# Feasibility Study to Evaluate the Potential Entry of a New F-MVNO into the Spanish Mobile Market

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*Authors' contributions*

*This work was carried out in collaboration between both authors. Author JT collaborated in the design of the study, performed the statistical analysis, managed the literature searches and wrote the first draft of the manuscript. Author JLMM collaborated in the design of the study, managed the analyses of the study and collaborated in the redaction of the final document. Both authors read and approved the final manuscript.*

*Original Research Article*

## ABSTRACT

The mobile market until a decade ago had been composed mainly of Mobile Network Operators (MNOs). To promote greater competition in this market the European Commission (EC) has promoted various actions in the regulatory and policy environment in Europe. This has significantly facilitated the appearance of new players in this market, such as Mobile Virtual Network Operators (MVNOs), which in the case of the Spanish mobile market grew from 4 MNOs to 38 non-homogeneous operators by early 2017. This paper presents an assessment of the economic feasibility of the entry of a new Full-Mobile Virtual Network Operator (F-MVNO) in the Spanish mobile market. This operator does not own band rights and therefore has to negotiate with a host operator (HO) for use of spectrum and has to provide the suitable and necessary devices that route and switch calls. Moreover, it has to ensure the interoperability of its own services with other operators and has to manage the services and traffic generated by its own subscribers. The

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examples of evaluation analyzed in this work consider six different scenarios over five years. The evaluation for each scenario calculates the average return per user (ARPU) or the income per subscriber and the fixed and variable costs needed to provide the proposed services. The data used in this evaluation are provided by the National Commission for Markets and Competition, NCMC or "la Comisión Nacional de los Mercados y la Competencia, CNMC" in Spain [1], which is in charge of publishing quarterly the available data about the Spanish mobile market. The results show for each scenario the minimum number of subscribers that a new F-MVNO needs to ensure its economic feasibility (break-even point) and the time necessary to reach it. The methodology used in this work may also serve as a guide to assess the economic feasibility of new F-MVNOs entering in other European countries.

## 1. INTRODUCTION

Traditionally, the access of operators to the mobile market has been dependent on having band through which operators can provide mobile communications services. However, the nature of the spectrum makes it a limited resource and unfortunately, demand always exceeds availability, which directly influences the development of the market competition. This limits the number of competitors accessing the mobile market and often leads to strong vertical integration with no new entrants. However, technological improvements and policy and regulatory developments taking place in the last decade have allowed new operators to enter in order to increase the competition among operators. Ultimately, the investment of these new entrants benefits users since they can gain more access possibilities at lower prices.

In fact, regulation has allowed the entry into the mobile market of Mobile Virtual Network Operators (MVNOs), such as Full-MVNOs (F-MVNO) or Light-MVNOs (L-MVNO), which do not have their own spectrum, but which compete with those already present in this market, such as Mobile Network Operators (MNOs). Although all these operators compete in the same retail market, the investment necessary and the costs incurred by each kind of operator in offering services are quite different. Thus, the MNO has its own spectrum and must establish a network access plan that covers the whole country. However, the F-MVNO operator has its own backbone network elements, but without proprietary access and the L-MVNO operator does not even have its own backbone network elements.

The examples analyzed in this work define six scenarios, which consider a distinct number of subscribers and different evolution of the value of the Average Revenue per User (ARPU) over future years. After calculating the average income and cost incurred per subscriber, a new F-MVNO using the method proposed in this work can evaluate the minimum number of subscribers that it needs in order to make a profit (break-even point). The Spanish mobile market has evolved very quickly from a quasi-static scenario, with only four MNOs, to one with 38 heterogeneous operators, which was composed of MNOs, F-MVNOs and L-MVNOs in early 2017[1] [2], creating a more competitive market. This paper may also be used as a methodological tool to evaluate the economic feasibility of a new F-MVNO in other EU countries simply by considering the appropriate rate and regulatory changes in each country.

The paper is organized as follows: Section 2 considers some related work, section 3 describes the F-MVNO business model and section 4 details the regulatory mobile market framework in European and how it is applied to the Spanish mobile market, including termination prices and other additional costs and defining the rules of access for F-MVNOs. Section 5 describes the evolution of the mobile market in Spain, using data compiled by the CNMC [1]. Section 6 evaluates in six examples (six scenarios), using our proposed methodology, the break-even–points and the time to reach them. Finally, section 7 summarizes conclusions. Additionally, Appendix A1 describes the characterization of the subscribers and Appendix 2 and 3 evaluate the income and incurred costs of a new F-MVNO entrant respectively.

## 2. RELATED WORK

Reference [3] analyzes the competitive effects of virtual mobile operators, in [4] some voluntary

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[1] *http://www.aopm.es/informacionGeneral.seam.*

relationships between mobile operators have analyzed and established, in [5] the regulated access and investment in infrastructure in the mobile telecommunications industry is approximately evaluated, in [6] the impact of the regulation of mobile termination rates and the relationships between MNOs and MVNOs in relation to retail prices are presented. In [7] the diversification of the strategies of the services based on the network is studied and in [8] the competition in the wholesale markets between (MNOs) and (MVNOs) is analyzed.

There is a lot of work and research in the literature related to MVNOs and particularly F-MVNOs, dealing with many interesting and different subjects. This work arises from three considerations: (i) new regulation from the EU encourages access of new entrants MVNOs (F-MVNOs or L-MVNOs) into the mobile market, (ii) MNOs and MVNOs have the possibility to reach agreements and (iii) operators compete in retail markets as mobile operators. To the best of our knowledge, there are no similar studies to this one in the literature. The analysis of the economic feasibility of new entrant F-MVNOs into the Spanish mobile market, a mature and deflationary market over the last 10 years, has not until now been the object of evaluation. In this sense, this paper proposes a methodological analysis that evaluates the associated averaged cost per subscriber incurred by an F-MVNO, as well as, the average income per subscriber, from compilation and elaboration of data from the CNMC [1]. After these two parameters are obtained, with the aim of demonstrating the potential of this practical method in the Spanish mobile market, some reasonable scenarios are proposed to quantify how many subscribers are necessary for a new entrant F- MVNO to obtain profits and when this will be possible. We believe that this tool could be useful for new entrant F-MVNOs as they can simulate and calculate in advance whether it is appropriate to make an investment or to avoid it in real or more reasonable scenarios. Although the calculations involved in these evaluations could seem quite easy, what is not so simple is to obtain the appropriate data to apply, since it needs to be based on realistic assumptions. In this sense, our paper describes how to do so with publicly available data while also considering regulatory and intrinsic aspects. This method is practical and flexible, which enables it to be applied in many scenarios**.** In some of them, the results could present counterintuitive properties that may

be explained through knowledge of the method. Finally, if other EU countries are analyzed, using this method, a comparison of the conditions among these countries could help to explain which of them present more or less difficulty to facilitate the entry of new F-MVNO operators.

## 3. THE F-MVNO BUSINESS MODEL

An F-MVNO provides mobile services to its subscribers without having proprietary spectrum. Therefore, it is necessary for it to reach access agreement with Mobile Network Operators MNOs. Thus, in this way the MNO becomes the Host Operator (HO) of the F-MVNO. Thus, this agreement provides the F-MVNO with appropriate and necessary functionality to originate and receive calls [2] . In this way, technically the backbone element deployment of the F-MVNO includes the necessary devices of a mobile network that are required for switching and routing calls and others that ensure the interoperability of its own network with other network operators and also manage the traffic of the services of its own subscribers. The F-MVNO should at least have the GMSC, HLR, SMSC, MMSC, GGSN [9] network elements as is shown in Fig. 1. Likewise, the F-MVNO establishes the necessary interconnection points with other operators in order to allow the interoperability of its services with other operators. When these operators use the F-MVNO backbone to make their calls, the F-MVNO will receive some established income, which is regulated in each mobile market and is termed the wholesale price. This kind of income is independent of what is obtained from its own subscribers denominated retail price.

Fig. 1 shows how subscribers' calls from F-MVNOs (blue line) enter through the spectrum of the associated HO of the F-MVNO receiver that routes them directly and that applies the appropriate policy for routing and delivering the services that its subscribers require. Thus, the F-MVNO is responsible not only for examining calls that go through other networks but also for receiving calls from other networks to its own subscribers. As the F -MVNO has its own backbone, it can also receive wholesale income from other operators by terminating their calls.

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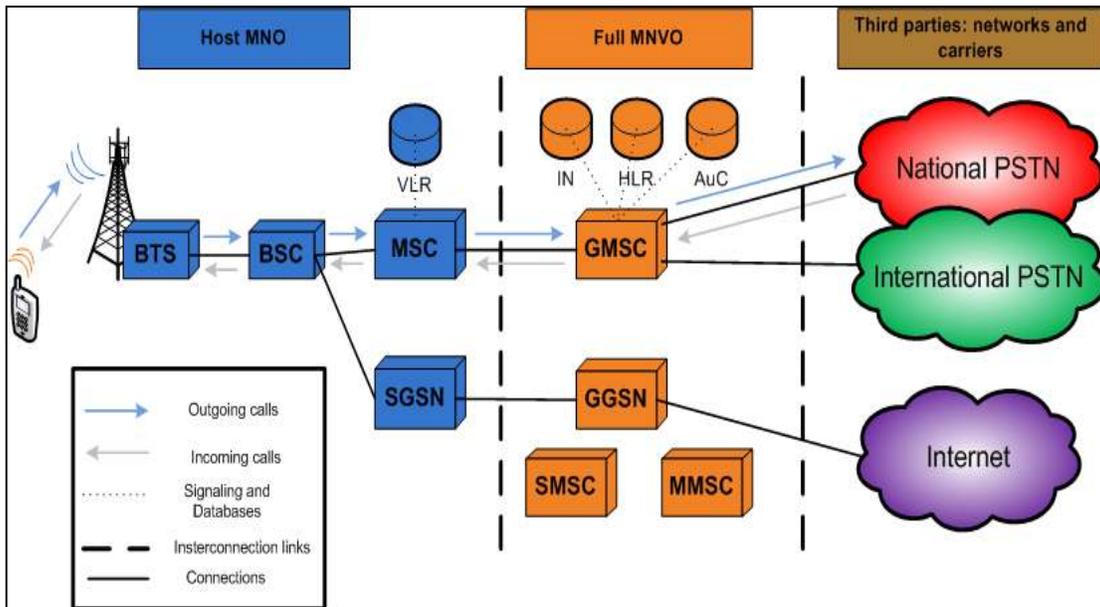[2] *Page 7 of Document 1 of the Resolution of February 7, 2008 of the CMT [8].*

**Fig. 1. Full MNVO – Backbone**

## 4. F-MVNO MOBILE MARKET REGULATORY FRAMEWORK IN EUROPE (SPAIN)

### 4.1 About the Main Features of the European Mobile Market

The European Commission (EC) established in 2003 the first recommendation for markets [10], which defined a list of 18 Telecommunications markets that "a priori" were regulated. Under this list, the Telecommunications Regulators in each country had to analyze the competitive situation of their respective 18 markets and determine whether they were in effective competition or otherwise, there were operators with dominant status. Years later, in a second recommendation [11] the EC established a second list of 7 markets of the Telecommunications sector which were in need to be regulated.

Of the markets subject to regulation, two were identified whose regulation has had a direct impact on the mobile communications market; on the one hand, the market for access and call origination on public mobile telephone networks, also known as "Market 15" [10] and, the market for voice call termination on individual mobile networks, also known as "Market 16" [12]. Due to the effects that this regulation has had on mobile operators, both markets are briefly described below for the mobile market in Spain.

### 4.2 About Access to the Mobile Market in Spain

Since the liberalization of the mobile market, CMT [3] (Comisión del Mercado de las Telecomunicaciones) or the National Reglamentation Authority, was commissioned to carry out those recommendations. In 2006, the CMT included in the mobile market all wholesale services accessing public mobile communications networks and their associated facilities that allow other operators to provide their subscribers with the full range of mobile communication services as a Mobile Network Operator (MNO) does. Both voice and data wholesale services are traded in an integrated way without the possibility of users choosing them separately.

At that time, three operators were in the market that were vertically integrated in such a way that their access networks only provided their own services without allowing other operators to offer mobile services in this market. The CMT concluded that there were sufficiently high retail market shares for these three incumbents to prevent entry to third parties, such as a new

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[3] *La Comisión del Mercado de las Telecomunicaciones (CMT) was the Telecommunications regulator from 1997 to October 2013, from this date its market regulation functions were carried out by the National Commission on Competition and Markets (CNMC) [1].*

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F-MVNO or L-MVNO. The emerging fourth MNO (Yoigo) was deploying its own UMTS network.

This scenario identified TME (Telefonica Mobile Spain), Vodafone and Orange as operators with Significant Market Power (SMP) and the CMT obliged them to meet and negotiate with other new entrant operators, to respond to reasonable requests to access specific resources of their networks at reasonable price and to provide specific wholesale services for resale to third parties. In April 2017, CNMC concluded [13] that mobile market did not meet the necessary characteristics to maintain the regulatory obligations imposed and it decided to establish a period of 6 months to remove those access obligations.

### 4.3 About the Call Termination Price (Wholesale Price) on Mobile Networks

In 2006, the CMT approved the analysis of "Market 16" [12] that consisted of the wholesale calls' termination service provided by the MNO to other operators, whether fixed or mobile, enabling them to complete calls to subscribers connected to that mobile network.

In Europe the model of payment for calls is known as Calling Party Pays CPP, in which, the subscriber that receives the call does not pay for it, which effectively means that in the case that your network operator decides to raise the termination´s price, there was no direct impact on its subscribers, but of course, subscribers of other operators would be affected by this increase. The key point is that operators of these subscribers cannot complete calls to the called subscriber if its operator does not have the call termination service. Under different analyses that have been carried out in this market, the CMT issued different market reports, suggesting and warning that there was a dominant position of the MNOs and MVNOs in their respective markets for call termination in their respective mobile networks and this fact was also aggravated by the billing system used, CPP, what created absolute entry barriers for new entrants. The regulation of the call termination market is in this way essential for establishing adequate wholesale charges for call traffic among mobile operators.

The impact on an operator of the wholesale charges, due to call termination, depends on its subscribers' base, that is, if this subscribers' base is small, the majority of the calls made will target other networks, while if the subscribers´ base is high, it is more likely to be attending calls among its own subscribers and, thus the wholesale costs will be less.

### 4.4 Other Issues that Influence the Costs of the Spanish Mobile Market

With the aim of characterizing other regulatory costs incurred by the F-MVNO, the cost of having mobile numbering and the cost of fulfilling the obligation to provide number preservation of its subscribers should be considered. The obligation to retain the numbers of its subscribers forces the F-MVNO to be a member of the Association of Mobile Operators for Portability, AOPM and to contribute to the running costs (fixed and variable) of this entity [2]. Therefore, operators have to pay a tariff, which is included in the Spanish regulation, and its value is 1.5 per thousand[4] of its gross income.

## 5. EVOLUTION OF THE SPANISH MOBILE MARKET

The CNMC [1] provides complete data about the mobile market in Spain. In this paper, we compiled data, from 2013 to 2016. In these data, there are several parameters or indexes of interest such as number of competitors (operators), income per line and consumption per subscriber and the evolution of the market, which is published quarterly. The market in Spain comprised 51.4 million lines ending 2016. Since 2013 the number of lines has increased by 1.3 million due to the economic improvement of the country, the penetration index in the population is, 110.7% (110 lines per 100 inhabitants) and 85,5% of the mobile lines are mobile broadband lines according to the quarterly report of the CNMC-IV 2016[5] [1]. In Fig. 2 the number of mobile lines and the evolution of the market share of different types of operators is shown. It should be noted that the market share has changed considerably since 2013, after new MVNOs accessed this market, since regulation made it possible. Moreover, it has to be noted that between 2014 and 2015 there were several acquisition movement between MNOs and MVNOs, leading to a new market shares in 2016.

As is shown in Fig. 2, in 2014 the fourth MNO (Yoigo) was already in the market and had a

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[4] *Annex I of Telecommunications Act 9/2014.*
[5] *Methodology: the data published in the 2014 (4th Quarter-) are data that operators have forwarded to the CNMC [1].*

**Fig. 2. Evolution of mobile lines (in millions) and market share from 2013 to 2016**
*(Compiled from data provided by the CNMC and MNVOs, from web information [1])*

market share of 6.7%. In 2016, there are 38 mobile operators and the top three have 72.8% of the market share while Yoigo has increased its share to 8.3% and the other MVNO operators share 8.9% of the market. It can be seen in Fig. 3 that the mobile lines associated with mobile broadband, have been increased 34.5% in just three years. The MVNO operators have profited using their presence to offer broadband services and maintaining their market share with respect to the total number of mobile lines. This evolution shows the tendency to provide mobile broadband in mobile lines, with an inter-annual growth between 17% and 6% reaching 39.7 million voice and data lines (mainly from mobile phones).
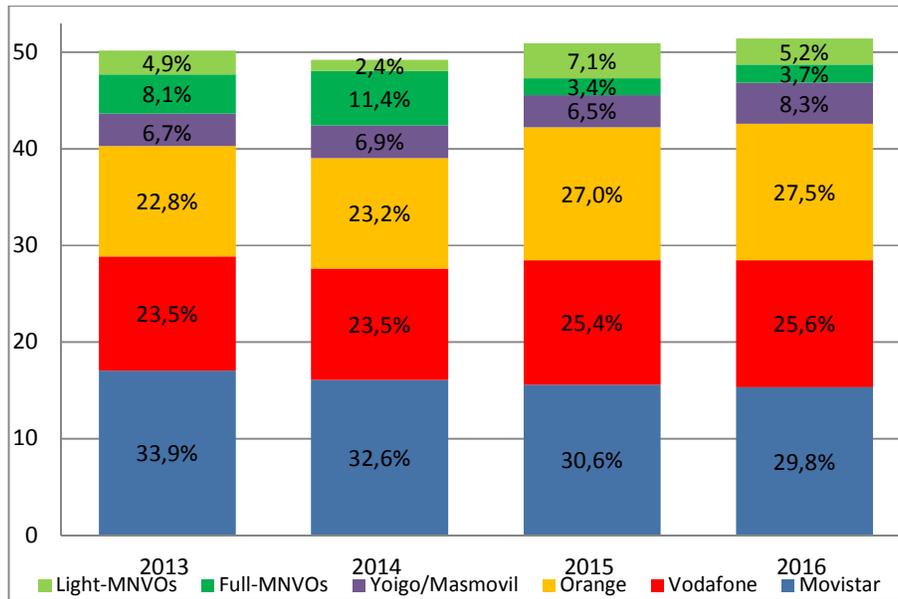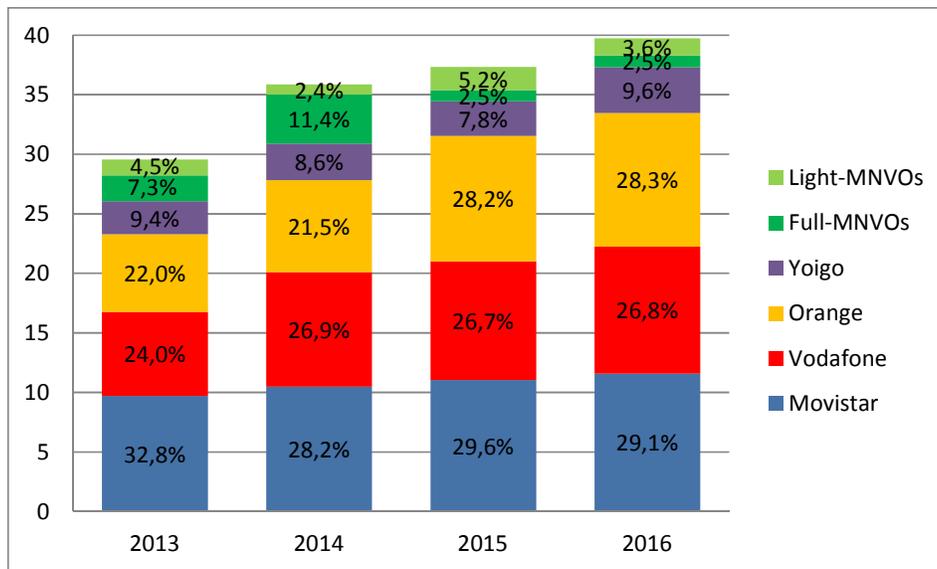


**Fig. 3. Evolution of voice lines related to mobile broadband (in millions) and market share from 2011 and 2014**
*(Compiled from data provided by the CNMC and MNVOs, from web information [1])*

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From the above data it can be concluded that, with respect to the market for mobile voice lines, the penetration rate is very high, so a new entrant, for example an F-MVNO, would have to attract users from other operators. However, this may be favored by the market tendency to increase the number of mobile broadband lines, which might finally provide an opportunity for new operators to gain a foothold in this market.

## 5.1 Evaluation of the Average Income and Consumption per Subscriber

Fig. 4 shows the evolution of the average income per subscriber for postpaid and prepaid lines between 2013 and 2016. As can be seen, the income per subscriber has declined in these years. Many reasons could be argued to explain this fact. One of the main reasons could be due to the severe economic crisis suffered in Spain during the period 2014 to 2016, but this tendency has gone on till nowadays. Others could also be argued, such as the hard price competition among all operators that started in 2009. In particular, the income from the retail prices of mobile communication services since then has been reduced every year (10% over the previous

year). Only broadband mobile services increased 16% inter-annually [1], due to the entrance of new subscribers for these services. From [1] prices in 2016 for the mobile communication services were 31% lower than in 2014.

A new entrant to the mobile market not only has to evaluate the existing regulatory framework, but also the competitive market situation that has considerably changed during the period from 2013 to 2016. The lower price of services implies a reduction in the Average Revenue Per User, ARPU, that the operators receive and of course a reduction in the profits obtained when the incurred costs are discounted.

In relation to the subscribers` consumption that the operators must report quarterly to the CNMC for publication, it can be observed that although the average income has been reduced as is shown in Fig. 4, the average consumption of the subscriber expressed in minutes has increased after some years remaining approximately equal (between 170 and 180 minutes per month for postpaid contracts and between 70 and 80 minutes per month for prepaid ones) and the volume of Short Text Messages
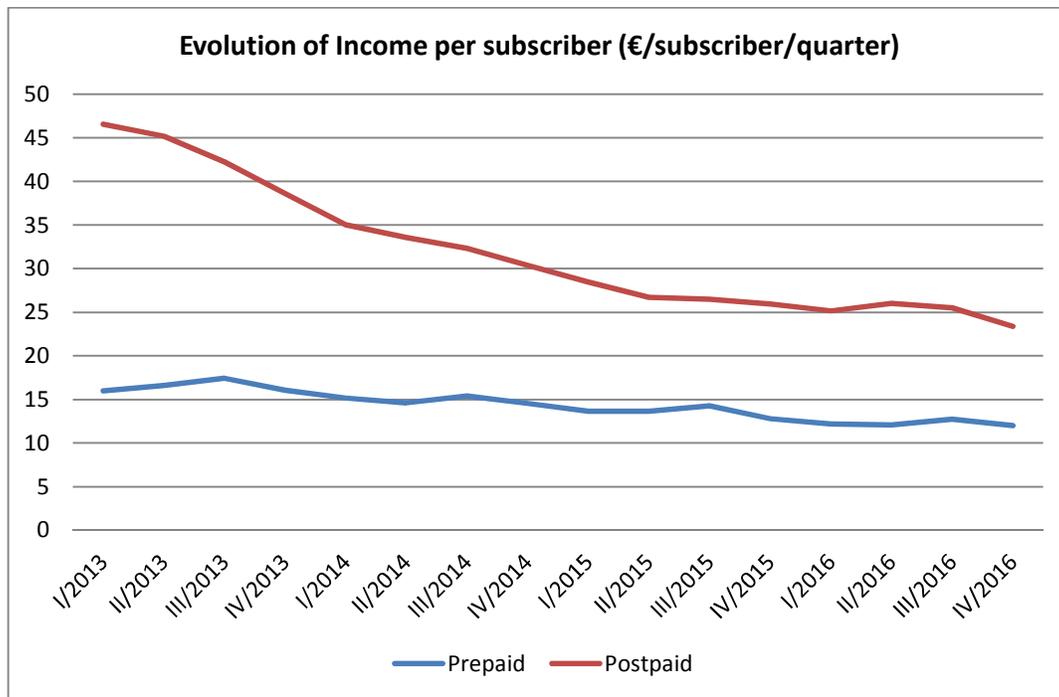


**Fig. 4. Evolution of the average income from mobile prepaid and postpaid contracts from the first quarter of 2013 to the fourth quarter of 2016. The data are expressed in Euros per line**
*(Compiled from data provided by the CNMC and MNVOs, from web information [1])*

(SMS) has fallen 10% from 2014 to 2016, representing an average consumption of seven SMS per line/per month. Finally, the total data transferred by mobile broadband has been multiplied by 4.6 times in three years from 37,030.62 TB to 171,610.82 TB [1] per quarter, which represents an average use per mobile broadband subscriber of 1,439.8 MB each month.

Other reports are also required, which are intended to verify and to contrast the accuracy of the information provided by operators and they refer to the consumption on mobile services of Spanish households, one of the best known is; "Report on consumption and expenditure of Spanish households in the electronic communications services", which is based on different queries to Spanish households, [14]. These reports reflect that the average expenditure per individual postpaid contract for mobile telephony stood at 15.5 €, with a fall of 13% in the last year. This report also states that subscribers who were billed by means of "mobile broadband flat rate", paid on average 6.5 €, with a significant reduction in the last year of 27%. Those subscribers billed by means of: "bundle package of broadband services and mobile voice", paid on average € 15.7, with a fall of 14% in the last year. These last two billing options represent different concepts of billing regardless of whether these prices could be applied to bundling fixed-line telephony, fixed broadband or television services, what would allow operators to reduce their profits on mobile services, with the aim of retaining their subscribers with a permanent contract. In other words, a subscriber without this bundle would not be able to contract only the mobile service at this price. From the data provided by the CNMC [1], Table 1 establishes an estimation of the income for each type of line per month and the percentage variation of this price per line with respect to the last year (tendency of the unitary prices). With these values, the estimation of the average income of a new operator is calculated (retail services).

Proceeding in the same way with the calculations of the retail consumption of the subscribers, with the previous sources [14] and assumptions, the consumption per subscriber and per month and the tendency of the subscribers' consumption can be extracted and compiled as is shown in Table 2.

Tables 1 and 2 show a clear tendency in the reduction of prices of mobile communications services, as well as a decrease in sending SMSs and great increase in using mobile broadband services.

It should also be noted that although these are the average values obtained from the data published in various reports of the NCMC [14], this does not mean that the market currently offers exactly what matches those values. Cross-subsidies by means of using bundled packages of fixed and mobile services and flat rates or subscribers' usage mean that the values obtained should only be treated as a guide to indicate what is happening in this sector in Spain.

**Table 1. Average income of each type of line per month and percentage variation of its unitary price with respect to the last year**

| Income per type of line | IV Q-2016 (€) | Percentage change from the last year IV- Q 2015 |
|---|---|---|
| Income per prepaid mobile | 4,0000 € | -6,10% |
| Income per postpaid mobile | 7,7933 € | -9,90% |
| Income per prepaid minute | 0,0507 € | -19,78% |
| Income per postpaid minute | 0,0437 € | -16,60% |
| Income per minute (national) | 0,0386 € | -17,29% |
| Income per minute (International) | 0,1354 € | -1,24% |
| Income per minute (Network intelligence) | 0,0799 € | -70,11% |
| Income per minute (roaming) | 0,0908 € | -56,93% |
| Income per national SMS | 0,0604 € | -12,84% |
| Income per international SMS | 0,3784 € | 10,51% |
| Income per SMS (roaming) | 0,1608 € | -16,55% |
| Income per mobile line of prepaid data | 4,6967 € | -0,70% |
| Income per mobile line of postpaid | 9,5567 € | 0,00% |
| Income by MB | 0,0062 € | -35,03% |

*(Compiled from data provided by the CNMC and MNVOs, from web information [1])*

**Table 2. Consumption and expenditure per subscriber and per month**

| Consumption per subscriber and per month | IV Q-2016 | Percentage change from the last year IV- Q 2015 |
|---|---|---|
| Prepaid voice minutes | 78,9 | 17,0% |
| Postpaid voice minutes | 178,5 | 8,2% |
| SMS | 7,1 | -3,3% |
| MB | 1439,8 | 54,0% |
| | IV- Q 2015 | IV Q-2016 |
| Total expenditure per subscriber and per month | 16,7 € | 17,1 € |

*(Compiled from data provided by the CNMC and MNVOs, from web information [1])*

It should be clear, of course, that these values do not match any particular rate because they are average values of consumption per subscriber and the traffic per line.

However, these data allow us to obtain reference values in order to identify the behaviour of the average consumption of the subscribers and the ARPU value that a new entrant in this market should expect to achieve, which would necessarily affect its investment plans and so too its decision to enter this market.

## 6. EXAMPLES OF ANALYSIS. APPLICATION SCENARIOS FOR A NEW ENTRANT F-MVNO

This section analyzes and quantifies, using the values contained in Tables 3 to 8, what should be the real expectation for a new F-MVNO entrant in the mobile communications market in Spain, considering different scenarios, in which not only the number of subscribers that the operator expects to reach for the subsequent five years is considered, but also two different ARPU values, one with hard reduction and the other with initial soft reduction, in the first years, and then a slight increase. This analysis will be carried out using the average consumption of subscribers, the estimated average income per subscriber and the costs incurred by a new F-MVNO, which are included in A-1, A-2 and A-3 respectively.

Six scenarios have been considered in these examples of analysis. The first one is considered pessimistic, since the evolution of the estimated subscribers for the new F- MVNO will vary from 15,000 to 105,000, and it considers two types of ARPU values, that is, hard reduction and initial soft reduction. The second is called moderate, the estimated subscribers are from 60,000 to 300,000, and it considers both types of ARPU values. Finally, a third scenario, optimistic, that starts with 100,000 reaching 960,000 subscribers

in the fifth year and it considers both types of ARPU values.

In a mature market, like the Spanish market is, there will be few new subscribers since mobile penetration is already high (more than 109%) as was pointed out in Section 5. In order to consider and estimate the increase of subscribers in these scenarios for a new F-MVNO, it will be assumed that most of the new subscribers will come from churning, that is, they will change from their own operator to another one for different reasons. One of these may be the price of the services offered. From one year to the next, the churn rate will be assumed in this work to be given by expression (1), which represents the number of unsubscribed lines compared to all subscribers in a given time period [18].

$$Churn\ rate_t =$$

$$\frac{number\ of\ unsubscribed\ lines_t}{\frac{number\ of\ subscribers_t\ +\ number\ of\ subscribers_{t-1}}{2}} \quad (1)$$

### 6.1 Scenario 1-a. A New F-MVNO Estimates a Population of 15,000 to 105,000 Subscribers with Hard Reduction in the ARPU over the Next Five Years

Based on previous assumptions, this scenario assumes that the number of subscribers for the new F-MVNO will be between 15,000 and 105,000. The values included in Table 3 are calculated consider the data in section 5 and those of the appendices A1, A2 and A3. Thus, Table 3 shows the total income, which is obtained from the retail income (from its own subscribers) and from the wholesale income (which comes from subscribers of other operators), as well as the costs that the new entrant F-MVNO have to face, which depend on its own number of subscribers. In this scenario, the estimation for the ARPU value considers a hard reduction over the next five years.

**Table 3. Total income and costs according to the number of subscribers in scenario 1-a**

| Subscribers | 1st year | 2nd year | 3rd year | 4th year | 5th year |
|---|---|---|---|---|---|
| | 15,0000 | 30,000 | 52,500 | 75,000 | 105,000 |
| Income from subscribers | 493.523,55 € | 1.889.249,96 € | 3.125.933,68 € | 5.325.314,50 € | 7.043.842,05 € |
| Income from other operators | 57.962,07 € | 262.770,43 € | 480.453,20 € | 731.009,38 € | 1.086.985,03 € |
| Variable Costs (to pay other MVNOs) | 91.500,55 € | 401.225,16 € | 716.849,16 € | 1.138.211,12 € | 1.636.138,74 € |
| Access agreement (due to variable traffic volume) | 239.010,92 € | 483.929,09 € | 850.812,19 € | 1.223.975,30 € | 1.725.709,94 € |
| SIM card print (variable) | 1.500,00 € | 3.000,00 € | 4725,00 € | 6.000,00 € | 8.400,00 € |
| Portability (variable fee) | 10.200,00 € | 10.245,00 € | 15.457,50 € | 15.637,50 € | 21.187,50 € |

**Table 4. Total income and costs according to the number of subscribers in scenario 1b**

| Subscribers | 1st year | 2nd year | 3rd year | 4th year | 5th year |
|---|---|---|---|---|---|
| | 15,0000 | 30.000 | 52.500 | 75.000 | 105.000 |
| Income from subscribers | 493.523,55 € | 2.044.458,24 € | 3.718.724,79 € | 7.222.253,53 € | 11.110.965,78 € |
| Income from other operators | 57.962,07 € | 262.770,43 € | 480.453,20 € | 731.009,38 € | 1.086.985,03€ |
| Variable Costs (to pay other MVNOs) | 91.500,55 € | 414.238,91 € | 763.470,27 € | 1.266.254,22 € | 1878.059,01 € |
| Access agreement (due to variable traffic volume) | 239.010,92 € | 527.140,13 € | 1.009.609,95 € | 1.831.534,11 € | 2.427.572,00 € |
| SIM card print (variable) | 1.500,00 € | 3.000,00 € | 4.725,00 € | 6.000,00 € | 8.400,00 € |
| Portability (variable fee) | 10.200,00 € | 10.245,00€ | 15.457,50 € | 15.637,50 € | 21.187,50 € |

**Table 5. Total incomes and total costs according to the number of subscribers in scenario 2-a**

| Subscribers | 1st | 2nd | 3rd | 4th | 5th |
|---|---|---|---|---|---|
| | 60.000 | 120.000 | 180.000 | 240.000 | 300.000 |
| Income from subscribers | 1.974.094,19 € | 7.556.999,85 € | 10.717.486,91 € | 17.041.006,39 € | 20.125263,01 € |
| Income from other operators | 231.848,30 € | 1.051.081,71 € | 1.647.268,11 € | 2.339.230,02 € | 3.105.671,53 € |
| Variable Costs (to pay other MVNOs) | 365.672,71 € | 1.653.595,33 € | 2.609.798,20 € | 4.036.348,42 € | 5.341.108,54 € |
| Access agreement (due to variable traffic volume) | 956.043,69 € | 2.108.488,53 € | 3.461.302,75 € | 5060.472,83 € | 6.935.189,12 € |
| SIM card print (variable) | 6.000,00 € | 12.000,00€ | 16.200,00 € | 19.200,00 € | 24.000,00 € |
| Portability (variable fee) | 40.800,00 € | 40.980,00€ | 41.340,00 € | 41.880,00 € | 43.050,00 € |

**Table 6. Total income and total costs according to the number of subscribers in scenario 2-b**

| Subscribers | 1st | 2nd | 3rd | 4th | 5th |
|---|---|---|---|---|---|
| | 60.000 | 120.000 | 180.000 | 240.000 | 300.000 |
| Income from subscribers | 1.974.094,19 € | 8.177.832,97 € | 12.749.913,56 € | 23.111.211,30 € | 31.745.61652 € |
| Income from other operators | 231.848,30 € | 1.051.081,71 € | 1.647.268,11 € | 2.339.230,02 € | 3.105.671,53€ |
| Variable Costs (to pay other MVNOs) | 365.672,71 € | 1.653.595,33 € | 2.609.798,20 € | 4.036.348,42 € | 5341.108,54 € |
| Access agreement (due to variable traffic volume) | 956.043,69 € | 2.108.488,53 € | 3.461.302,75 € | 5.060472,83 € | 6.935.189,12 € |
| SIM card print (variable) | 6.000,00 € | 12.000,00 € | 16.200,00 € | 19.200,00 € | 24.000,00 € |
| Portability (variable fee) | 40.800,00 € | 40.980,00 € | 41.340,00 € | 41.880,00 € | 43.050,00 € |

**Table 7. Total income and total costs according to the number of subscribers in scenario 3-a**

| Subscribers | 1st year | 2nd year | 3rd year | 4th year | 5th year |
|---|---|---|---|---|---|
| | 100.000 | 300.000 | 500.000 | 750.000 | 960.000 |
| Income from subscribers | 3.290.156,99 € | 15.751.621,57 € | 32.747.876,66 € | 49.525.424,81 € | 66.010.86268 € |
| Income from other operators | 386.413,83 € | 2.190.848,44 € | 5.033.319,23 € | 6.798.387,24 € | 9.938.148,89 € |
| Variable Costs (to pay other MVNOs) | 608.966,36 € | 3.431.685,59 € | 7.912.010,22 € | 11.589.645,00 € | 17.247.940,24 € |
| Access agreement (due to variable traffic volume) | 1.593.406,15 € | 5.270.624,50 € | 9.612.773,41 € | 15809.648,14 € | 22.185.337,40 € |
| SIM card print (variable) | 10.000,00 € | 30.000,00 € | 45.000,00 € | 60.000,00 € | 76.800,00 € |
| Portability (variable fee) | 68.000,00 € | 136.450,00 € | 137.500,00 € | 173.375,00 € | 150.000,00 € |

**Table 8. Total income and total costs according to the number of subscribers in scenario 3-b**

| Subscribers | 1st year | 2nd year | 3rd year | 4th year | 5th year |
|---|---|---|---|---|---|
| | 100.000 | 300.000 | 500.000 | 750.000 | 960.000 |
| Income from subscribers | 3.290.156,99 € | 17.045.670,60 € | 38.958.069,20 € | 67.166.957,84 € | 104.125.622,19 € |
| Income from other operators | 386.413,83 € | 2.190.848,44 € | 5.033.319,23 € | 6.798.387,24 € | 9.938.148,89 € |
| Variable Costs (to pay other MVNOs) | 608.966,36 € | 3.431.685,59 € | 7.912.010,22 € | 11.589.645,00 € | 17.247.940,24 € |
| Access agreement (due to variable traffic volume) | 1.593.406,15 € | 5.270.624,50 € | 9.612.773,41 € | 15809.648,14 € | 22.185.337,40 € |
| SIM card print (variable) | 10.000,00 € | 30.000,00 € | 45.000,00 € | 60.000,00 € | 76.800,00 € |
| Portability (variable fee) | 68.000,00 € | 136.450,00 € | 137.500,00 € | 173.375,00 € | 150.000,00 € |

As is shown in Fig. 5, the fixed cost incurred by the new F- MVNO for the next five years are too high and it will not make a profit with this low number of subscribers. The break-even point indicates the subscribers needed to reach equilibrium between fixed costs and estimated total income. It should also be noted that the increment in the value of the break-even point in the fifth year is not only due to fixed costs but also to variable ones, since the new F-MVNO has to pay the call termination fees of its own subscribers to other operators.

## 6.2 Scenario 1-b. A New F-MVNO Estimates a Population of 15,000 to 105,000 Subscribers and Initial Soft Reduction in the ARPU over the Next Five Years

Based on previous assumptions, this scenario assumes that the number of subscribers for the new F-MVNO will be between 15,000 and 105,000. The values included in Table 3 are calculated considering the data in section 5 and those of the appendices A1, A2 and A3. Thus, Table 4 includes the total income, which is obtained from the retail income (from its own subscribers) and from the wholesale income (which comes from subscribers of other operators), as well as the costs that the new entrant F-MVNO has to face, which depend on its own number of subscribers. In this scenario, the estimation for the ARPU value considers an

initial soft reduction of the ARPU value over the next five years.

As is shown in Fig. 6, although costs are similar to the cost of scenario 1-a, the total income increases more because the ARPU values do not suffer such a hard reduction and so the new F-MNVO with around 75,000 subscribers could make profits. In fact, the break-even point decreases as fast as the total income increases.

## 6.3 Scenario 2-a. A New F-MVNO Estimates a Population of 60,000 to 300,000 Subscribers with Hard Reduction in the ARPU over the Next Five Years

Based on previous assumptions, this scenario assumes that the number of subscribers for the new F-MVNO will be between 60,000 and 300,000. The values included in Table 5 are calculated considering the data in section 5 and those of appendices A1, A2 and A3. Thus, Table 5 includes the total income, which is obtained from the retail income (from its own subscribers) and from the wholesale income (which comes from subscribers of other operators), as well as the costs that the new entrant F-MVNO has to face, which depend on its own number of subscribers. In this scenario, the estimation for the ARPU value considers a hard reduction over the next five years.

| | 1st year: 15000 | 2nd year: 30000 | 3rd year: 52500 | 4th year: 75000 | 5th year: 105000 |
|---|---|---|---|---|---|
| INCOME | €551,485.62 | €2,152,020.39 | €3,606,386.88 | €6,056,323.88 | €8,130,827.09 |
| TOTAL COSTS | €4,787,779.52 | €5,618,801.30 | €6,630,500.97 | €7,711,211.99 | €9,066,876.28 |
| FIXED COSTS | €4,445,568.05 | €4,720,402.05 | €5,042,657.11 | €5,327,388.07 | €5,675,440.10 |
| VARIABLE COSTS | €342,211.47 | €898,399.25 | €1,587,843.85 | €2,383,823.92 | €3,391,436.18 |
| RESULTS | €(4,236,293.90) | €(3,466,780.91) | €(3,024,114.09) | €(1,654,888.11) | €(936,049.19) |
| Break even point | 318,642 | 112,962 | 131,154 | 108,796 | 125,738 |

**Fig. 5. Total incomes, total costs and break-even point for scenario 1-a**

As is shown in Fig. 7, in this scenario, 76% of the total cost is the fixed cost incurred by the new F-MVNO in the first year, while in the fifth the fixed cost has reduced to 32% of the total cost. This is due to the increment in the number of subscribers, and of course, the wholesale services' payment from other operators for the traffic carried. In reference to the profit margin, the new F-MVNO obtains income exceeding the total cost when it reaches more than 120,000 subscribers. However, with this number of subscribers it will not make a profit, since it has to pay more due to the associated cost of having more subscribers. In this sense, in the fifth year the new F-MVNO would need at least 156,641 subscribers in order to avoid losses. Thus, in this scenario the break-even point increases at the same rate as subscribers do, since the F-MVNO has to pay the call termination fees of its own subscribers to other operators and, even worse, with an estimated hard reduction of the ARPU value over the next five years.

## 6.4 Scenario 2-b. A New F-MVNO Estimates a Population of 60,000 to 300,000 Subscribers and Initial Soft Reduction in the ARPU over the Next Five Years

Based on previous assumptions, this scenario assumes that the number of subscribers for the new F-MVNO will be between 60,000 and 300,000. The values included in Table 6 are calculated considering the data in section 5 and those of the appendices A1, A2 and A3. Thus, Table 6 includes the total income, which is obtained from the retail income (from its own subscribers) and from the wholesale income (which comes from subscribers of other operators), as well as the costs that the new entrant F-MVNO has to face, which depend on its own number of subscribers. In this scenario, the estimation for the ARPU value considers an initial soft reduction for the ARPU value over the next five years.

As in the previous scenario and as Fig. 8 shows, the fixed cost represents 76% of the total cost incurred by the new F-MVNO in the first year, while in the fifth, this costs only represents 32% of the total cost. However, instead of increasing the break-even point decreases, as the new F-MVNO does not have to face a hard reduction of the ARPU value over the next five years. In fact, after the third year, the income of the new F-MVNO increases proportionally with the number of subscribers because the variable cost now is

not so significant. This enables the new entrant F-MNVO to stabilize its number of subscribers in order to make a profit in a range from 70,000 to 78,000 subscribers.

## 6.5 Scenario 3-a. A New F-MVNO Estimates a Population of 100,000 to 960,000 Subscribers with Hard Reduction in the ARPU over the Next Five Years

Based on previous assumptions, this scenario assumes that the number of subscribers for the new F-MVNO will be between 100,000 and 960,000. The values shown in Table 7 are calculated considering the data in section 5 and those of the appendices A1, A2 and A3. Thus, Table 7 includes the total income, which is obtained from the retail income (from its own subscribers) and from the wholesale income (which comes from subscribers of other operators), as well as the costs that the new entrant F-MVNO has to face, which depend on its own number of subscribers. In this scenario, the estimation for the ARPU value considers a hard reduction over the next five years.
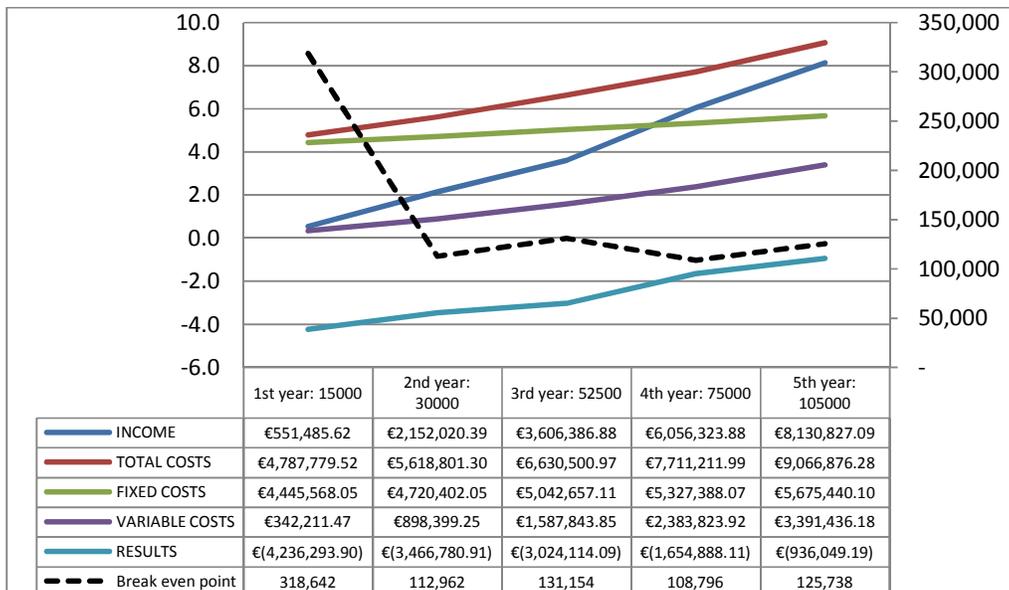
Fig. 9 shows that the total cost only exceeds the total income in the first year, indeed the lowest break-even point identified is around 142,600 subscribers and the worst, not considering the first year, is about 177,891 subscribers. The break-even point in the fifth year is quite steady like in previous years, since the variable cost for the new F-MNVO increases at the same rate as its own number of subscribers. If the number of subscribers increases, the variable costs are higher than in scenario 2-a. Likewise, it is important to note that the variable cost, that is, what the new F-MVNO has to pay to other operators, represents approximately 32% and 86% of the total cost in the first and the fifth year respectively. In this scenario, the new F-MVNO would not be interested in increasing the number of subscribers, since the variable cost becomes very high and in this situation, it does not increase its own profit margin.

## 6.6 Scenario 3-b. A New F-MVNO Estimates a Population of 100,000 to 960,000 subscribers and Initial Soft Reduction in the ARPU over the Next Five Years

Based on previous assumptions, this scenario assumes that the number of subscribers for the
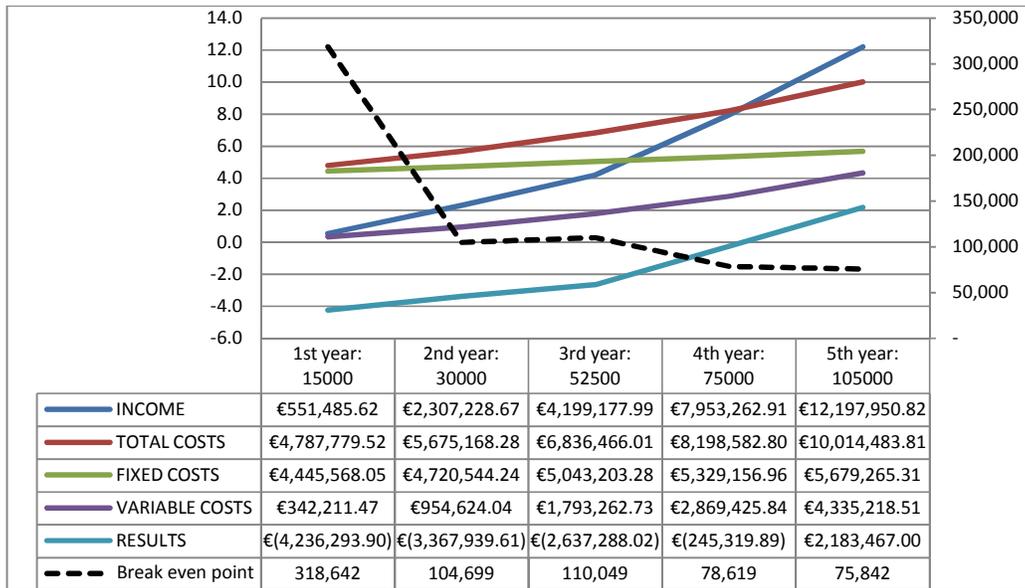
| | 1st year: 15000 | 2nd year: 30000 | 3rd year: 52500 | 4th year: 75000 | 5th year: 105000 |
|---|---|---|---|---|---|
| INCOME | €551,485.62 | €2,307,228.67 | €4,199,177.99 | €7,953,262.91 | €12,197,950.82 |
| TOTAL COSTS | €4,787,779.52 | €5,675,168.28 | €6,836,466.01 | €8,198,582.80 | €10,014,483.81 |
| FIXED COSTS | €4,445,568.05 | €4,720,544.24 | €5,043,203.28 | €5,329,156.96 | €5,679,265.31 |
| VARIABLE COSTS | €342,211.47 | €954,624.04 | €1,793,262.73 | €2,869,425.84 | €4,335,218.51 |
| RESULTS | €(4,236,293.90) | €(3,367,939.61) | €(2,637,288.02) | €(245,319.89) | €2,183,467.00 |
| Break even point | 318,642 | 104,699 | 110,049 | 78,619 | 75,842 |

**Fig. 6. Total income, total costs and break-even point for scenario 1-b**

| | 1st year: 60000 | 2nd year: 120000 | 3rd year: 180000 | 4th year: 240000 | 5th year: 300000 |
|---|---|---|---|---|---|
| INCOME | €2,205,942.49 | €8,608,081.56 | €12,364,755.02 | €19,380,236.40 | €23,230,934.54 |
| TOTAL COSTS | €5,815,290.84 | €8,539,881.29 | €11,176,996.67 | €14,494,106.87 | €18,028,164.22 |
| FIXED COSTS | €4,446,774.45 | €4,724,817.43 | €5,048,355.72 | €5,336,205.62 | €5,684,816.55 |
| VARIABLE COSTS | €1,368,516.40 | €3,815,063.86 | €6,128,640.95 | €9,157,901.25 | €12,343,347.67 |
| RESULTS | €(3,609,348.35) | €68,200.28 | €1,187,758.35 | €4,886,129.53 | €5,202,770.32 |
| Break even point | 318,603 | 118,293 | 145,716 | 125,283 | 156,641 |

**Fig. 7. Total income, total costs and break-even point for scenario 2-a**

new F-MVNO will be between 100,000 and 960,000. The values shown in Table 8 are calculated considering the data in section 5 and those of the appendices A1, A2 and A3. Thus, Table 8 includes the total income, which is obtained from the retail income (from its own subscribers) and the wholesale income (which comes from subscribers of other operators), as well as the costs that the new entrant F-MVNO has to face, which depend on its own number of subscribers. In this scenario, the estimation for the ARPU value considers an initial soft reduction of the ARPU value over the next five years.

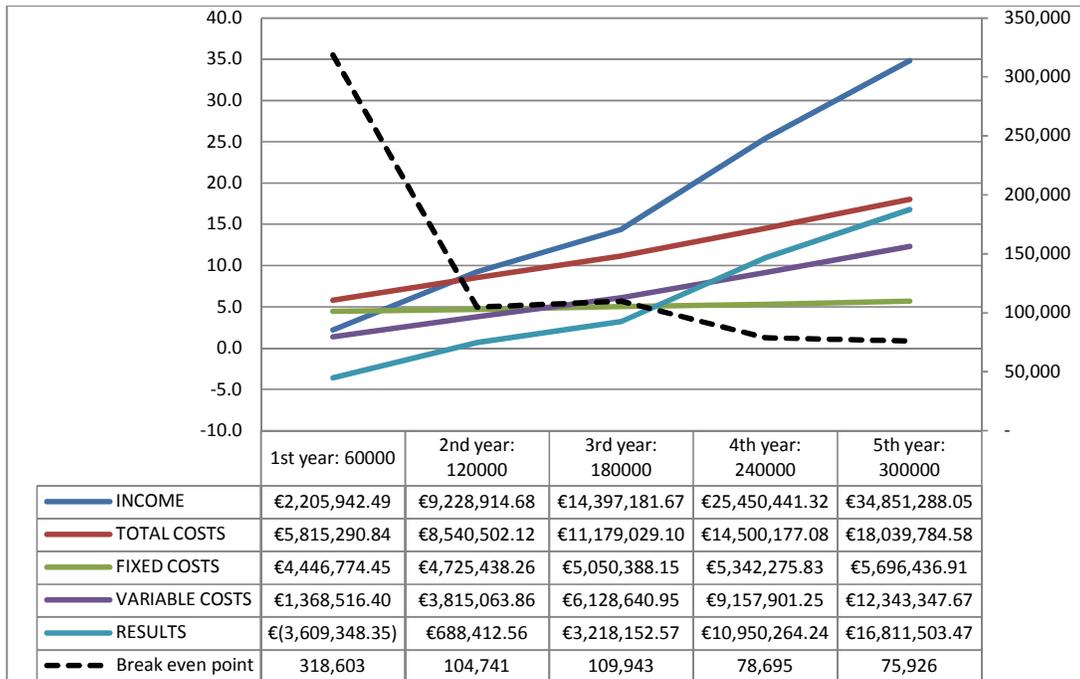| | 1st year: 60000 | 2nd year: 120000 | 3rd year: 180000 | 4th year: 240000 | 5th year: 300000 |
|---|---|---|---|---|---|
| INCOME | €2,205,942.49 | €9,228,914.68 | €14,397,181.67 | €25,450,441.32 | €34,851,288.05 |
| TOTAL COSTS | €5,815,290.84 | €8,540,502.12 | €11,179,029.10 | €14,500,177.08 | €18,039,784.58 |
| FIXED COSTS | €4,446,774.45 | €4,725,438.26 | €5,050,388.15 | €5,342,275.83 | €5,696,436.91 |
| VARIABLE COSTS | €1,368,516.40 | €3,815,063.86 | €6,128,640.95 | €9,157,901.25 | €12,343,347.67 |
| RESULTS | €(3,609,348.35) | €688,412.56 | €3,218,152.57 | €10,950,264.24 | €16,811,503.47 |
| Break even point | 318,603 | 104,741 | 109,943 | 78,695 | 75,926 |

**Fig. 8. Total income, total costs and break-even point for scenario 2-b**

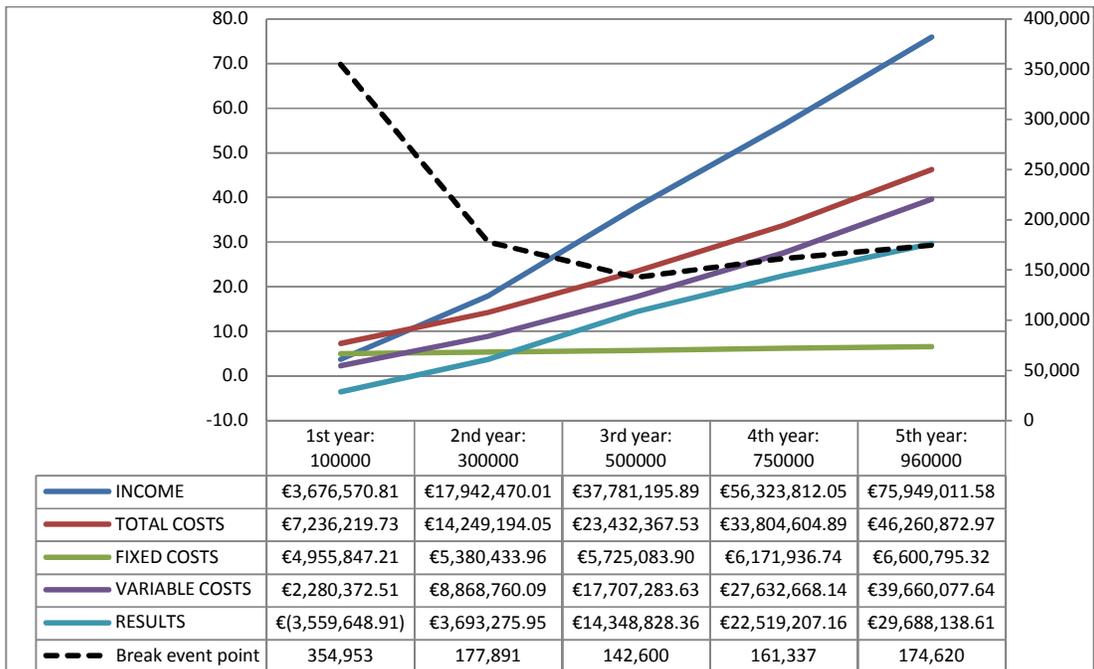| | 1st year: 100000 | 2nd year: 300000 | 3rd year: 500000 | 4th year: 750000 | 5th year: 960000 |
|---|---|---|---|---|---|
| INCOME | €3,676,570.81 | €17,942,470.01 | €37,781,195.89 | €56,323,812.05 | €75,949,011.58 |
| TOTAL COSTS | €7,236,219.73 | €14,249,194.05 | €23,432,367.53 | €33,804,604.89 | €46,260,872.97 |
| FIXED COSTS | €4,955,847.21 | €5,380,433.96 | €5,725,083.90 | €6,171,936.74 | €6,600,795.32 |
| VARIABLE COSTS | €2,280,372.51 | €8,868,760.09 | €17,707,283.63 | €27,632,668.14 | €39,660,077.64 |
| RESULTS | €(3,559,648.91) | €3,693,275.95 | €14,348,828.36 | €22,519,207.16 | €29,688,138.61 |
| Break event point | 354,953 | 177,891 | 142,600 | 161,337 | 174,620 |

**Fig. 9. Total income, total costs and break-even point for scenario 3-a**

Fig. 10 shows that only in the first year the total cost exceeds the total income, indeed the lowest break-even point identified is around 85,659 subscribers and the worst without considering the first one, is about 155,725 subscribers.
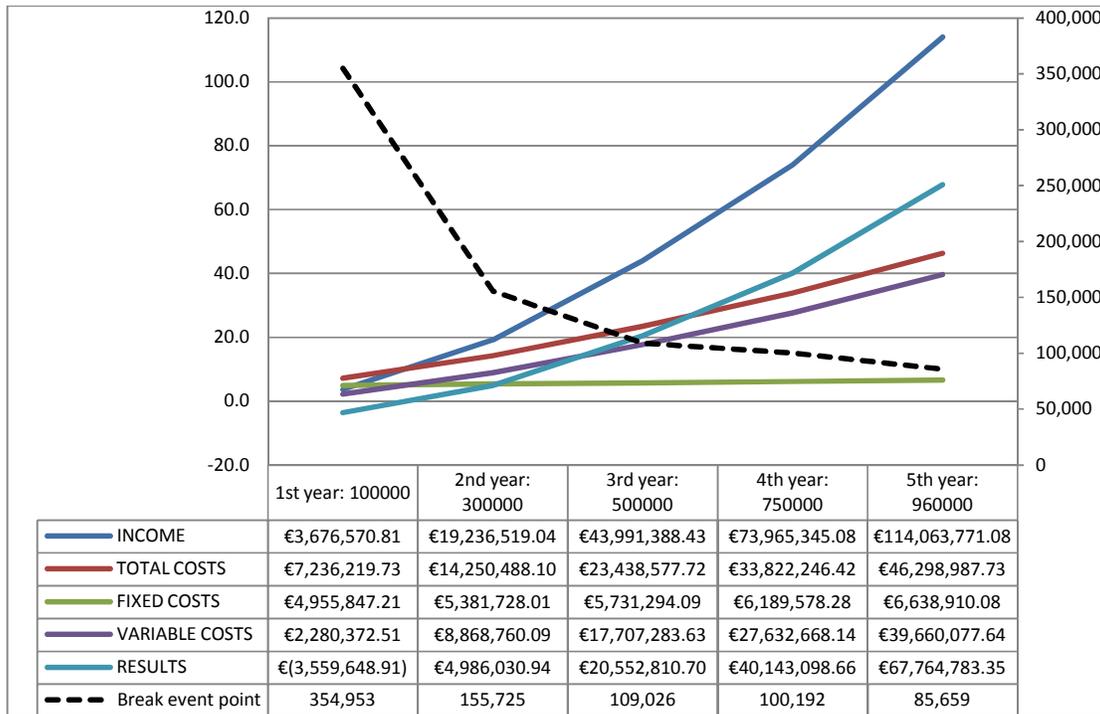
15

| | 1st year: 100000 | 2nd year: 300000 | 3rd year: 500000 | 4th year: 750000 | 5th year: 960000 |
|---|---|---|---|---|---|
| INCOME | €3,676,570.81 | €19,236,519.04 | €43,991,388.43 | €73,965,345.08 | €114,063,771.08 |
| TOTAL COSTS | €7,236,219.73 | €14,250,488.10 | €23,438,577.72 | €33,822,246.42 | €46,298,987.73 |
| FIXED COSTS | €4,955,847.21 | €5,381,728.01 | €5,731,294.09 | €6,189,578.28 | €6,638,910.08 |
| VARIABLE COSTS | €2,280,372.51 | €8,868,760.09 | €17,707,283.63 | €27,632,668.14 | €39,660,077.64 |
| RESULTS | €(3,559,648.91) | €4,986,030.94 | €20,552,810.70 | €40,143,098.66 | €67,764,783.35 |
| Break event point | 354,953 | 155,725 | 109,026 | 100,192 | 85,659 |

**Fig. 10. Total income, total costs and break-even point for scenario 3-b**

The break-even point in the first year is greater than for the next years since the new F-MVNO when entering the market does not have subscribers, which means that the future subscribers will generate only partial incomes, that is, only over a fraction of the year. This fact implies that the income per subscriber is lower and the new F-MVNO will require many more subscribers to cover both fixed and variable costs.

With respect to the cost, if the number of subscribers increases, the variable costs will be higher than in scenario 2-b. Likewise, it is important to note that the variable cost, which the F-MVNO has to pay to other operators, represents approximately 32% and 86% of the total cost in the first and the fifth year respectively.

It should also be noted that the total cost does not grow at the same rate as the number of new subscribers of the new F-MVNO. This is because the F- MNVO obtains income for call terminating fees from other operators as is shown in Table 8. On the other hand, the new F-MVNO can stabilize the number of subscribers for which its own business is profitable because the fixed and variable costs of its subscribers do not grow at

the same rate as their number. Moreover, as is shown in Fig. 10, the necessary critical mass of subscribers for the new F-MVNO is between 85,000 and 100,000 subscribers to make the investment in the future mobile network profitable.

## 7. CONCLUSIONS

This paper analyzes the economic feasibility of a new F-MVNO entering the mobile market in Spain, taking into account the rules and regulations in force in Spain and considering six scenarios that evolve over five years, in which different numbers of users and distinct Average Revenue Per User (ARPU) have been assumed. The data used in the paper have been extracted and compiled from the web information offered by the National Commission of Markets and Competition (NCMC) or CNMC [1].

This paper presents an evaluation of the associated total income and costs that a new F-MVNO has to consider if it desires to enter in the Spanish mobile market. The regulatory market in Spain requires knowledge of some technical, regulatory and economic aspects to be able to evaluate other parameters such as consumption, income per subscriber and the fixed and variable

costs, according to the number of estimated subscribers. These parameters are the basis to finally evaluate the suitability of entering (to invest in the market) or not. The authors consider that this work could be utilized as a guide for a new F-MVNO entrant in the mobile market to estimate in advance the suitability of entering or not other specific markets in the EU and what could be the necessary goals to reach (ARPU value, number of subscribers, cost involved, etc.) in order to consolidate the investment. The data included in this paper is related to the Spanish mobile market and of course, the data used in this work should be revised before taking any type of real actions. The methodology applied in this paper could be applied to other mobile markets in the E.U, where regulations and other specific aspects of each market are also well known. The following conclusions are extracted from the analysis of the six scenarios presented for the Spanish mobile market in Section 6.

- The fixed cost associated with a new F-MVNO is very high compared to other types of operators that require less initial investment such as L-MVNO, since it has to deal with the acquisition, installation and maintenance of the basic elements that compose the mobile network backbone.
- In the most pessimistic scenarios (scenarios 1a and 1b), the total costs that a new F-MVNO has to face are mainly due to the fixed cost of the mobile network, since this represents a value 95% of the total cost. However, in the scenario (scenario 2b), the fixed costs do not exceed 32% of the total cost. In fact, the wholesale cost, which is generated from its own subscribers terminating calls in other networks is between 24% and 68% of the total cost, that is, more outgoing traffic from its own users terminates in other operators, but on the contrary, it also implies that it receives more incoming calls from subscribers of other operators, which provides more variable income to the new F-MVNO.
- The scenarios where a hard reduction of the value of ARPU is assumed (scenarios1a, 2a and 3a) show that this reduction generates a clear instability for a new F-MVNO entrant. This means that it needs to increase its own number of subscribers to make profits, but once it has done so, the income and the variable cost grow at the same rate as the number of subscribers do, so the new F-MVNO does not improve its profit margins

through increasing the number of its own subscribers.
- A new entrant F-MVNO requires a critical mass of subscribers to cover the fixed cost incurred (in scenarios 1b, 2b and 3b), that is, at least 75,000 subscribers. If this minimum is not achievable for a new F-MVNO entrant, it will be necessary to look for other alternatives. Of course, this last conclusion could vary if the new operator offers other business products (i.e., fixed broadband, internet access, etc.), since in this case it already has a customer base for which it could provide a convergent offer that could also include mobile services, enabling the new operator to reach the break-even point much earlier.

## ACKNOWLEDGEMENT

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. CNMC. Informe Trimestral IV 2016; 2017. Available:http://data.cnmc.es/datagraph/jsp/inf_trim.jsp
[Accessed 19 June 2017]
2. AOPM. Presentación de la AOPM; 2010. Available:http://www.aopm.es/root/archivos/contenidos/0/2/2/71153_AOPM_PresentacionAOPM.pdf
[Accessed 19 June 2017]
3. P. K., Wiethaus L. On the competitive effects of mobile virtual network operators. Telecommunications Policy. 2010;34(5–6): 262–269.
4. A. B., Dippon CM. Voluntary relationships among mobile network operators and mobile virtual network operators: An economic explanation. Information Economics and Policy. 2009;21(1):72–84.
5. Y. K., N. G., R. L., Y. K., D. F., Jihwan Kim. Access regulation and infrastructure investment in the mobile telecommunications industry. Tele-communications Policy. 2011;35(11): 907–919.
6. M. G., N. L. G., Livio Cricelli. The impact of regulating mobile termination rates and

MNO–MVNO relationships on retail prices. Telecommunications Policy. 2012;36(1):1–12.

7.  L. L., Nicoletta Corrocher. Diversification strategies in network-based services: The case of mobile virtual network operators. Telecommunications Policy. 2013;37(11): 1110-1123.

8.  J. W., Elisabet Garrido. Competition in wholesale markets: Do MNOs compete to host MVNOs? Telecommunications Policy. 2013;37(11):1124-1141.

9.  T. Union. Mobile virtual network operators article of ITU. ITU; 2001.
    Available:http://www.itu.int/itunews/issue/2001/08/mvno.html
    [Accessed 23 November 2015]

10. E. Commission. Commission recommendation of 11 February 2003 on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation, 11 February; 2003.
    Available:http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32003H0311&from=EN
    [Accessed 23 November 2015]

11. E. Comission. Commission recommendation of 17 December 2007 on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation, 17 December; 2007.
    Available:http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32007H0879&from=EN
    [Accessed 23 November 2015]

12. CMT. Resolución de 7 de febrero de 2008 por la que se aprueba la definición y el análisis de los mercados de terminación de llamadas vocales en las redes móviles individuales de los Operadores Móviles Virtuales Completos, 7 February; 2008.
    Available:https://www.cnmc.es/expedientes/aem-2007794
    [Accessed 19 June 2017]

13. CNMC. Resolución de 4 de abril de 2017 por la cual se aprueba la definición y análisis del mercado mayorista de acceso y originación en redes móviles -mercado 15/2003- y se acuerda su notificación a la Comisión Europea y al Organismo de Reguladores Europeos de Comunicaciones Electrónicas, 4 April; 2017.
    Available:https://www.cnmc.es/expedientes/anmedtsa00216
    [Accessed 19 June 2017]

14. CNMC. Informe sobre los consumos y gastos de los hogares españoles en los servicios de comunicaciones electrónicas el primer semestre de 2014; 2015.
    Available:https://www.cnmc.es/2015-03-18-informe-sobre-los-consumos-y-gastos-de-los-hogares-espanoles-en-los-servicios-de
    [Accessed 19 June 2017]

15. CMT. Resolución de 10 de mayo de 2012 por la que se aprueba la definición y el análisis de los mercados de terminación de llamadas vocales en redes móviles individuales, la designación de operadores con poder significativo de Mercado.
    Available:https://www.cnmc.es/expedientes/mtz-20112503 Barcelona, 2012
    [Accessed 19 June 2017]

16. SVP ADVISORS. Marco metodológico del modelo ascendiente de costes incrementales a largo plazo (Bottom-up LRIC) para redes móviles. Informe elaborado para la CMT; 2011.
    Available:https://es.slideshare.net/rafaelgg/svp-advisors-marco-metodolgico-modelo-bulric-mvil-cmt
    [Accessed 19 June 2017]

17. CMT. Resolución de 18 de julio de 2013 por la que se aprueba la revisión de precios de la oferta de referencia de líneas alquiladas de Telefónica de España, S.A.U. y se acuerda su notificación a la Comisión Europea y al Organismo de Reguladores Europeos de Comunicaciones Electrónicas, 18 July; 2013.
    Available:https://www.cnmc.es/expedientes/dt-20121555
    [Accessed 19 June 2017]

18. CNMC. Informe Económico de las Telecomunicaicones y del Sector Audiovisual 2016.
    Available:http://data.cnmc.es/datagraph/jsp/inf_anual.jsp, Barcelona, 2017.

## APPENDICES

### A1. Characterization of the Subscribers of an F-MVNO

From the data indicated in Section 5, it is assumed in this paper that subscribers of a new F-MVNO would be distributed in four profiles (prepaid voice, prepaid voice and data, postpaid voice and postpaid voice and data). Each one of these profiles represents a part of the total number of subscribers of the F-MVNO. This share is aligned to the tendency in the Spanish mobile market in recent years, so the postpaid service tends to have more clients, while the number of prepaid subscribers tends to fall, in turn, the average tendency among the subscribers is reflected by two facts: the acquisition of a voice line and the contracting of the data service by means of bundle packages.

It has been estimated and assumed in this work that the distribution of subscribers of a new F-MVNO corresponds to: 21% with prepaid voice service, 9,6% with prepaid voice and data services, 20% with postpaid voice and 49% with postpaid voice and data services. The subscribers´ evolution distribution considered in this paper for the following five years is shown in Table A 1-1.

**Table A 1-1. Distribution and evolution considered of subscribers for each service for the following five years**

| Years | 1st | 2nd | 3rd | 4th | 5th |
|---|---|---|---|---|---|
| Prepaid voice subscribers | 0,2139 | 0,151155 | 0,139672151 | 0,096693004 | 0,059071212 |
| Prepaid voice + data subscribers | 0,0961 | 0,104749 | 0,104853749 | 0,105902286 | 0,106961309 |
| Postpaid voice subscribers | 0,2001 | 0,210105 | 0,168084 | 0,1512756 | 0,13614804 |
| Postpaid voice + data subscribers | 0,4899 | 0,533991 | 0,5873901 | 0,64612911 | 0,697819439 |

Meanwhile, this paper also assumes that the average consumption by subscriber is the published value in the aforementioned quarterly reports of the CNMC [1], that is: 78 minutes for prepaid voice, 178 voice minutes for postpaid, 6 SMS messages and 1439 MBytes of data as was highlighted in Table 2. The evolution of the consumption of each service considered in this paper for the next five years is shown in Table A1-2.

**Table A 1-2. Distribution and evolution of the consumption of the services for the next five years**

| Years | 1st | 2nd | 3rd | 4th | 5th |
|---|---|---|---|---|---|
| Prepaid minutes consumption | 78,86 | 92,29 | 93,86 | 95,45 | 97,08 |
| Postpaid minutes consumption | 178,54 | 193,14 | 201,03 | 209,25 | 217,81 |
| SMS consumption | 6,00 | 6,06 | 6,12 | 6,18 | 6,24 |
| MB consumption | 1.439,77 | 1583,75 | 1742,12 | 1916,33 | 2107,96 |

### A2. Characterization and Evaluation of the Income of an F- MVNO

The income of a new F-MVNO entrant will come from two main sources; the retail income, which is provided from its users, and the wholesale income, which comes from the call termination service offered by each F-MVNO operator to other operators (MNOs and MVNOs). According to the subscriber profiles described in the evaluation of a new F-MVNO entrant, two scenarios have been assumed that take into consideration the evolution of the ARPU value over the next five years for each profile. In this section, we will assume these two scenarios: the first one considers that the new F-MVNO entrant follows an aggressive ARPU and supposes an important reduction in its average value, namely, 30% of the average estimated in the market. In this case we assume that the new entrant has to compete very hard on price and it needs to attract subscribers from other operators. Although the evolution of the prices over the next five years could be difficult to predict, in this paper

we assume the values shown in Table A 2-1, in which the important reduction of the ARPU (hard reduction) each year maintains the same reduction rate observed between years 2015 and 2016 (6.1% for prepaid lines and 9.9% for postpaid lines). The reason behind this scenario is that a new entrant in this competitive market has to compete hard on price if it wants to attract subscribers from other operators.

The second scenario however assumes a non-aggressive evolution of the ARPU. Initially a small reduction (soft reduction) and later a slight increment of about 5% for both prepaid and postpaid services, since we consider that competition in 4G scenarios will be expected on price and better quality of services.

Based on these assumptions and on the data obtained in sub-section 5.1, the proposed ARPU with hard reduction for the next five years is shown in Table A 2-1.

**Table A 2-1. Scenario a) ARPU evolution considering hard reduction**

| Years | 1st | 2nd | 3rd | 4th | 5th |
|---|---|---|---|---|---|
| ARPU Prepaid voice | 2,80 € | 2,63 € | 2,47 € | 2,32€ | 2,18 € |
| ARPU Prepaid voice + data | 6,09 € | 5,72 € | 5,37 € | 5,04 € | 4,73 € |
| ARPU Postpaid voice | 5,46 € | 4,92 € | 4,43 € | 3,99 € | 3,59 € |
| ARPU Postpaid voice + data | 12,15 € | 10,94 € | 9,86 € | 8,88 € | 8,00 € |

Likewise, based on the data highlighted in sub-section 5.1, the proposed ARPU with initial soft reduction and later with a slight increment in the price for the next five years is shown in Table A 2-2.

**Table A 2-2. Scenario b) ARPU evolution with initial soft reduction**

| Years | 1st | 2nd | 3rd | | 4th | 5th |
|---|---|---|---|---|---|---|
| ARPU Prepaid voice | 2,80 € | 2,74 € | 2,73 € | 2,81€ | 2,95 € | 2,80 € |
| ARPU Prepaid voice + data | 6,09 € | 5,97 € | 5,94 € | 6,11 € | 6,42 € | 6,09 € |
| ARPU Postpaid voice | 5,46 € | 5,35 € | 5,32 € | 5,48 € | 5,75 € | 5,46 € |
| ARPU Postpaid voice + data | 12,15 € | 11,90 € | 11,84 € | 12,20 € | 12,81 € | 12,15 € |

With the characterization of each type of subscribers, their profiles and their ARPU per month, the calculation of the total retail income for a new F-MVNO entrant is calculated using (1)

$$Retail\ Income = \left(\sum_{i=1}^{4} Number\ of\ subcribers\ per\ Profile\ Tariff_i \cdot ARPU_i\right) \cdot t \qquad (1)$$

Where ***i*** represents each one of the four types of service profile and ***t*** is the average time in months that subscribers remained in the F-MVNO in a year (t can take values from 0 to 12).

However, a new entrant F-MVNO will also receive wholesale income due to the incoming traffic from subscribers of other operators to its own subscribers. The price that it receives is the assigned price for terminating calls, as was indicated in the analysis of the market carried out by the CNMC, "Market 7" [15]. Thus, the incoming traffic from other operators will be paid at the established price for termination calls. It is also assumed that subscribers receive the same number of minutes of voice that they make, that is, the traffic between operators is balanced. Therefore, as the number of subscribers of F-MVNO increases, more calls are made among its own subscribers and therefore, less is paid for call termination and costs reduce.

Thereby, the F-MVNO charges the call termination price for incoming calls from other operators, reduces the cost per carried call among its own subscribers since they do not have to go through its host operator, HO. The "Market 7 "has established for the Spanish mobile market that an F-MVNO will receive per minute (1.09 c €) [15] as call termination price.

## A3. Characterization and Evaluation of the Costs of an F-MVNO

The main costs associated with a new F-MVNO can be differentiated and organized in five traditional groups:

- Group 1: Expenses and costs associated with acquiring assets or equipment (CAPEX). This section includes not only the acquisition of equipment but also the cost of its installation, commissioning and the acquisition of the spectrum. Among others the main equipment considered here is: MSCs, SMSCs, SGSNs, GGSNs and HLRs devices. The cost per unit of equipment as well as its installation and maintenance have been extracted from the public consultation carried out in 2011 [15] that uses the bottom-up model of Long-teRm Incremental Costs (LRIC) [16] for mobile networks. The unit price established and other related costs were in fact attached in an annex of [16], which forms an extensive Excel document. However, for the purposes of this work and the evaluation of the cost of this group only the most common values listed there have been considered and finally included. The price of the necessary links was taken from the regulated prices of the dominant operator [17].
- Group 2: Operating costs associated with the network (OPEX), which include the cost associated with the space where the equipment is placed, energy costs, the cost of network function, operation and maintenance, including the staff needed to develop the appropriate tasks.
- Group 3: Cost that is not directly related to the CAPEX and OPEX costs such as is dedicated to host web services, to outsource subscribers' services, to review the legality of the contracts, etc.
- Group 4: Cost related to marketing activities (advertising, etc.) of retail services in print, broadcast media, social networks and forums.
- Group 5: Cost associated with regulations in the Spanish mobile market, including fees and other mandatory requirements such as: the operator, numbering and radio electric domain rate and the Portability Association and database subscribers.

Finally, a new F- MVNO also has to face the cost originated by the call termination, which is originated by its own subscribers over other networks. The established price in the regulated "Market 7" for the Spanish mobile market is 1.09 c € per minute [14] as was highlighted in A 2.

Table A 3-1 presents a quantification of the fixed and variable costs for a new F-MVNO entrant in the Spanish mobile market and the prevision for the next five years, considering the values contained in references [14,15] and the use of the reference model [16].

**Table A3-1. CAPEX, OPEX and other costs considered for the next five years**

| Types of cost | Initial costs | 1st | 2nd | 3rd | 4th | 5th |
|---|---|---|---|---|---|---|
| **CAPEX** | | | | | | |
| MSC (Acquisition) | 1,070,005.07 € | 214.001,01 € | 214.001,01 € | 214.001,01 € | 214.001,01 € | 214.001,01 € |
| MSC (Installation) | 468.027,31 € | 93.605,46 € | 93.605,46 € | 93.605,46 € | 93.605,46 € | 93.605,46 € |
| SGSN (Acquisition) | 1.129.466,54 € | 225.893,31 € | 225893,31 € | 225.893,31 € | 225.893,31 € | 225.893,31 € |
| SGSN (Installation) | 188.131,72 € | 37.626,34 € | 37.626,34 € | 37.626,34 € | 37.626,34 € | 37.626,34 € |
| GGSN (Acquisition) | 1.325.349,25 € | 265.069,85 € | 265.069,85 € | 265.069,85 € | 265.069,85 € | 265.069,85 € |
| GGSN (Installation) | 128.715,70 € | 25.743,14 € | 25.743,14 € | 25.743,14 € | 25.743,14 € | 25.743,14 € |
| HLR (Acquisition) | 1.009.589,82 € | 201.917,96 € | 201.917,96 € | 201.917,96 € | 201.917,96 € | 201.917,96 € |
| HLR (Installation) | 492.177,48 € | 98.435,50 € | 98.435,50 € | 98.435,50 € | 98.435,50 € | 98.435,50 € |
| SMSC (Acquisition) | 762.895,24 € | 152.579,05 € | 152.579,05 € | 152.579,05 € | 152.579,05 € | 152.579,05 € |
| SMSC (Installation) | 399.660,25 € | 79.932,05 € | 79.932,05 € | 79.932,05 € | 79.932,05 € | 79.932,05 € |
| Billing systems | 500.000,00 € | 100.000,00 € | 100.000,00 € | 100.000,00 € | 100.000,00 € | 100.000,00 € |
| Links with host operator I (voice x2 - 155Mbps) Alta | 3.584,16 € | 716,83 € | 716,83 € | 716,83 € | 716,83 € | 716,83 € |
| Links with host operator (data x2 - 155Mbps) | 3.584,16 € | 716,83 € | 716,83 € | 716,83 € | 716,83 € | 716,83 € |
| Interconnection links (voice x2 - 155Mbps) | 3.584,16 € | 716,83 € | 716,83 € | 716,83 € | 716,83 € | 716,83 € |
| Internet data links (data x2- 155Mbps) | 3.584,16 € | 716,83 € | 716,83 € | 716,83 € | 716,83 € | 716,83 € |
| **OPEX** | | | | | | |
| MSC (Maintenance) | | 112.060,46 € | 112.060,46 € | 113.181,06 € | 115.444,69 € | 117.753,58 € |
| SGSN (Maintenance) | | 93.360,10 € | 93.360,10 € | 94.293,70 € | 96.179,58 € | 98.103,17 € |
| GGSN (Maintenance) | | 219.117,28 € | 219.117,28 € | 221.308,45 € | 225.734,62 € | 230.249,31 € |
| HLR (Maintenance) | | 213.044,03 € | 213.044,03 € | 215.174,47 € | 219.477,96 € | 223.867,52 € |
| SMSC (Maintenance) | | 288.618,75 € | 288.618,75 € | 291.504,94 € | 297.335,04 € | 303.281,74 € |
| Maintenance of the Billing System | | 50.000,00 € | 50.000,00 € | 50.500,00 € | 51.000,00 € | 51.000,00 € |
| Links with the host operator (voice x2 - 155Mbps) | | 26.523,60 € | 26.523,60 € | 26.523,60 € | 18.566,52 € | 18.566,52 € |
| Links with the host operator (data x2 - 155Mbps) | | 26.523,60 € | 26.523,60 € | 26.523,60 € | 18.566,52 € | 18.566,52 € |
| Interconnection links voice x2 - 155Mbps) | | 26.523,60 € | 26.523,60 € | 26.523,60 € | 18.566,52 € | 18.566,52 € |

| Types of cost | Initial costs | 1st | 2nd | 3rd | 4th | 5th |
|---|---|---|---|---|---|---|
| Internet data links (data x2- 155Mbps) | | 26.523,60 € | 26.523,60 € | 26.523,60 € | 18.566,52 € | 18.566,52 € |
| **Other costs** | | | | | | |
| Access agreement (fixed) | | 1.000.000,00 € | 1.000.000,00 € | 1.000.000,00 € | 1.000.000,00 € | 1.000.000,00 € |
| Rent of the office | | 72.000,00 € | 74.880,00 € | 79.200,00 € | 83.520,00 € | 86.400,00 € |
| Cost of Utilities (electricity, water, etc) | | 7.200,00 € | 7.488,00 € | 7.920,00 € | 8.352,00 € | 8.640,00 € |
| Hosting and maintenance of Web services | | 12.000,00 € | 12.480,00 € | 13.200,00 € | 13.920,00 € | 14.400,00 € |
| Advertising and Marketing | | 300.000,00 € | 300.000,00 € | 300.000,00 € | 300.000,00 € | 300.000,00 € |
| Association of Portability (fixed fee) | | 10.000,00 € | 10.100,00 € | 10.200,00 € | 10.300,00 € | 10.400,00 € |

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