operator, he needs to communicate the new number to his habitual contacts and this creates a cost for him (or potential costs exist if he does not do so). *Endogenous* switching costs emerge because firms try to implement artificial network externalities. On-net tariffs are usually more convenient than off-net tariffs. This means that tariffs are designed so that calling a customer who uses the same operator as you do is cheaper than calling a customer of another firm. Therefore, switching costs emerge because people in the same social group have benefits in subscribing to the same operator. This means that switching costs exist, even with number portability. Customers usually communicate their habitual contacts that they changed operator, since this change affects the cost of calls.
In our framework, we will take exogenous switching costs as given, while we investigate firms' incentive to introduce network-based discrimination. Nonetheless, for our argument what is important is the existence of switching costs *per se*, because it guarantees some degree of market power to firms, making pure price competition less attractive and moving the nature of competition towards a model of Schumpeterian competition, i.e. competition based upon the development of different types of innovations.

3.2 Typologies of innovations in mobile communications services

The aim of this paragraph is to propose a classification of innovation in the mobile service industry. We will adapt the classification of innovation in services proposed by Gallouj and Weinstein, (1997) to distinguish new tariff plans according to their degree of novelty. As we will argue, different types of innovations are associated to different degrees of uncertainty.

Incremental, improvement and recombinative innovations

The conceptualisation of innovation in services helps identify several types of innovation, stemming from different mechanisms (Gallouj and Weinstein, 1997). Innovation may be the result of either intentional efforts, e.g. planned R&D activity, or unintentional processes, e.g. learning mechanisms. In particular, it is possible to distinguish six types of innovations: radical innovation, incremental innovation, improvement innovation, ad hoc innovation, recombinative innovation, formalisation innovation.

Radical innovations are given by the introduction of a totally new type of product (service). *Incremental innovations* involve the substitution of existing characteristics or the introduction of new ones. In this case, the structure of the system remains unchanged. This type of innovation may also generate the improvement of final characteristics, as well as the reduction in production costs. *Recombinative innovations* require the combination of different final and technical characteristics. They may also involve the creation of a new product by combining the characteristics of two or more existing products, or the creation of new products by splitting up an existing product separating various characteristics and turning certain elements into autonomous products. *Ad hoc innovations* are given by social, interactive constructions of a solution for particular problems posed by specific customers, and they often implies that firms and clients cooperate by sharing their knowledge and experience on the specific issue. *Improvement innovations* refer to the process of improving selected characteristics without changing the overall architecture of the system. Finally, *formalisation innovations* refer to the process of putting the service characteristics in "order", by specifying them and making them concretes.

In the mobile communications sector, four innovations stand out as particularly relevant: radical innovation, incremental innovation, recombinative innovation and improvement innovation. Radical innovations consist in the introduction of new types of services, such as SMS or MMS. We do not investigate the factors affecting the decision of firms to introduce such innovations, mainly because mobile operators are not the only responsible for the introduction of this kind of innovation. This leads us to consider three types of new tariff plans:

- ✓ a new tariff plan that introduces a new characteristic to discriminate among consumers (e.g. geographical location), which we define as *incremental innovation*;
- ✓ a new tariff plan that involves the recombination of two or more service characteristics from existing tariff plans, which we define as *recombinative innovation*;
- ✓ a new tariff plan that introduces a new category of an existing characteristic (e.g. a new time zone), which we define as *improvement innovation*.

Formally, we have an incremental or a recombinative innovation if $T_j \neq T_k$ for all the previously existing tariff plans k. In this case, an innovation is incremental if it is the first to introduce or to remove a characteristic, while it is recombinative otherwise. We have improvement innovation if instead $T_j = T_k$ while $C_j \neq C_k$. If $T_j = T_k$ and $C_j = C_k$, we are in a situation of "imitation" if tariff plans i and j are offered by different firms, while we have simple "re-naming" (possibly involving a variation in prices) if the two contracts are offered by the same firm.

4. Innovative strategies: the role of firms' capabilities and market characteristics

In the previous section we introduced the main concepts underlying our theoretical framework. Starting from this, in this section we analyse how demand affects firms' innovative strategies in the mobile communications sector. On the basis of our literature review, we investigate two main research questions:

i) How does demand affect the degree of innovativeness in terms of number of innovations?

ii) How does demand affect the characteristics of innovations in terms of the relative importance of incremental/recombinative/improvement innovations and type of service characteristics?

More specifically, we identify two observable variables associated to the concepts of demand as a source of information and demand as incentive to innovate: firms' installed base of customers and market saturation, i.e. percentage of users over total (relevant) population. Then, we formulate four propositions that relate the two variables to our research q questions. Such propositions must be intended not as hypotheses to be tested, but rather as guidance to explore the empirical evidence we provide in section 5.

4.1 Firm's installed base of customers as a source of information

As mentioned in section 2, the literature has widely investigated the importance of users as a source of information in contexts of demand uncertainty, which generates risks associated with the introduction of innovations. Such risks occur precisely because firms may have incorrect or incomplete information on demand characteristics. The risks firms face are therefore not exogenous, but depends on the available information. We argue that at least part of this information is associated to the **installed base of customers**. This positively affects the availability of information that can be acquired on users' needs and behaviours, which in turns determines the capability of segmenting the market by designing specific tariff plans. In relation to the mobile communications sector, however, our notion of users as a source of information departs from the conceptualisation of the literature on demand and innovation. In this industry, that there is not a strong interaction between users and service providers, but users constitute a "passive" source of information. In this spirit, it is reasonable to argue that firms with a large installed base are more likely to implement aggressive innovative strategies by exploiting the information collected on users. Having the opportunity of reaching a vast and heterogeneous population of

potential customers, these firms tend to provide many different tariff plans and differentiate prices, in order to extract the maximum possible surplus from different categories of customers. In particular, firms with many customers can observe the telephone traffic of their customers, and infer significant regularities in users' behaviour. For instance, when the Italian operator TIM introduced the Eurofamily plan, it did so by thoroughly analysing the level of network usage. It found out that the network was heavily used just during day time (8 hours) and concluded that there could have been potential users in the market, willing to call during evening hours, providing that they had more convenient tariffs. Furthermore, firms monitor users' behaviour and adopt "price plan review" systems, through which they suggest customers the most suitable tariff plan for them.

In the relationship between the installed base of consumers and innovation, there is, however, another aspect to be considered. According to the theoretical and empirical literature on demand and innovation (Von Hippel, 1982 and 1986; Rogers, 1995; Morrison et al., 2000; Haddon, 2002), it is in general possible to identify different categories of users in terms of socio-economic characteristics. We have previously underlined that the existence of heterogeneous customers might reduce the incentives to innovate, as some products/services might serve the needs of some users but not of others. If we consider the heterogeneity of users, we can classify new tariff plans into two main categories: *new tariff plans for new users* and *new tariff plans for existing users*. In the first case, a firm serves n classes of users (for a new entrant, n=0) and wants to capture an additional class, by providing a new tariff plan specifically designed for the new target. In the second case, a firm introduces a new tariff plan to discriminate among its existing users.

When firms introduce a new tariff plan, they always face a certain risk (probability) of *cannibalisation*, i.e. existing customers may change their tariff plan. However, it is important to distinguish between desirable or undesirable cannibalisation. If a firm introduces an innovation aimed at a new class of consumers, cannibalisation is always undesirable and causes a loss in the surplus extracted from consumers. When a firm introduces an innovation for an existing category of consumers, some

cannibalisation is surely desirable, since the shift of consumers from one tariff plan to the other is precisely the objective of the strategy of product differentiation, and the firm's surplus increases. However, also undesirable cannibalisation can occur, if some users shift to the new tariff plan even if it was not designed for them. The overall *cost* associated to the undesirable cannibalisation is given by

(number of users) (unit cost of cannibalisation)*

where the unit cost is defined in terms of loss in the extracted surplus per user with respect to the provision of optimally designed tariff plans.

The risk of undesirable cannibalisation is inversely proportional to the amount of information firms possess, i.e. to the number of users. However, there is an opposite effect related to the overall cost of cannibalisation, which is, on the contrary, increasing in the number of users. This leads to the following proposition.

Proposition 1: Ceteris paribus, firms with a large installed base of customers are more innovative than firms with a small installed base, if the risk of undesirable cannibalisation associated to a larger installed base is sufficiently low.

Besides conjectures on the degree of firms' innovativeness, we also propose an argument concerning the role of the installed base on providing different types of innovations. First, we notice that risks and costs of cannibalisation depend upon the type of innovation. In particular, uncertainty is stronger when firms develop incremental innovations, since they introduce a totally new service characteristic to discriminate among consumers. Recombinative innovations involve the risk of assembling different users' preferences (possibly with lower accuracy in segmenting the market), by combining characteristics originally pertaining to different tariff plans. In the case of improvement innovations, on the contrary, firms modify an existing characteristic and bear a smaller risk of failure.

However, it is reasonable to argue than the information available from the installed base can reduce in particular the risk associated to improve innovations, since firms can observe the behaviour of consumers adopting similar tariff plans.
Therefore, having more information – i.e. a larger installed base of users - stimulates firms to develop relatively more improvement innovations, i.e. we expect the fraction of improvement to be higher in large firms. Our argument can be summarised in the following proposition.

Proposition 2: Ceteris paribus, firms with a large installed base of customers to introduce relatively more improvement innovations as compared to firms with a small installed base.

Summing up, in this section we argued that firms' installed base of customers determines the capability of segmenting the market. When the installed base of users is relatively small, firms tend to provide a small number of tariff plans, in order to attract as many new customers as possible with simple and clear tariff plans, without worrying too much about market segmentation. For example, when the Italian operator Omnitel entered the market, it did so by offering a tariff plan which introduced per second fees (*Night and Day* in October 1995) and a tariff plan which eliminated the subscription fee for mobile communications services, therefore reducing consumers' fixed costs (*Libero* in June 1996). Similarly, when Wind entered the Italian market, it proposed a series of tariff plans that *eliminated the call connection fee* (*Dove*, *Quando*, *Ovunque* in March 1999*)* and explicitly included VAT in its tariffs. In Italy, these strategies accelerated the diffusion of mobile services in the consumer segment and this group of users became the largest market segment, outnumbering the traditional demand stemming from business users. An important consequence of this shift in the demand pattern from businesses to consumers was that the average revenue per user (ARPU) started decreasing over time[6]. On the contrary, when TIM faced competition from new entrants, it implemented an aggressive policy of market segmentation based upon the identification of six different clusters of their existing users. This resulted in the proliferation of the tariff plans and particularly in the

[6] According to OECD (2003), between 1994 and 2001 the ARPU of major European countries substantially decreased. In Italy, for example, the ARPU went from $886 in 1994 to 240 in 2001; in France from $875 to $238; in Germany from $1129 to $288; in UK from $488 to $256.

development of the *TIM menu*, the first example in Italy of "second-degree price discrimination". Through *TIM menu*, users have the opportunity of combining different variables to design their own tariff plan and implicitly signal that they belong to a specific category (Addis and Costabile, 2002).

4.2 Market saturation and the incentives to innovate

The second variable which needs to be taken into account when analysing the innovative strategies of mobile communications operators is the degree of **market saturation**. Market saturation affects innovative activities, as it provides the overall incentives to innovate. However, the literature has also underlined that as market grows, more categories of users appear in the market and firms risk wasting time and resources in research without profiting from innovations. We consider in particular two dimensions along which market saturation affects innovative activities. First, as market saturation increases, the ratio between existing and new users increases. If firms operate in the initial stages of diffusion of mobile services, i.e. with low market saturation, the number of potential new customers is high and firms face almost no risk of migration. Therefore, it is reasonable to argue that their innovative strategy is concentrated on the attraction of potential adopters. Under the reasonable assumption that firms grow over time along with market saturation, the number of potential new customers decreases, the risk of customers' migration and undesirable cannibalisation increases, and innovations in tariff plans are developed to strengthen existing customers' loyalty, more than to attract new customers. The case of TIM, the market leader in Italy, well illustrates this point. When the market was still immature, TIM developed tariff plans to attract new customers different from business users (i.e. the *Eurofamily* plan). As market saturation grew, the company started implementing a strategy of increasing price differentiation, following a "reverse marketing" approach. For example, with the introduction of *TIM Menu* in 1999, users were even able to choose the most suitable combination of characteristics and tariffs. In order to limit the risks associated with the provision of radically new tariff plans in contexts of high heterogeneity, as time goes by firms tend to modify some characteristics of their existing tariff plans after having

observed their own customers' behaviour, instead of introducing new characteristics. It is worth noticing that in contexts of market saturation, the development of improvement innovations is also stimulated by the fact that firms can improve not only around their tariff plans, but also around their rivals' ones. This argument is summarised in the following proposition.

Proposition 3: Ceteris paribus, we can expect a major focus on improvement innovation as market saturation increases.

Market saturation also affects the specific characteristics of new tariff plans. One the one hand, since the overall market size (in terms of total volume of calls) increases more than proportionally with market saturation, as market grows firms have more incentives to provide tariff plans that exploit the overall market size, regardless of firms' installed base of customers. In particular, firms may provide rebate tariff plans, whereby users receive bonuses for the calls they make or receive. On the other hand, with more users in the market, firms have the opportunity to exploit social groups of consumers (e.g. friends and families) instead of targeting single users. Tariff plans that discriminate between operators, proposing lower prices for calls within the same network as compared to calls among different operators prove to be particularly attractive in this context. In this case, if a member of the group switches to a particular operator, other members of the group have higher incentives to do same. Our argument can be summarised in the following proposition.

Proposition 4: Ceteris paribus, we expect firms to offer tariff plans characterized by rebate mechanisms and network-based discrimination, as market saturation grows

5. Innovative strategies in the Italian market: empirical evidence

In this section, we propose empirical evidence on innovative strategies in the market for mobile communications services in Italy. In order to do that, we built an original dataset that consider all tariff plans that have been offered by Italian operators between October 1992 and October 2005. Italy represents an interesting case study for

several reasons. First, Italy is one of the most developed markets for mobile communications. Mobile penetration in Italy rose from 93% in 2003 to 104% in 2004. According to the latest figures from the International Telecommunication Union, Italy now records the highest mobile penetration rate in Europe, with 109.42 phones per 100 inhabitants. The figures reveal that, globally, only Hong Kong has a higher penetration rate than Italy - 114.5% - but Italy is ahead in absolute terms, with as many as 62.7 million mobile users. In terms of mobile revenues, Italy is the fourth among OECD countries, after United States, Japan and Germany.
Second, among the main determinants of this performance is the originality and success of innovative strategies of incumbent and new entrant firms. In this context, firms' innovative activity has been characterised not only by technological innovations, such as the extension and technological upgrading of the network, but also, and more prominently, by the creation of new markets through service innovations, even in absence of a technological breakthrough. Strategies of market segmentation and firms' strong commitment to customers are important features of the competitive arena. This is because the increasing degree of competition and the continuous development of new tariff schemes and new services have undermined first mover advantages in the maintenance of a large customer base. It is reasonable to argue that the progressive market openness has stimulated the creativity of market leaders, instead of perpetuating a myopic attitude. This is witnessed by the sequence of innovations developed by TIM and Vodafone-Omnitel in response to the entry of new operators, which have allowed them to preserve their market power.

The history of mobile communications in Italy started in 1973 with the introduction of the first radio-communication service (*Radio Telefono Mobile Integrato* – RTMI) on a 160 MHz frequency band, which was used by a few people working in the public sector (public administrations or defence). In the 1980s, the Radio Telephone Mobile (RTM) emerged, which operated on a 450 MHz frequency band and attracted 100.000 customers. In April 1990, Total Access Communication System (TACS) services were introduced during the Football World Championships in Italy: at that time, users could already benefit from small and relatively cheap handsets. As a consequence, the number of users rose to 266.000 and new services emerged in the market such as

answering machines and call diversion systems. Until 1994, TIM (the former SIP – Radio-Communications Business Unit) was the only operator in the market. The process of deregulation and market liberalisation drove the entrance of another firm in the industry – Omnitel Pronto Italia (now Vodafone Omnitel). In terms of technological evolution, the entry of this firm corresponded to the development of GSM standard and related services. The launch of GSM services dramatically reduced the subscriptions to TACS (E-TACS) services of TIM, from 95.9% of total subscriptions in 1995 to 22% in 1998. The market growth of mobile communications services was impressive: right after the introduction of GSM, the number of users grew at a rate of 75%. Vodafone Omnitel soon became a serious competitor of TIM: in less than a year, its market share rose from 18% to 47%.

The grant of two more GSM licences to Wind and Blu (in 1997 and 2000 respectively) further boosted the growth in the number of users: in 2001, the leader was TIM with 47% of SIM cards, followed by Omnitel (34%), Wind (15%) and Blu (4%). Following the emergence of new technological opportunities related to the provision of UMTS services, a new firm has recently entered the Italian market, H3G, who obtained the UMTS license in 2002 and started competing in the market with the existing operators, implementing an aggressive marketing strategy based upon a pervasive advertising campaign and the supply of interesting offerings. Blu exited the market in 2002 and its customers were shared among TIM, Vodafone-Omnitel and Wind. At present, together with the demand saturation and the maturity of the products, which tend to make the business less profitable, two other factors are threatening firms' profitability and market positioning: the technological convergence between mobile communications and the Internet, and the progressive commoditisation of the product. The existence of multi-sim customers (users who own more than one SIM card) and the number portability could in principle determine a high turbulence in the market shares and the possible entry of new operators.

Our dataset consists of 280 tariff plans provided by four operators over 13 years. As underlined before, each contract is defined as a set of 11 characteristics and is a binomial vector, where 1 indicates the existence of a specific characteristic. We have

108 different types of tariff plans (i.e. 108 different vectors T) and 172 replications. We will analyze our data along the following dimensions: number of tariff plans over time; types of innovations offered, with a focus on heterogeneity across time and firms; types of tariff plans offered, again with a focus on heterogeneity across time and firms. As we said, firms entered the market in different periods, so that, over time, we distinguish among four time spans: monopoly (1992-1995), duopoly (1995-1998), three-firm market (1999-2002), four-firm market (2003-2005)[7]. In exploring the data, the four propositions developed in the previous section will be our guidance, but we will also comment upon other interesting aspects that emerge from the analysis.

Figure 1 reports the total number of tariff plans introduced in the market over time by firm, while figure 2 illustrates the cumulative number of tariff plans over time.

[Figure 1 about here]

[Figure 2 about here]

Between 1992 and 2005, the number of new tariff plans per year has increased, with a peak in 1999 in relation to the introduction of *Tim Menu* by Tim, a set of different tariff plans which allowed users to choose the favourite combination of different characteristics. The introduction of Tim Menu followed the entry of Wind in the market and represented a great effort by Tim to develop improvement innovations. In absolute terms, Tim and Vodafone are leaders in terms of service offering, by providing over time 156 and 71 tariff plans respectively, while Wind has provided 34 tariff plans and H3G has offered 19 tariff plans in the market. Tim has been the most active firm over time also in relative terms, introducing on average 12 tariff plans per year. Vodafone developed 7.1 tariff plans per year, while Wind introduced 5.6 tariff plans and H3G designed 6.3 tariff plans.

[7] We omit Blue from the analysis, since was in the market for two years, without reaching a significant market share.

We can now turn to examine the innovative strategies of different operators, focusing on tariff plans which are new to the market according to the mix of characteristics. There are two remarks we can make in this respect. According to our definition of innovation, 232 out of 280 tariff plans are innovative and this means that, when introducing a new tariff plan, firms do not imitate very much their competitors, but adopt strategies of service differentiation. This is in line with our theoretical assumption that in a context of demand heterogeneity, uncertainty and high switching costs, price competition is not very attractive. When firm propose new tariff plans, they often introduce (possibly small) variations to the existing tariff plans. Therefore the innovative process at the industry level can be seen as process of "collective" learning, where firms continuously search for optimally designed tariff plans in a context of high demand uncertainty. Related to this, consider the following exercise. Suppose to partition the set of tariff plans along T (i.e., according the presence or absence of certain service characteristics) and compute for each category the Herfindhal index measuring the concentration of that type of tariff plan among firms. The average value of these indexes over categories of tariff plans is 0.839. This means that the diversification of firms across tariff plans is extremely high, or in other words, a high degree of variety and differentiation within the market exists. Furthermore, we observe that firms offer tariff plans in relatively small subset of feasible categories (63 for TIM; 31 for Vodafone; 22 for Wind; 11 for H3G) and subsets of different firms typically do not overlap. Indeed in 63 out of 93 categories (68%) there is just one firm which provides tariff plans

Table 1 shows the number of tariff plans by firm, distinguishing among radical, incremental, recombinative and improvement innovations, and highlighting tariff plans that are imitation of competitors' tariff plans or that are simple renaming of existing tariff plans.

[Table 1 about here]

Tim is the most innovative firm, as it provided 148 new tariff plans over time, followed by Vodafone (52), Wind (20) and H3G (17). Even if we consider the average

number of innovative tariff plans per year, Tim is still leader, with 11.3 innovations, followed by H3G, with 5.7 innovations, Vodafone, with 5.2 innovations and Wind with 3.3 innovations. This evidence can be interpreted in light of Proposition 1. Considering the three leading firms (Tim, Vodafone and Wind), we find a positive effect of size on the degree of innovativeness. This implies that the lower risk associated to a larger installed base more than compensate the higher cost of cannibalisation. Tim is the market leader and over time has developed a very large number of innovations, exploiting the information on users' preferences and behaviour. Wind, at the opposite, has a small installed base of customers and has been much less innovative.

We have previously discussed also the role of firm size in determining the type of innovation. In particular, having relatively more information allows firms to be particularly innovative around their existing contracts, i.e. to develop improvement innovations. The empirical evidence shows that improvement innovations constitute 63% of Tim's total innovations and 58% of Vodafone's total innovations, while this percentage is lower for Wind (40%). For the three leading firms, this result is in line with Proposition 2: larger firms introduce relatively more improvement innovation.

The situation of H3G is peculiar, both in terms of innovativeness (with 5.7 innovations per year) and in terms of type of innovations offered (64% of H3G's innovations are improvement innovations). This result is related to H3G being a late comer in this industry. First, according to Proposition 3, firms tend to provide more improvement innovations as market grows. This effect seems to be stronger than the firm-specific effect for H3G. As shown in Table 2 below, incremental and recombinative innovations are particularly frequent in the initial stages of the market, when firms compete for new users, while improvement innovations become more relevant in contexts of market saturation, when firms have the opportunity of improving around their own innovations and their rivals' ones. The late entry in the market forced H3G to rely upon improvement innovations, as a way of subtracting users from the competitors and this explains the high share of improvement innovations of the late comer. Second, in a mature market, the level of uncertainty is

lower, especially if a firm wants to innovate around existing contracts (improvement innovation). These two factors, jointly considered, may explain H3G specificities.

[Table 2 about here]

Looking at the empirical evidence summarized in Table 2, we observe that incremental innovations occurred in the first phases of industry evolution (50% before 1997, 100% before 2001), when firms introduced new characteristics mainly to capture new users. Over time, as we underlined in our theoretical framework, the relative number of improvement innovations increases, as firms concentrate more on their existing users and design innovations on the basis of their information. In particular, we observe that most recombinative and improvement innovations were developed in 1999 by Tim and Vodafone, in response to Wind's entry in the market. This provides evidence for our Proposition 3, according to which, as market grows, firms tend to provide more improvement innovations. As we previously said, although mobile operators in principle respond not only to demand patterns, but also to competitors' strategies, pure imitation in this market seems to be a negligible phenomenon. Firms look at their competitors' offerings when taking their decisions in terms of service provision, but often improve existing characteristics in order to provide innovative tariff plans.

A final issue for our analysis is the examination of the types of tariff plans offered over time in the market by different firms. Table 3 illustrates the pattern of evolution in service characteristics for all firms over time.

[Table 3 about here]

The empirical evidence shows some interesting features in terms of types of contracts. In particular, we observe a clear trend of the characteristics of new contracts, a trend which characterises the entire industry, with a relatively minor role for firm-specific effect. The results are in line with Proposition 4. First, there is a pattern towards the increasing provision of contracts which offer rebate mechanisms. These mechanisms are particularly profitable for firms (and appealing for users), if users have a potentially high number of people to call, i.e. when the overall market is large. These contracts started emerging with three firms, when the market was growing, and more and more users were using mobile services. The percentage of rebate type of contracts over total went from 7.14% in the period 1999-2000 to 44.44% in the period 2003-2005. This is in line with our theoretical argument on the importance of market saturation for the proliferation of contracts that exploit the overall market size.

Second, there is a clear evolution over time in favour of contracts, which exploit the existence of local network externalities. In particular, the empirical analysis shows an increase over time in the number of tariff plans that advantage users with the same mobile operator. In other words, over time we observe firms introducing new contracts with on-net charges much lower than off-net charges. The percentage of new contracts of this type went from 10.71% in the period 1997-1998 to 48.15% in the period 2003-2005, with a peak in 1999-2000, when 73.81% of new contracts had this characteristic. This trend supports our hypothesis that, with growing market saturation, firms have the opportunity to exploit networks of users instead of individual consumers. This means that, with more users in the market, firms have more incentives in designing tariff plans that exploit network effects at the "local" level (i.e. *friends and family* types of contracts).

It is worth noting that the rising importance of these characteristics has been accompanied by a stark reduction in the number of new contracts which discriminate with respect to time, days and location, in favour of "flat" tariffs. This is the result of increased competition in the market, with Vodafone and Wind following a more aggressive strategy in terms of price competition, as soon as they enter the market. A low market power limits firms' capability to discriminate across consumers with

heterogeneous preferences and stimulates the provision of simple contracts, which do not discriminate very much along various users' characteristics. It is interesting to combine this last piece of evidence with our previous remark about the great variety of contracts across firms. Jointly consider, we can argue that the stage of industry evolution is the most significant factor affecting the relative profitability of various types of contracts (such as flat tariffs or rebate mechanisms). At the same time, different firms offer different "variants" of such contracts in search of the optimally designed tariff plans, possibly aimed at specific market niches.

6. Conclusions

The present work represents both a theoretical and an empirical contribution within the literature on the role of demand in affecting innovative strategies and competition in sectors characterized by high uncertainty and heterogeneity of users. In particular, it emphasises innovation (here defined as a new tariff plan) as the key element of firms' strategies in the mobile communications sector and argues that firms' innovative strategies depend upon demand conceived as a source of information and as a source of incentives.

In this framework, demand affects firms' choices in two ways. First, the ability of designing different tariff plans is related to the degree of *information* firms have on users' needs and behaviour. Firms with a relatively larger installed base of users are more able to segment the market than firms with few customers. Therefore they possess a comparative advantage in terms of opportunity to innovate. Second, the incentives to introduce innovations depend upon the level of *market saturation*. The literature has underlined that the number of users in the market for a specific product/service determines the incentives for firms to innovate. However, as different categories of users appear in the market, the positive effect of demand size on innovation is reduced. Firms need to avoid the risks associated to demand heterogeneity by introducing improvement innovations and exploiting the overall size of the market and the existence of local network externalities.

From an empirical point of view, we use our conceptual framework to analyze innovation in the mobile communications service industry in Italy. We observe that the empirical evidence is consistent with our theoretical propositions. In particular, large firms tend to develop more innovations and to "specialise" on improvement innovations. The latter effect however does not hold in contexts of market saturation, as the number of improvement innovations is less dependent upon firms' installed base and more upon the need of discriminating among existing users. Furthermore, as market grows, firms tend to develop improvement innovations with the aim of exploiting the overall market size and competing for groups of consumers (due to the existence of local network effects). At a more general level, competition in this industry cannot be seen the equilibrium outcome of pricing strategies in an environment characterized by "weak uncertainty" and homogeneous customers. It rather seems that in this sector, as in many other industries and consistent with a Schumpeterian view, competition must be more properly seen a dynamic process in strongly uncertain world, where firms compete offering new contracts (i.e. new services) aimed at better meeting consumer needs, which are extremely heterogeneous.

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FIGURES AND TABLES

Figure 1 Number of tariff plans introduced per year by firm

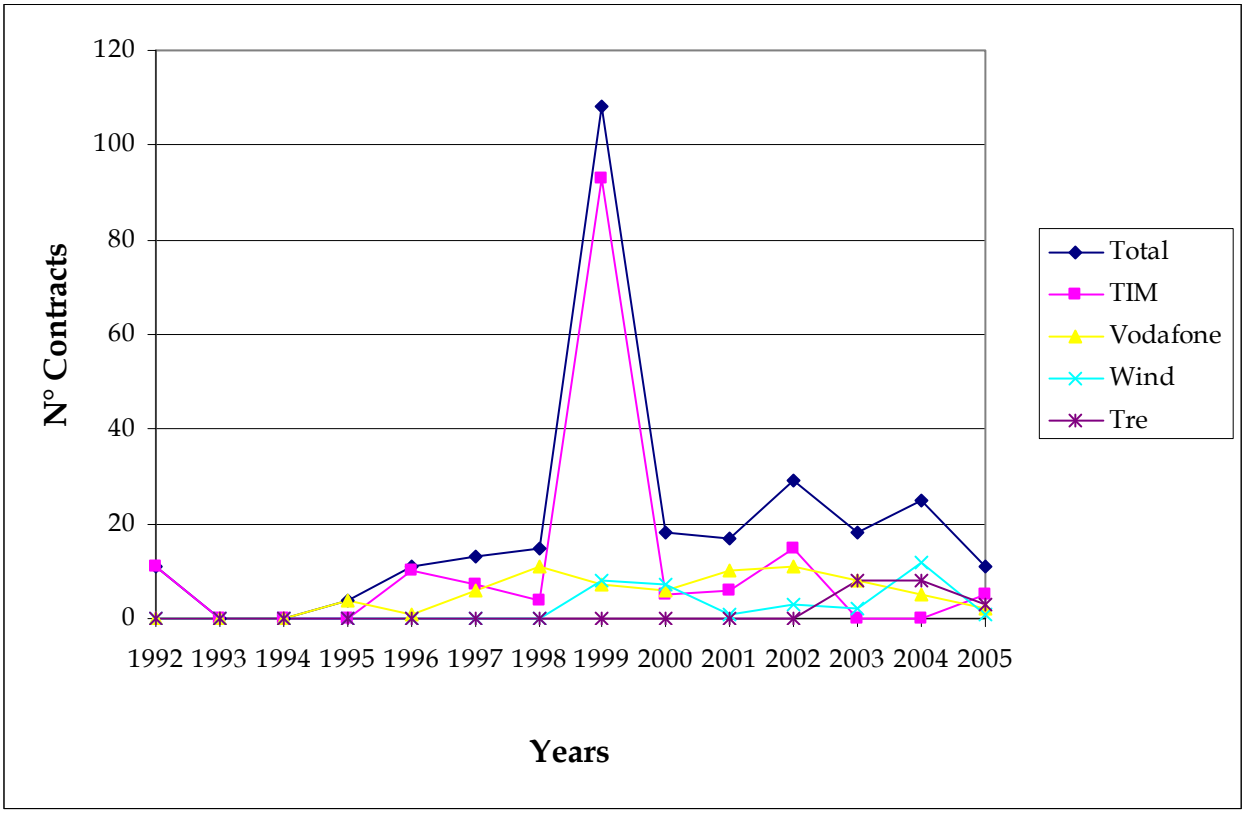

Figure 2 Cumulative number of tariff plans over time

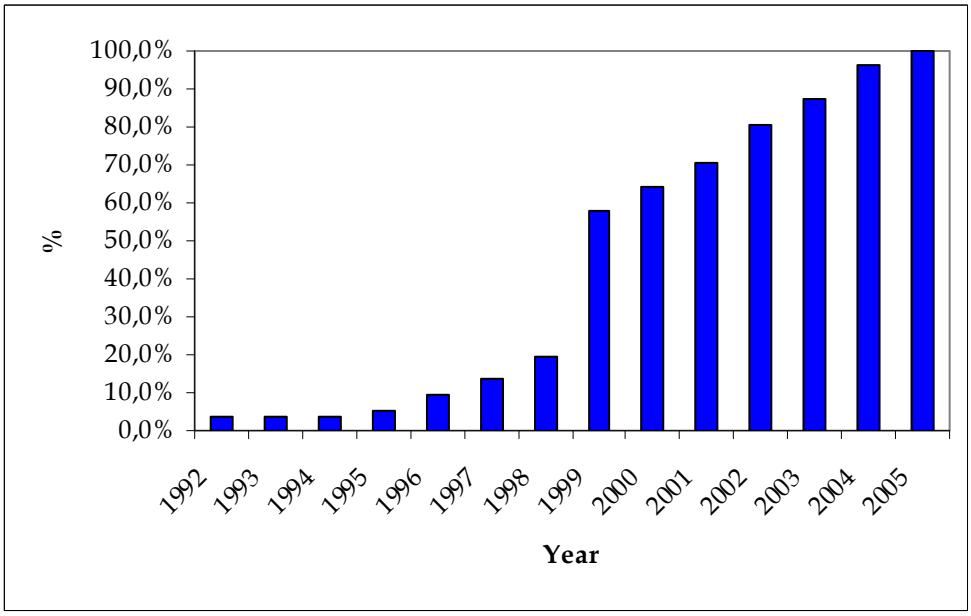

Table 1 – Innovations and imitations by firm

	Incremental	*Recombinative*	*Improvement*	*Total innovations*	*Imitation*	*Renaming*	*Total tariff plans*
Tim	4	49	90	**143**	5	3	**156**
Vodafone	4	18	30	**52**	5	14	**71**
Wind	2	10	8	**20**	3	8	**34**
H3G	0	6	11	**17**	0	0	**19**
Total	10	83	139	**232**	13	25	**280**

Table 2 – Type of innovations over time

	Incremental	*Recombinative*	*Improvement*
1992	2	0	9
1993	0	0	0
1994	0	0	0
1995	1	0	2
1996	2	4	2
1997	0	3	9
1998	1	8	6
1999	3	37	65
2000	1	12	3
2001	0	5	7
2002	0	6	10
2003	0	4	9
2004	0	3	11
2005	0	1	6
TOTAL	**10**	**83**	**139**

Table 3 – Type of tariff plans over time

INDUSTRY EVOLUTION	*CHARACTERISTICS*							
	Time-based charges	**Day-based charges**	**Location-based charges**	**On-net vs. off-net charges**	**Rebate mechanism**	**Minutes for free and price related to total expenditure**	**Call length**	**Total**
ALL FIRMS								
Monopoly	100,00%	100,00%	0,00%	0,00%	0,00%	36,36%	0,00%	11
Duopoly '95-'96	80,00%	86,67%	6,67%	0,00%	0,00%	26,67%	0,00%	15
Duopoly '97-'98	46,43%	46,43%	14,29%	10,71%	0,00%	28,57%	0,00%	28
Three firms '99-2000	55,56%	40,48%	31,75%	73,81%	7,14%	24,60%	3,17%	126
Three firms '01-'02	6,52%	4,35%	0,00%	52,17%	45,65%	4,35%	2,17%	46
Four firms '03-'05	0,00%	0,00%	0,00%	48,15%	44,44%	18,52%	3,70%	54
TIM								
Monopoly	100,00%	100,00%	0,00%	0,00%	0,00%	36,36%	0,00%	11
Duopoly '95-'96	70,00%	80,00%	10,00%	0,00%	0,00%	40,00%	0,00%	10
Duopoly '97-'98	9,09%	9,09%	18,18%	9,09%	0,00%	54,55%	0,00%	11
Three firms '99-2000	62,24%	39,80%	38,78%	83,67%	6,12%	31,63%	0,00%	98
Three firms '01-'02	4,76%	0,00%	0,00%	52,38%	42,86%	0,00%	0,00%	21
Four firms '03-'05	0,00%	0,00%	0,00%	60,00%	40,00%	0,00%	0,00%	5
VODAFONE								
Duopoly '95-'96	60,00%	60,00%	0,00%	0,00%	0,00%	0,00%	0,00%	5
Duopoly '97-'98	75,00%	75,00%	12,50%	12,50%	0,00%	12,50%	0,00%	17
Three firms '99-2000	46,15%	30,77%	0,00%	23,08%	23,08%	0,00%	0,00%	13
Three firms '01-'02	9,52%	9,52%	0,00%	47,62%	42,86%	4,76%	0,00%	21
Four firms '03-'05	0,00%	0,00%	0,00%	33,33%	53,33%	0,00%	0,00%	15
WIND								
Three firms '99-2000	20,00%	53,33%	13,33%	53,33%	0,00%	0,00%	26,67%	15
Three firms '01-'02	0,00%	0,00%	0,00%	25,00%	50,00%	0,00%	25,00%	4
Four firms '03-'05	0,00%	0,00%	0,00%	53,33%	33,33%	6,67%	13,33%	15
H3G								
Four firms '03-'05	0,00%	0,00%	0,00%	52,63%	47,37%	47,37%	0	19