



## **Diffusion of mobile phones in Portugal: unexpected success?**

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### **Abstract**

This paper begins with a somewhat paradoxical situation: Portugal is one of the less innovative countries within the European Union by most innovation indicators but, simultaneously, it is a leading country in the diffusion of mobile phones. The remarkable evolution of the mobile telecommunications sector over the last 15 years turns the issue a little more intriguing. This paper addresses the diffusion of mobile phones in Portugal and focuses particularly on the take-off stage, which signalled a sudden change in the pattern of diffusion. The introduction of an innovation – pre-paid cards – explains most of the change in the diffusion curve occurred around 1996 and the subsequent increase in the penetration rate. Prior known research has not considered pre-paid cards an important determinant of mobile phone diffusion, but pre-paid services had an enormous impact on the rate of adoption of mobile phones in many countries and it is the major take-off determinant of mobile phone diffusion in Portugal. The time lag between the launching of this innovation in Portugal and its adoption by other EU countries explains why Portugal not just caught up with the EU average mobile phone penetration rate around 1996, but moved ahead of it from then on.

**Keywords:** Mobile phones, pre-paid cards, Portugal, diffusion curve, take-off.

**JEL classification:** O33

## Diffusion of mobile phones in Portugal: unexpected success?

### 1. Introduction

Most innovation reports and innovation indicators show that Portugal is one of the least innovative countries within the European Union (EU). A recent report states the following regarding innovation in Portugal: “From the analysis of the European Innovation Scoreboard (EIS) indicators, two main results emerge. First, a weak overall performance with regard to innovation, with most indicators falling below the EU-15 average. [...] Second, there are signs of recovery, but at a pace too slow to enable a fast catching-up” (European Commission, 2004). This is a *typical* conclusion when the EU countries innovativeness is compared and ranked according to a given set of criteria, which may be useful for political purposes (v.g., to help designing better innovation instruments at EU level), but such conclusions are based on average aggregated results and fail to capture important innovation success stories of major social and economic importance that do not fit in the general picture portrayed.

The diffusion of innovations seems to occur later in Portugal than in most other EU countries. Tellis et al. (2003) analyzed the time-to-take-off period<sup>1</sup> of 137 new products (consumer durables) in 16 European countries and came to the “clear conclusion” that Portugal is the country with the longest time-to-take-off period: “Time-to-takeoff differs dramatically between countries (e.g., 3.3 years for Denmark and 9.3 years for Portugal). On average, time-to-takeoff is almost half as long in Scandinavian countries (4 years) versus Mediterranean countries (7.4 years)” (p. 205). “These differences are based on such a large number of different products and time periods that the results are unlikely to be due to chance” (p. 199-0). Mobile phones were not included in their set of products but their findings may lead us to admit a similar pattern of diffusion for mobile phones. That is, one would hardly expect to see Portugal as a leading country in the diffusion of mobile technology, capable of launching “global innovations” (Stoneman, 1995) in such an innovative sector as the mobile telecommunications sector.

However, Portugal is a leading country in the use of mobile phones, with a penetration rate well above the EU (15) average. Rather intriguingly, Portugal does not behave that well in other information and communication technologies, such as fixed telephones, Internet accesses and

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<sup>1</sup> The time-to-take-off “is the duration of the introductory stage or the period from the introduction to the takeoff”; take-off “is the point of transition between the introduction and growth stage of a new product” (Tellis et al., 2003: 188-9).

number of household with computers.<sup>2</sup> Indeed, according to the ITU's Digital Access Index (DAI), which measures the overall ability of individuals in a country to access and use ICT's, Portugal is ranked last among all EU (15) countries (ITU, 2003). It is the good performance in the diffusion of mobile technology – one of the DAI's eight indicators – which is of interest to study in more detail here, particularly the factors that explain the take-off stage. The good performance of mobile phones may be a single case in the context of the communication technologies in Portugal but its success is a source of knowledge with important policy implications. The paper attempts to show that one particular innovation – pre-paid cards –, complemented with an advanced financial infrastructure and a social receptiveness for new technologies were the basic elements of success. The paper goes further and attempts to provide a rational explanation for the emergence of such innovation in Portugal.

## **2. Prior research on the diffusion of mobile telephony**

As with many other technologies, mobile communication technology has been around for quite a while before becoming widely disseminated. The last 10-15 years witnessed a remarkable evolution of mobile technology in all respects (including regulation, communication standards, handsets, network infrastructure, services offered), and mass adoption of mobile phones in almost every country where this technology has been introduced. Over this period, penetration rates of mobile phones raised above 90% in most European Union countries, far exceeding scholar's best expectations and predictions.<sup>3</sup> Mobile technology went through a myriad of technological innovations and handsets benefited from many new capabilities, better performance and smaller size which are transforming mobile phones into "the first truly personal computer" (Jarvenpaa and Lang, 2005: 7). Mobile phones became unquestionably useful and desirable objects, which appear to be above the cultural, social and economic differences amongst countries.

Despite the stack of research on the diffusion of innovations, the literature on the patterns of diffusion of mobile phones is still particularly scant (Jang et al., 2005: 143), and did not always produce consistent results. Prior research looked at the phenomenon under different perspectives and used

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<sup>2</sup> Penetration rates: main telephone lines 2003 (Portugal 40.3%; EU-15 53.7%), households with Internet at home 2003 (Portugal 22%; EU-15 41%), broadband lines in percentage of population 2004 (Portugal 6.4%; EU-15 7.6%) (Eurostat, 2005).

<sup>3</sup> For instance, Gruber and Verboven (2001) estimated a saturation point around 60 mobile phone subscribers per 100 inhabitants for the EU area; Frank (2000) forecasted a final penetration rate of 91.7% in 2009 for Finland; Botelho and Pinto (2004) predicted a saturation point for Portugal around 67.4% penetration rate. All of these predictions and estimations proved to be far from the truth.

multiple variables in different contexts, thus allowing us to understand better its complexity even if at the expense of less comparability. Previous studies on the diffusion of mobile phones covered several areas of research, including the following: modeling the diffusion process for a particular country (Botelho and Pinto, 2004; Frank, 2000; Pereira and Pernías-Cerrillo, 2005) or region (Frank, 2003); finding differences between countries in the diffusion process (Jang et al., 2005; Jarvenpaa and Lang, 2005; Massini, 2004; Sundqvist et al., 2005); examining the determinants of the diffusion process (Gruber and Verboven, 2001; Gruber, 2001; Hodge, 2005; Jang et al., 2005; Massini, 2004). Empirical analysis of specific stages of the diffusion process, in particular the take-off stage, has not received enough attention so far.

Authors have used several variables in their attempt to explain the diffusion process: handset price, tariffs, population density, income, analogue vs. digital technology, competition (number of licenses), entry time, culture, penetration rate of fixed network, among others.<sup>4</sup> And, from an econometric perspective, most of these variables seem to affect positively the rate of adoption of mobile phones, though to a different degree. The transition from analogue to digital technology (which permitted an increase in radio spectrum capacity) and the introduction of competition (number of licenses) appear to be important determinants of the diffusion process (Gruber and Verboven, 2001; Jang et al., 2005), but the impact of economic factors is not yet clear. Massini (2004) found that economic factors such as handset price, tariffs and consumption expenditures play an important role in the diffusion speed and saturation level. Hodge's (2005) results confirm the importance of tariffs (fixed vs. mobile) for lower-income people to have access to mobile phones. Sundqvist et al. (2005) found out that the country's wealth, measured by GDP, influences the country's early adoption – richer countries tend to adopt mobile technology first. However, in their analysis of the key factors influencing the diffusion rate for 29 OECD countries and Taiwan, Jang et al. (2005) conclude that GDP per capita have no significant effect on mobile phone diffusion. The purpose of this paper is not to analyse in detail the role of GDP per capita on mobile phone diffusion, but we believe that the latter conclusion also applies in the case of Portugal; while the penetration rate of mobile phones in Portugal is above EU (15) average as from 1997 (see below), the Portuguese GDP per capita is just about 70% of the EU (15) average GDP per capita<sup>5</sup>. With pre-paid cards, other groups of people (especially low-incomers) had access to mobile phones and this fact may explain the inconsistent results concerning the impact of economic factors.

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<sup>4</sup> See Table A1 in Annex.

<sup>5</sup> GDP per capita in PPS (Purchasing Power Standards). Source: Eurostat.

Unlike other research studies that examined the determinants of mobile phone diffusion without discriminating any particular stage, normally by comparing the phenomenon in different countries, here we focus on the take-off stage of mobile phone diffusion in Portugal. We attempt not only to identify the main determinants of this stage but also to explain why they have succeeded. By doing this, we are able to better understand why a country like Portugal was able to be among the most dynamic countries in the mobile telecommunications sector. Rogers (2003) believe that the need of critical mass – roughly, his term for take-off<sup>6</sup> – was not important in the case of mobile phones because mobile adopters are connected to the existing base of *all* telephone users, but, “[h]ad cellular telephones been designed so that each adopter could talk only with other cell phone users, a critical mass would have been important in the diffusion of this innovation” (Rogers, 2003: 350). Indeed, mobile phones are connected to all telephone users, including fixed telephone users, but mobile phones have features which are not present in fixed telephone sets – that is, they are not perfect substitutes. Mobility is one of such features (that is, mobile phones allow people to reach other people, not just a fixed telephone set). SMS (Short Message Service) was (is) another, widely used by mobile phone users who send millions of messages everyday. In Portugal, for instance, phone calls between mobile and fixed phones cost substantially more than phone calls between mobile phones from the same operator. If there was no need of critical mass, why is that mobile phone diffusion curves follow a normal s-shaped curve? These examples suggest that critical mass was important and pre-paid cards were important to reach critical mass.

### **3. Diffusion of mobile phones in Portugal**

Some research has been done on the diffusion of mobile phones in Portugal. Barros and Cadima (2000) analysed the impact of mobile technology on the incumbent fixed-link telephony service and found out a negative effect between the two; Botelho and Pinto (2004) modelled the diffusion process and found that a logistic function is adequate to describe its pattern and rate of adoption; Pereira and Pernías-Cerrillo (2005) used a “dynamic approach” to model the diffusion of cellular telephony in Portugal and found that it outperforms traditional static specifications; Gagnepain and Pereira (2005) modelled the effect of entry on cost structure and competition in the Portuguese mobile phone industry.

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<sup>6</sup> Which is inferred from the following passage: “...the amount of time required to reach critical mass for a new product in a nation (this variable is called ‘time-to-take-off’)” (Rogers, 2003: 351). Critical mass is “the point at which enough individuals in a system have adopted an innovation so that the innovation’s further rate of adoption becomes self-sustaining” (Rogers, 2003: 343).

One way of understanding the diffusion of mobile phone technology in Portugal is to compare it against that of the EU (15) average. Benchmarking EU average is a normal procedure when making international comparisons within the European Union area, which is important to compare and rank countries, identify best practices and design better EU policies. With respect to mobile phone technology, comparison against EU average data is also relevant taking into consideration the role of the European Union in promoting a European-wide technical standard in mobile and wireless communications, and in promoting competition in the mobile telecommunications sector. The EU, through its Special Mobile Group, specified the technical standards necessary for the development of a pan-European digital cellular mobile communication system, named GSM (Massini, 2004). The first generation of the common digital<sup>7</sup> mobile communication system – GSM 900 – was commercially launched in 1992 and adopted by most European Union countries in that year (including Portugal) and the following year (Table 1). The introduction of digital mobile telephony “meant a drastic increase in the efficiency of spectrum use and in service quality” (Koski and Kretschmer, 2005: 91). In relation to competition, the European Commission adopted several directives to remove restrictions and increase competition in the mobile sector; for instance, it ended monopoly situations in the mobile sector in 1996 by imposing the duopoly provision of GSM services in all Member States. These two areas of intervention – technological standards and competition – were very important for market liberalisation and the establishment of a common regulatory framework. The introduction of mobile technology varied substantially within EU area countries – Northern Europe countries were the pioneers in the first half of 1980s – but there were some common technological and competitive conditions at least from 1992 onwards.

**Table 1** Introduction of digital (2G) technology

1992	1993	1994	1995
Denmark, Finland, France, Germany, Portugal, Sweden, UK	Greece, Ireland, Italy, Luxembourg	Austria, Belgium, Netherlands	Spain

**Source:** Based on Koski and Kretschmer (2005: 91, Figure 1)

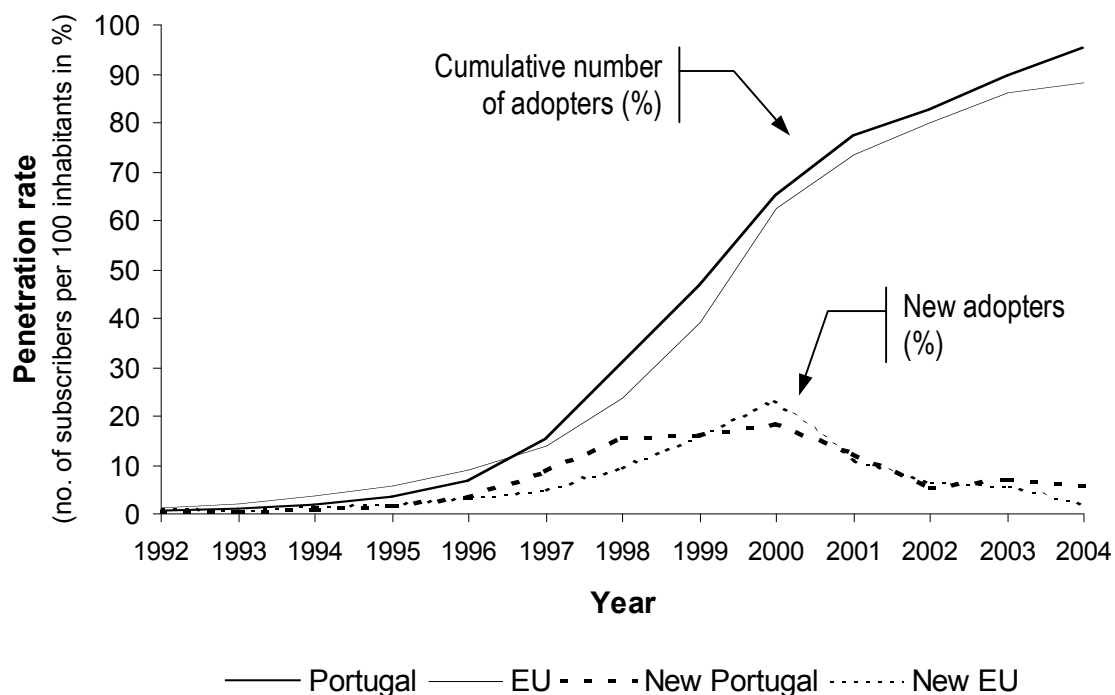
Mobile (analogue) technology was first introduced in Portugal in 1989. The diffusion process of mobile phones followed a normal S-shape diffusion curve and it took just about 15 years to reach a

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<sup>7</sup> Three generations of mobile phone systems can be distinguished: analogue technology (also known as 1G), digital technology (2G) and UMTS (3G).

penetration rate above one hundred percent.<sup>8</sup> Figure 1 compares the diffusion curves of mobile phones in Portugal and in the EU (15 countries) for the period 1992-2004. This period covers roughly the first and second generations of GSM digital technology in most countries, and comprises the most significant part of the diffusion process under analysis. Figure 1 clearly shows two distinct phases in the diffusion process: before and after the take-off stage. Penetration rate of early adopters was much smaller in Portugal than the EU average, but the situation has reversed after the take-off stage around 1996. Before the take-off stage, the diffusion trajectory of this innovation was consistent with the *usual* innovative performance of Portugal referred to in many EU reports, and with the findings in Tellis et. al (2003) – that is, performance below EU average – and it was also likely consistent with any forecast at the beginning of 1990s on the evolution of the diffusion curve of mobile phones. The change in the pattern of diffusion after that stage is interesting and deserves a detailed analysis of its causes.

**Figure 1** Diffusion of mobile phones in Portugal and in the EU (15) average – 1992-2004



Source: Table A-2 in Annex.

<sup>8</sup> It is difficult to accurately know in advance the number of potential adopters for mobile phones because mobile phone users may have more than one phone number or be subscribers to more than one mobile phone operator. "Penetration rate" – number of mobile phone subscribers divided by the number of people – is the ratio commonly used, but it may exceed one hundred percent. Indeed, in 2005 some countries already have penetration rates higher than 100%, including Portugal.



Take-off is the point of transition between the introduction and growth stages of a product and a sign of the mass adoption of that product (Tellis et al., 2003: 188-9). Normally, take-off occurs at about 10 to 20 percent adoption, when interpersonal networks become activated so that a critical mass of adopters begin using an innovation (Rogers, 2003: 12). According to Figure 1, the take-off stage of mobile phone diffusion in Portugal occurred around 1996, when the penetration rate was below 10 percent, while “[t]he benchmark for the take-off in most [OECD plus Taiwan] countries seems to have been around 1997” (Jang et al., 2005: 135). Indeed, the take-off stage of several EU countries seem to have occurred later than 1996, including Germany, France, Greece, UK, Spain and The Netherlands. Between 1996 and 1997, Portugal climbed from position 11 to position 6 in the penetration rate ranking (see Table A-2 in Annex). Northern Europe countries lead the ranking but these results for Portugal are not in line with the findings in Tellis et al. (2003), even having in mind that consumer durables are not the same as mobile phones.

Jang et al. (2005: 139-0) believe that technology maturation and economies of scale resulted in significant price falls, which, in turn, favoured those countries that introduced mobile technology late in the process in terms of shorter penetration periods and faster growth rates after successful penetration. This finding may be correct but it does not fully explain the sudden change in the pattern of diffusion of mobile phones in Portugal described in Figure 1 and the ultimate success of this innovation. Twelve out of fifteen EU countries introduced digital technology in 1992 or 1993, but Portugal appears to have benefited from a shorter time-to-take-off period or a higher rate of adoption, or both. We will see below that other factors besides the maturation of technology and economies of scale created conditions for a significant fall in prices.

#### **4. Take-off determinants**

Many factors may have influence on the diffusion process and they normally vary in intensity and scope from country to country. As mentioned above, authors have suggested a number of different variables to explain the diffusion process of mobile phones and many of them have attempted to estimate diffusion models for mobile telecommunications. Research directed at examining the take-off stage of mobile phone diffusion is particularly scarce, despite its likely importance for a better understanding of the factors that explain the success of this technology. In this section, we attempt to identify which major factors explain the take-off of mobile phone diffusion in Portugal.

The take-off of mobile phone diffusion in Portugal is due to a major innovation introduced in 1995 by

TMN, one of the two Portuguese mobile phone operators at the time:

“In September 1995 Telecom Portugal (TMN)<sup>9</sup> introduced the first mobile pre-paid card which could be recharged and made this feature readily accessible from automatic teller machines [ATM]. The impact of this service was immediately apparent with revenue from mobile services increasing 65% in 1996. In 1997, TMN's number of subscribers grew by 129%, compared to 1996, and Telecom Portugal attributed this success achieved to their pre-paid products. By the end of 1997, 63% of TMN's customers used pre-paid products. By June 1999, some 85% of TMN's customers were pre-paid. While Southern European countries were not the first countries to introduce pre-paid service, they were leaders in adapting the concept to card services” (OECD, 2000: 56).

At the 10<sup>th</sup> anniversary of launching the first pre-paid card, named MIMO, TMN says: “MIMO was the result of a deep strategic reflection focused on client. Highly innovative in its two new ideas, ‘ready to talk’ and ‘cost control’, the pre-paid card was a new wave, the decisive wave, of mobile telecommunications. It was the opportunity for mobile phones to become democratic and popular [...] This strategic turn operated by TMN (and followed by its competitor a year later) created the conditions for an explosive market rise whose effects can still be felt ten years later.”<sup>10</sup>

TMN's innovation had two fundamental new features that became standard in Portugal: pre-paid cards are rechargeable and can be easily recharged at any ATM in Portugal. Actually, there are no physical cards but only virtual cards, “accounts” or “electronic burses”. That is, each ready-to-use pre-paid kit contains a subsidized phone, a SIM card with a given amount of money for immediate use in communications, and a SIM card identification code (number). With this code, mobile phone subscribers can easily recharge their pre-paid cards (i.e., top up their accounts) by using a normal debit card at any ATM. This ready-to-use mobile phone concept and the rather *straightforward* process for topping up cards are the basis of mobile phone success in Portugal. The conjugation of a number of factors explain why this innovation emerged in Portugal in 1995, as we will see in the next section. Early pre-paid cards should be recharged with a minimum amount every 60 days, otherwise they would only work for incoming calls for another 60 days, period after which cards would stop working.<sup>11</sup>

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<sup>9</sup> Telecom Portugal was TMN's parent company.

<sup>10</sup> TMN, Press Release, September 6 2005 ([http://www.tmn.pt/empresa/press/2005/2005\\_06\\_setembro.shtml](http://www.tmn.pt/empresa/press/2005/2005_06_setembro.shtml)). Author's translation.

<sup>11</sup> These general conditions applied to most pre-paid cards when they were first introduced in Portugal. Later, there were many other schemes and conditions.

This innovation turned out to be one of the main reasons for the increase of mobile phone subscribers, not just in Portugal but in many other EU countries and almost every country where pre-paid cards have been introduced. In Portugal, TMN has reaped the benefits of being the pioneer: refreshed its image as a modern and innovative firm; regained market leadership (in terms of number of subscribers) that had lost to its rival Telecel (later Vodafone) in 1994, and kept it ever since, even after the entry into the market of a third mobile operator (Optimus) in 1998; and improved its financial situation. The introduction of pre-paid cards occurred at the end of 1995, just before the take-off stage and the beginning of a sharp increase in the rate of adoption<sup>12</sup> (see Figure 1 above). The success of pre-paid card service in Portugal is rather obvious when one compares pre-paid subscribers as a percentage of the total number of subscribers (Table 2). At the end of 1995 (less than four months after introducing pre-paid cards), 11% of the TMN's subscribers were already pre-paid, corresponding to 22% in the increase of net subscribers in that year.<sup>13</sup> In 1997, just two years after the introduction of pre-paid cards, pre-paid subscribers represented around 56,6% of all mobile subscribers in Portugal, and today, on average, they represent just below 80%. In 1998, TMN's new pre-paid subscribers increased at a faster rate (around 2% more) than the rate of increase of all its new subscribers (pre- and post-paid), meaning that there was a net transference of customers from post-paid subscribers to pre-paid subscribers.

**Table 2** Mobile pre-paid subscribers as a percentage of all subscribers – Portugal (%)

Operator	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
TMN <sup>a</sup>	11	30	63	81	83,6	84,1	83,6	83,6	84,0	83,4
Vodafone <sup>a</sup>	na	6	50	70	73	72	75	74	73	72
Optimus <sup>a</sup>	na	na	na	-	-	81,5	81,2	81,8	81,8	85,4
Total <sup>b</sup>	5,5	18,0	56,6	79,0	79,3	79,6	79,8	78,4	78,7	78,5

**Sources:** a) Data sent by operators and/or collected from the firms' web sites; b) Author's calculations (1995 to 1997), Table 3 (1998 to 2003), and Anacom (2004a). **Notes:** (na) not applicable; (-) data not available; Vodafone's data from 2000 onwards refer to March 31; Optimus started operations in 1998.

The success of this innovation in Portugal did not go unnoticed to mobile operators from other EU countries and from other countries around the world. On the contrary, the adoption of this innovation was even faster than that of mobile telephony itself and, today, it is difficult to find mobile operators from the EU and OECD countries that do not have their own mobile phone pre-paid card schemes.

<sup>12</sup> We are not suggesting that pre-paid cards are the sole responsible for all the change in the pattern of diffusion, but we are pretty confident that this innovation explains most of it. OECD shares this idea: "Yet none of the pricing innovations, introduced since 1995, have had anything like the impact of pre-paid cards" (OECD, 2000: 11).

<sup>13</sup> At the beginning of 1996 Pedro Pereira da Silva, the then TMN's Communications and Marketing Director, predicted that at the end of the millennium there would be about 800 000 mobile phone subscribers in Portugal (Silva, 1996). Indeed, in the year 2000, the number of subscribers was just above 6,6 million. One conclusion appears to be very clear: even TMN was not fully prepared for the success of pre-paid cards!

Indeed, pre-paid cards contributed a great deal to the diffusion of mobile phones in most countries around the world and in the EU countries in particular. Pre-paid subscribers comprise about 41% and 36% of all mobile telephony subscribers in OECD countries and in the world, respectively (OECD, 2005). There are abundant official and company reports stressing the importance of pre-paid cards on mobile phone diffusion. For instance, a report from the Italian Ministero del Tesouro states: "The Italian market is now the largest in Europe in terms of subscribers and value. After the introduction of pre-paid card services the mobile penetration rate showed a visible growth..." (Ministero del Tesouro, 2000: 22); in Norway, "[t]he introduction of prepaid subscriptions as well as subsidized handsets was two developments that were central to the widespread adoption of mobile telephony" (ITU, 2004: 28); the Swedish Trade Council (2001) made a comparative study on 30 markets and one of its conclusions is that pre-paid cards are the main reason for the rapid increase in mobile subscribers.

The importance of pre-paid cards, measured as a percentage of all subscribers, varies from country to country and according to different groups (e.g., students, executives, homeless). Table 3 shows that there are considerable differences among the EU (15) countries in relation to the weight of pre-paid subscribers in the total number of subscribers, but all the countries had pre-paid services in operation in 1999.<sup>14</sup> In 2003, pre-paid users comprised more than 60% of all mobile subscribers in more than half the EU (15) countries; Italy had the highest score (91,2%), Portugal the second highest (78,7%) and Finland the smallest percentage (2,0%). A OECD report explains such difference in the following way:

"In Europe the rapid expansion of mobile penetration rates owes more to the popularity of prepaid cards than any other factor. Prepaid cards were introduced in the southern Mediterranean countries from 1996 onwards and immediately fostered very high growth rates. In 1996, for example, Finland's mobile penetration rate was double Italy and Portugal's rate and more than four times the rate in Greece. By 2001, Italy and Portugal had exceeded Finland's penetration and Greece had almost reached parity. This was not because Finland's mobile market ceased to grow. Rather, it reflects that growth rates were much higher in countries where prepaid cards became popular." (OECD, 2003: 89)

**Table 3** Mobile cellular subscribers using pre-paid services as a percentage of all subscribers

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003
Austria					47,5	52,1	50,9	48,4	47,1

<sup>14</sup> In Table 3, one cannot assume that, for each country, the introduction of pre-paid services corresponds to the first year with data because some data may be missing as in the case of Portugal.

Belgium					40,0	60,0	67,0	65,5	62,3
Denmark					37,3	37,0	37,2	30,2	23,5
Finland					0,9	2,0	2,0	2,0	2,0
France					35,3	46,6	48,8	44,3	41,1
Germany				15,0	23,6	54,6	55,9	53,0	51,4
Greece				34,8	52,7	58,5	63,1	65,1	65,4
Ireland					40,0	62,7	71,0	71,8	73,4
Italy		9,0	47,0	74,0	84,0	88,2	89,6	89,9	91,2
Luxembourg					22,4	39,4	41,5	37,9	59,0
Netherlands				47,0	58,0	67,0	65,2	62,7	61,8
Portugal	5,5 *	18,0 *	56,6 *	79,0	79,3	79,6	79,8	78,4	78,7
Spain				37,0	60,0	64,0	65,0	63,0	58,4
Sweden			7,4	24,7	38,7	43,5	49,4	54,5	56,8
United Kingdom				22,4	50,4	68,4	69,1	67,6	67,9
OECD - Total	-	0,9	4,1	13,5	26,6	36,9	41,0	41,2	41,0

**Source:** OECD (2005: 110, extract from Table 4.9), except data marked with an (\*), which are author's own calculations.<sup>15</sup> **Note:** (-) data not available.

The introduction of pre-paid services has had an enormous competitive impact in many countries. According to Prichard and Powell (1998), “[i]n most countries where a GSM operator has launched a pre-paid service, competing operators have responded with a 'me-too' service, usually within a matter of months”. Not doing so, would cost firms the ability to capture a substantial market share in a time when most European mobile markets were around the take-off stage in the diffusion curve. The Swedish case illustrates the advantages of being fast at introducing this innovation:

“In the mobile telephony field, the prepaid card Comviq Kontant kept up its rapid pace of expansion. Comviq was one of the very first mobile telecom companies in Europe to invest aggressively in this technical solution, which was developed in Portugal. The Swedish market quickly welcomed the prepaid card. Actually, the other two Swedish GSM operators were the only ones who took their time before realizing this crying need among consumers. Comviq has retained its strong position as market leader in this segment” (Netcom, 1999: 2).

Why are pre-paid cards so successful worldwide? Pre-paid cards have a number of advantages<sup>16</sup> for both mobile phone subscribers and mobile phone operators that make them useful and popular. Subscribers do not have to pay a monthly fee and, thus, have greater control over their telephone costs – they pay only for the calls they make. In particular, pre-paid services gave parents an easy and effective means for controlling their children's mobile phone costs. Pre-paid cards enabled

<sup>15</sup> Calculations based on the operators' pre-paid subscriptions in percentage and market shares for the years 1995, 1996 and 1997.

<sup>16</sup> These advantages apply to Portugal; in other countries things may vary.

mobile service to be available for many potential users who would not otherwise have had a credit rating sufficient to qualify for a traditional pricing package (OECD, 2000: 58); that is, mobile telephony became an affordable service to otherwise excluded groups, such as schoolchildren, students, unemployed or homeless people. But, pre-paid services attracted also many users that were not comfortable with post-paid services, despite having sufficient credit rating. Pre-paid cards gave mobile operators a reliable and effective tool to transform the mobile phone into a democratic object, accessible to a much larger basis of users than executives, companies and high-income people. In Portugal and in other countries, mobile operators were fast at exploring these new opportunities by continuously launching new pre-paid products designed to target specific market segments (see Box 1). Some other advantages of pre-paid services are not less important to users: anonymity (access to mobile phones with pre-paid cards do not require the subscriber identification), simplicity (ready-to-use kits can be acquired in many different places), and the convenience of being able to recharge pre-paid cards (“accounts”) at any ATM, at any time (now it can be done on the Internet and by other means as well). The main disadvantage of pre-paid cards for customers is the so-called “SIM locking” – that is, pre-paid kits that include a subsidized handset normally bound the customer to a mobile operator for a given period of time. To “unlock” the telephone, mobile operators charge a fee.

**Box 1** TMN’s pre-paid products in 1996

“TMN offers the MIMO service whereby, in lieu of monthly payments, customers prepay for mobile telephone service and make additional prepayments through bank transfers to their MIMO account (including by using public automated teller machines (ATMs)). TMN also offers SPOT, a prepaid product similar to MIMO, which is marketed towards teenagers and young adults, and Gémeo, which allows customers to have two mobile telephones (one installed in a car and another that is portable) that share the same number. Another prepaid product offered by TMN is TACO, which allows customers to receive credits that may be converted into calls for each complete minute of calls received. TMN has introduced other services with respect to its pre-paid products, such voice-mail, on-line credit and invoices from ATM machines. Dueto, a product designed for two customers that call each other frequently, provides discounts on calls made between the two customers made between the two customers and on monthly fees. TMN’s prepaid and discount products have gained wide commercial acceptance and have been an important element in the growth of TMN’s mobile telephone services.” (Source: Extract from Portugal Telecom (1997: 16)).

Mobile phone operators get substantial benefits from pre-paid services as well, mainly because “there is no credit relationship or billing system required” (OECD, 2000: 58). Indeed, not only the risk of credit is non-existent or extremely small, because payment is made in advance (with the exception of roaming calls), but operators benefit also from a “financial deposit” when subscribers recharge

their cards.<sup>17</sup> Besides that, mobile operators obtain enormous financial economies because there is no need of a billing system and the mailing relationship with their customers is reduced to a minimum, since most subscribers are anonymous.<sup>18</sup> Pre-paid services also contributed for the increase of operators' benefits from economies of scale and scope, though the per capita amount spent by customers on mobile calls tended to decrease with the increase of customers from the groups identified above.

Pre-paid services have had an enormous impact on the rate of adoption of mobile phones and it is the major take-off determinant of mobile phone diffusion in Portugal. The success of pre-paid services in Portugal and the lag time between the launching of this innovation in Portugal and its adoption by other EU countries explains most of the change in the pattern of diffusion occurred in 1996, when the penetration rate of mobile phones in Portugal caught up with the EU average and moved ahead of it (see Figure 1 above). Next section attempts to show that Portugal had all the necessary conditions for the emergence and success of this innovation.

## **5. A favourable context for the emergence of this innovation**

One question stands out quite naturally at this point: Why did this innovation first occur in Portugal and not elsewhere? After all, the pre-paid card concept was not new at the time and Portugal is considered rather less innovative than most of the leading countries in the mobile telecommunications sector. Predicting where (and when) innovations will come out is a very difficult and, to a certain extent, useless exercise, but few would imagine that the concept of mobile pre-paid card would come out in Portugal. Most diffusion studies have different concerns and do not ask questions of this kind, but understanding the context in which this innovation occurred helps to explain this *unexpected* occurrence and the nature of the innovation process.

All known research studies on the diffusion of mobile telephony did not consider the introduction of pre-paid cards as an important determinant in the diffusion process, despite the fact that many company reports emphasize the importance of pre-paid services to the increase of the number of subscribers. Perhaps, this is because pre-paid cards were not seen by researchers as a tool that permits mobile operators to offer new products at different price rates (see Box 1), to reach new

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<sup>17</sup> The "financial deposit" issue has generated some controversy and required the involvement of the European Commission.

<sup>18</sup> In Portugal, mobile operators have to produce a detailed communications invoice on subscriber's request. For this, subscribers have to provide mailing details to mobile operators.

groups of clients and customize products to meet their needs, to reduce business risk and operational costs, to increase the number of clients and get economies of scale and scope. That is, pre-paid services affect directly several business variables (e.g., tariffs, handset prices, payment options, market competition) that prior studies found to be relevant in the diffusion process, but the link between the two has not been properly established. Like the introduction of digital technology was found to be an important determinant for the diffusion of mobile phones, so is the introduction of mobile pre-paid cards, because both have a positive effect on the supply side – the former increased de spectrum capacity and the type of services available (e.g., SMS service), and the latter gave mobile operators the opportunity to offer mobile services to a larger basis of potential customers and take advantage of the increased spectrum capacity permitted by digital technology.

Actually, the launching of mobile pre-paid cards involved two distinct but interlinked innovations:<sup>19</sup> one was the pre-paid card concept itself (ready-to-talk, lower price, no monthly fee, no contract, pre-payment, rechargeable, simplicity, anonymity); the other was the fully automatic technological process to recharge pre-paid cards at any ATM (Figure 2). This *package* of innovations must be considered together to better understand the launch timing and success of mobile pre-paid cards in Portugal. The latter innovation was not fundamental for the introduction and implementation of pre-paid services but contributed greatly for its success. Indeed, many other countries adopted the concept of pre-paid card but implemented other means than ATM networks for “topping up” cards. Even in Portugal, the ATM network was not an exclusive means to recharge pre-paid cards because it could also be done at the operator’s sales outlets. However, to be successful, the process of topping up cards needed to be simple, readily available and be “at hand” everywhere. In 1995, TMN’s sales outlets were neither sufficient in number nor its geographical coverage was adequate to meet all such requirements. The good geographical coverage of the Portuguese ATM network and the general use of debit cards for electronic payments by the Portuguese (see below) met the required conditions for topping up pre-paid cards. Furthermore, it was prepared to respond to the unexpected rise in the demand for these services noticed after 1996 with the sharp increase in the demand for mobile phones.<sup>20</sup> And, not less important, the system was operational all day long and every day. While the pre-paid card concept attracted potential users to buy a mobile phone, the recharging system guaranteed a smooth relationship between operator and the anonymous

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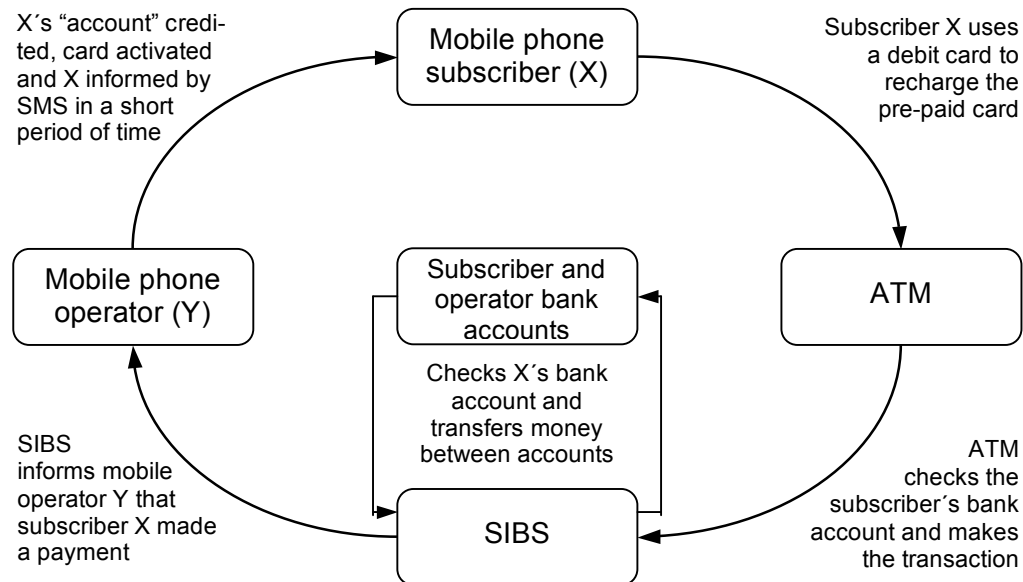
<sup>19</sup> There are other important innovations associated with the launching of pre-paid cards (e.g. internal organisation, marketing, image, sales outlets) which we are not going to analyse here.

<sup>20</sup> The first pre-paid card, Mimo, required the subscriber to recharge the card every two months, 6 times a year. Multiplying this by the number of subscribers, one can easily imagine the advantages of being able to recharge the card at any Multibanco ATM. And one should have in mind that even TMN was not prepared for the unexpected success of pre-paid services.



subscriber, even if not bound by a formal contract.

**Figure 2** Schematic representation of the pre-paid card recharging system



**Source:** Author's elaboration.

Multiple factors explain the emergence of pre-paid cards in 1995 in Portugal. Competitive factors are important because the incumbent TMN (originating from a monopoly situation) had lost the market leadership in 1994 for Telecel (now Vodafone) (that entered the market in 1992) and TMN was in search of new competitive strategies. TMN was having difficulty to strive in a competitive market, its image was bad and its financial situation serious, with mounting financial losses. In 1994, TMN was the sole provider of analogue mobile service in Portugal and had just about 40% of the GSM market, the dominant technology. TMN needed to respond to Telecel's "aggressive marketing strategy" (Portugal Telecom, 1996: 23) and chose innovation to do so. The launching of pre-paid services permitted TMN to reach unexplored market segments and regain market leadership, which caught competition completely by surprise because Telecel took about a year to launch a similar pre-paid service. This lag time permitted TMN to regain the market leadership, recover from its bad financial situation and pass on the image of a modern and innovative firm.

Another important factor was what may be called financial infrastructure. In 1995, Brisa (a Portuguese motorway concessionary) implemented its "Via Verde" traffic control system to the entire

motorway network in Portugal, system that was under development and testing since 1991.<sup>21</sup> Apparently with nothing in common, “Via Verde” and pre-paid cards rely on the same financial infrastructure, are contemporary and both are based on the principle of automatic payment process through electronic means. To ensure customer satisfaction and be successful, both systems need to be backed by an efficient, reliable and universal financial infrastructure, with no additional costs for customers. SIBS is the *cornerstone* of that infrastructure (Box 2). The success of “Via Verde” was a great source of ideas and technological solutions for the development of an automatic process of pre-paid card recharging.

**Box 2** Historical notes on SIBS (Sociedade Interbancária de Serviços, SA)

“In the beginning of the 80's, as a consequence of a favourable context, the Portuguese banking community creates an interbank cooperation model, which would become fundamental to respond to the challenges presented to the financial sector. The automation of routine banking transactions, through the creation of an interbank services network, universal and opened to all participants in this project, expressed in the right moment, what it would be in a long term vision, simultaneously innovative and pioneer. Guided by this purpose and by the mission of constant commitment to the innovation of electronic payment systems activity it was incorporated SIBS - Sociedade Interbancária de Serviços, SA, in 1983, as a result of the twelve founder shareholders' decision. The creation of a shared technical and operational structure allowed, from the beginning, the attainment of scale economies due to a more rational and effective use of financial, technical and human resources necessary to good pursuit of the project. Two decades after its incorporation, the company has presently thirty-three shareholders, representing almost the totality of retail banking in Portugal.

The first project developed in SIBS' scope of activity was the design and launching of a shared ATM (Automatic Teller Machines) network [Multibanco], which started operating on September 1985 [...] Ten years after its foundation the network had 3.745 equipments, and today 10.000 Multibanco ATMs are available to bank customers, processing in average 50 million operations per month. [...] Throughout its lifetime, thanks to the special attention given to the needs of Bank Institutions and to the constant capability of technological innovation, new operations and functions have been introduced, some of them deserving a special reference due to the enormous acceptance they had near the public, such as payment of services, allowing the payment of the so-called “utilities” (water, electricity or gas supply, etc.) as well as mobile phones from different operators.” (Source: <http://www.sibs.pt/>, on 04.12.2005).

Figure 2 represents schematically the process for pre-paid card recharging. It is a fully automatic but rather complex electronic process involving several organizations, where SIBS is the central player because it makes the link between the Multibanco ATM network, all retail banks operating in Portugal and the three mobile telephone operators. This universal interbank service network controlled by SIBS, the sole in Portugal and in operation since 1983, provided experience, reliability

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<sup>21</sup> “Via Verde” is a fully automatic traffic control system designed to charge motorway tolls without requiring the vehicle to stop. An electronic system identifies the “Via Verde” user through an electronic device installed on the car’s windscreen at the motorway toll stations (entrance and exit). Then, it calculates the amount to pay and automatically debits the “Via Verde” user’s bank account associated with “Via Verde”. According to Brisa, it was the first time that a traffic control system was implemented to the whole motorway network of a country.

and the necessary technological conditions for the development and successful implementation of the mobile pre-paid card recharging system.<sup>22</sup> Pre-paid subscribers were offered an easy way for periodically topping up their cards and TMN benefited from a reliable and effective means of collecting payments.

Two other conditions were crucial for the success of this pre-paid card recharging system: a good ATM network and the generalised use of debit cards. Indeed, both conditions were met at the time and TMN was well aware of that: "...knowing the penetration rate of debit cards and vulgarisation of Multibanco ATMs in Portugal, TMN created the opportunity for a subscriber to recharge his card in a way as simple as any other operation for payment of a service. This additional advantage allow clients to use TMN's mobile services *ad eternum* with no need to establish a contract with the firm" (Silva, 1996: 20, author's translation). The Multibanco network was strategic for the success of pre-paid services.

Table 4 compares the number of ATMs and the use of cards with a debit function between Portugal and the EU average. At least from 1996 onwards, the conclusion to draw is clear: Portugal is well above EU average in relation to the number of ATMs per million of inhabitants and use of debit cards. Over the period, the number of ATMs increased at a faster rate in Portugal and, coincidentally or not, the number of ATMs almost doubled in 1996. At the end of 1994, the number of ATMs installed in Portugal was 3 329 (400% more than in 1990), covering the whole country (EMI, 1996). In 1995, when pre-paid cards were introduced, the number of debit cards amounted to more than 6 million (Table 5), that is, a penetration rate above 60% (considering that the number of inhabitants in Portugal is just above 10 million). Besides that, payments by debit/credit cards as a percentage of the total volume of cashless transactions were more than twice as many in Portugal than in the European Union average (Table 4). The massive increase in the use of debit cards in Portugal since mid-1980s is linked to the creation of SIBS (EMI, 1996). A growing number of services can be paid with debit cards at ATMs since then at no additional cost for debit card users.

**Table 4** ATMs and debit cards – Portugal and EU

	1996	1997	1998	1999	2000
Number of ATMs per 10 <sup>6</sup> inhabitants (end of year) - Portugal	541	632	710	852	970

<sup>22</sup> There are other projects where SIBS got experience in the implementation of electronic systems using the Multibanco network. For instance, SIBS and Banco the Portugal developed the Portuguese multi-purpose card, PMB (Porta Moedas Multibanco), an electronic purse which was implemented in March 1995 and could be loaded at any Multibanco ATM by using a debit card. See EMI (1996) for further details.

- EU (weighted average)	450	489	533	574	623
Increase in the number of ATMs (%)					
- Portugal	46,1	17,0	12,8	20,1	14,0
- EU (weighted average)	10,0	8,1	8,7	8,3	9,1
Number of transactions per inhabitant					
- Portugal	18	22	26	29	32
- EU (weighted average)	16	18	19	20	21
Cards with a debit function per 1000 inhabitants					
- Portugal				1084	1175
- EU (weighted average)				816	874
Payments by debit/credit cards (percentage of total volume of cashless transactions)					
- Portugal	34,3	39,5	44,0	47,2	50,6
- EU (weighted average)	16,7	18,4	21,0	23,3	26,6

Source: ECB (2002).

**Table 5** Number of cards with a debit function in Portugal

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Debit cards (10 <sup>3</sup> )	4 362	5 095	5 669	6 266	7 024	8 132	9 315	10 824	11 756	13 250	14 574	14 688

Source: Banco de Portugal – Departamento de Sistemas de Pagamento.

The good geographical coverage of Multibanco ATM network, the generalised use of debit cards and the receptiveness of the Portuguese to new technologies were important factors for the success of the pre-paid card recharging system. Although this was seen by TMN as an additional advantage for users, it was a very important aspect of pre-paid cards in terms of simplicity, comfort and attractiveness. The recharging system was crucial to cope with the sharp increase in the demand for mobile phones after 1996. This was also very important to keep the relationship between operator and client to a minimum and to preserve the anonymity of users.

## 6. Conclusion and policy implications

This paper begins with a somewhat paradoxical situation: Portugal is one of the less innovative countries within the European Union by most innovation indicators but, simultaneously, it is a leading country in the diffusion of mobile phones. The remarkable evolution of the mobile telecommunications sector over the last 15 years (e.g., technology, market, competition, regulation) turns the issue a little more intriguing. In its attempt to shed light on this situation, the paper focuses particularly on the take-off stage of mobile phone diffusion in Portugal, which occurred around 1996 and signalled a sudden change in the pattern of diffusion. The introduction of an innovation – pre-paid cards – explains most of the change in the diffusion curve occurred around 1996 and the subsequent increase in the penetration rate. Pre-paid services had an enormous impact on the rate of adoption of mobile phones in many countries and it is the major take-off determinant of mobile

phone diffusion in Portugal. The time lag between the launching of this innovation in Portugal and its adoption by other EU countries explains why Portugal not just caught up with the EU average mobile phone penetration rate around 1996, but moved ahead of it from then on.

The launch and success of this innovation can be explained by a number of favourable circumstances. Competitive pressure pushed TMN to follow a competitive strategy based on innovation. TMN's source of inspiration to launch a rechargeable pre-paid card came from non-rechargeable pre-paid cards in use at the time by a German mobile operator. But TMN went a bit further and launched a complete ready-to-talk kit at a competitive price, completed with an innovative and sophisticated recharging system over the ATM network. As pre-paid cards need to be recharged periodically, pre-paid services in Portugal benefited greatly from the reliable financial infrastructure and the general use of debit cards in Portugal, which turned the recharging process as simple as any other ATM operation for payment of a service. Such favourable technological and social conditions allowed TMN to take full advantage of the pre-paid card concept from the very beginning.

Pre-paid cards were very successful in most countries where it was introduced and contributed to the democratisation in the use of mobile phones worldwide. Prior known research has not considered pre-paid cards an important determinant of mobile phone diffusion. However, pre-paid services have a number of associated advantages, both for subscribers and mobile phone operators, which make them attractive for users and competitively so important that cannot be ignored by competitors. Today, pre-paid subscribers comprise more than 40% of all mobile phone subscribers in OECD countries (OECD, 2005), which leaves us wondering to what extent is the evolution of the mobile telecommunications sector over the last decade explained by the introduction of pre-paid cards. It is certainly a matter of research requiring proper attention.

The findings of this paper do not change the overall situation of Portugal in any innovation ranking, and it was not the aim of this paper either. But it sheds some light over the paradoxical situation referred to above: aggregate country indicators are unable to show the innovative potential at the sectoral level. Favourable environmental conditions are an important ally to firms that place innovation at the core of their strategic priorities. The success of mobile phones is certainly a great source of knowledge that can be used to promote the use of other technologies in Portugal, such as the Internet.

## Annex

**Table A-1** Analysis of the determinants of mobile phone diffusion of some prior research works

Research works	Factors analysed	Findings
Massini (2004)	- Handset price; - Tariff; - Consumption expenditures;	"A clear result is that economic variables play an important role in both the diffusion speed and the saturation level." (p. 274)
Jang et al. (2005)	- Population density; - Income per capita; - Availability of digital technology; - Market competition; - Number of new vendors; - Payment options: calling party pays, receiving party pays; - Penetration rate of fixed network;	"...our finding that socio-economic indicators, such as population density and per capita GDP, have no significant effect on mobile diffusion. However, the switch to digital technology does prove to be an important driving force for mobile telecommunications diffusion... the choice of payment programs and the penetration rate of fixed networks play critical roles in affecting diffusion." (p. 134)
Gruber and Verboven (2001)	- Transition from analogue to digital technology; - Introduction of competition (number of licenses granted);	"...the transition from the analogue to the digital technology during the early 1990s... had a major impact on the diffusion of mobile telecommunications. ... The impact of introducing competition was also significant, during both the analogue and the digital period, though the effect was smaller than the technology effect." (p. 578)
Koski and Kretschmer (2005)	- Entry timing; - Service prices; - Diffusion speed;	
Sundqvist et al. (2005)	- Country (GDP); - Culture; - Timing;	"...country's wealth and cultural similarity to the innovation center positively influence the country's early adoption." (p. 107) "The country effect was found to explain the adoption year and the market potential. The time effect was the most important predictor for the rate of diffusion. The innovation coefficient cannot be explained by country, culture or time effects..." (p. 109)
Hodge (2005)	- Tariff structure of fixed vs. mobile;	"It finds that the balance between fixed monthly and usage fees makes mobile both affordable and cheaper than fixed line for the bottom 50–60% of households that spend relatively little on communication." (p. 493)

**Table A-2** Mobile subscribers per 100 inhabitants – 1992-2004 (%)

Country	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Austria	2,2	2,8	3,5	4,8	7,5	14,6	28,8	53,8	76,4	81,4	83,6	87,6	-
Belgium	0,6	0,7	1,3	2,3	4,7	9,6	17,2	31,2	54,9	74,8	78,8	84,0	-
Denmark	4,1	6,9	9,7	15,7	25,0	27,3	36,4	49,4	63,0	73,9	83,3	88,4	-
Finland	7,0	9,1	12,8	20,3	28,8	40,7	55,2	63,4	72,0	80,5	86,8	91,1	-
France	0,8	0,8	1,4	2,4	4,1	9,6	18,7	34,2	48,9	60,7	63,0	67,7	-
Germany	1,2	2,2	3,0	4,6	7,1	10,0	17,0	28,6	58,6	68,2	71,7	78,5	-
Greece	-	0,3	1,5	2,6	5,0	8,7	19,0	35,8	54,3	72,8	85,1	94,1	-
Ireland	1,2	1,6	2,3	3,7	8,0	14,0	25,5	42,7	53,2	71,8	78,4	85,7	-
Italy	1,4	2,1	3,9	6,9	11,2	20,4	35,3	52,2	73,2	88,3	91,6	97,6	-
Luxembourg	0,3	1,3	3,2	6,6	10,8	16,0	30,5	48,2	69,2	97,9	106,0	119,8	-
Netherlands	1,1	1,4	2,1	3,5	6,5	10,8	21,3	43,0	69,1	71,7	73,1	80,7	-
Portugal	0,4	1,0	1,7	3,4	6,6	14,9	30,4	45,9	65,2	77,5	82,3	89,4	95
Spain	0,5	0,7	1,1	2,4	7,6	11,0	17,9	37,6	60,0	73,3	82,7	91,8	-
Sweden	7,8	9,7	15,7	22,7	28,2	35,8	46,4	57,9	71,8	80,5	89,1	98,2	-
United Kingdom	2,6	3,8	6,0	9,3	11,7	14,5	22,3	40,9	68,3	76,1	84,3	89,2	-
EU-15 average	1,2	1,9	3,6	5,7	9	14	23,5	39,3	62,4	73,5	80,1	86,0	88

**Sources:** OECD Telecommunications Database 2005 (accessed on 16.12.2005), except data for "EU-15 average" and "2004" which is from Anacom (2004b).

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