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Virtual operators in the mobile industry: a techno-economic analysis

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Abstract For a company planning to become a mobile operator, two alternative ways to enter the market exist. In addition to the traditional way of acquiring a spectrum license and building a mobile network, market entrance is also possible by becoming a virtual operator and utilizing the existing networks of incumbent operators. Potentially, virtual operators will have an important role in shaping the mobile market structure and competition. In this paper, techno-economic modeling methods are used to analyze the position of virtual operators in the mobile communications industry. Four alternative virtual operator scenarios are constructed and analyzed using a linear, deterministic, and quantitative techno-economic model. The results highlight the importance of wholesale contracts with incumbent mobile network operators in determining the virtual operators' business profitability. Unbalance in termination prices between fixed and mobile networks is shown to give incentives for virtual operators to invest in their own network infrastructure.

Keywords Virtual operator · Mobile · MVNO · Techno-economic modeling

1 Introduction

Competition in today's mobile market takes place on many different levels: between network operators utilizing various access network technologies, between service operators with heterogeneous backgrounds and assets, as well as between various application and content providers. A special division

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can be drawn between service-based and infrastructure-based competition. Service-based competition takes place when a new entrant operator utilizes the existing network infrastructure of an incumbent, whereas in infrastructure-based competition the new entrant builds and operates its own access network infrastructure.

During the past 5 years, the European mobile markets have witnessed the entrance of many new players with no access networks of their own. Having a different level of control on the services they are offering, these 'virtual' operators are both competing and co-operating with the traditional players. As a result of this development, the number of new players has increased in almost all Western European markets. Figure 1 gives an overview of the amount of authorized virtual operators in the 25 EU countries in September 2005.

As shown in Fig. 1, the amount of virtual operators differs significantly between the EU countries. The U.K., Denmark, Sweden, and Finland were among the first countries to witness the emergence of a vast number of virtual operators, but today also the continental Europe is experiencing the effects of these new players. Although the virtual operator phenomenon originated and has had its biggest effects in the saturated and developed markets of Europe, the model is emerging now also in other continents. This study, however, is mostly focused on the Western European markets.

The objective of this paper is to identify the strategic alternatives of virtual operators regarding the level of investments and service differentiation, and to analyze the techno-economic feasibility of different virtual operator scenarios witnessed in the marketplace today. Previous studies have recognized the difference between virtual operator models (e.g. [9, 10, 15]). Varoutas et al. [16] presents the results of a techno-economic analysis for two different virtual

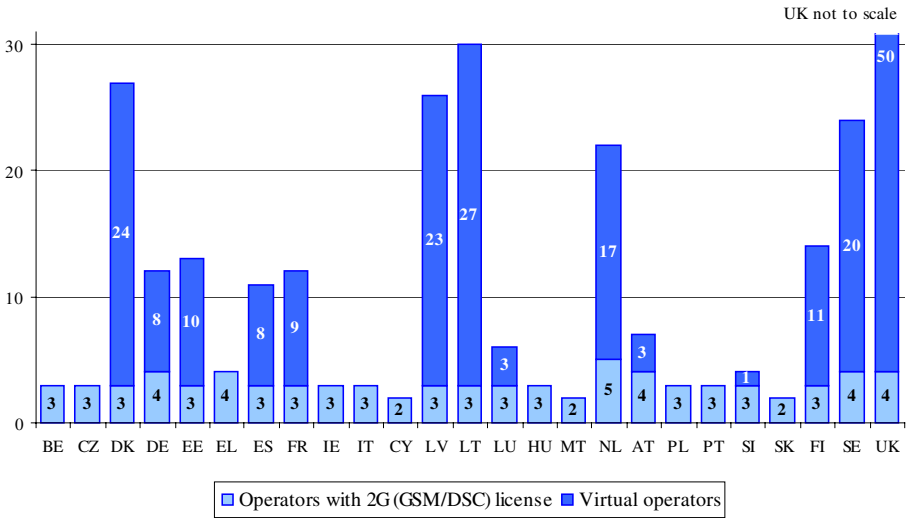


Fig. 1 Operators authorized to provide 2G mobile services in 25 EU-countries, September 2005 [2]

operator models and country types, but does not take into account different infrastructure investment alternatives.

In this paper, techno-economic modeling methods are used to analyze the financial position and feasibility of virtual operators in the mobile communications industry. The paper contributes to the existing body of knowledge by comparing the virtual operator models from the point of view of infrastructure investments and service differentiation.

2 Virtual operators—strategic mapping

In this section, we describe two separate strategic choices that virtual operators have to make when entering the mobile market: the level of network infrastructure investments and the level of service differentiation. After a brief discussion, some of the virtual operators present in the European markets are introduced. As a result of this review, a 'virtual operator strategy matrix' is constructed and explained, and used to illustrate the strategic positions of selected European virtual operators.

2.1 Mobile virtual network operators and service providers

Existing virtual operators have different backgrounds; some have earlier experience from the telecom markets whereas others might have their roots in other industries. Virtual operators include e.g. fixed telephone and broadband operators, mobile operators from another geographical market, as well as new entrants such as content providers, or Internet service providers (SP).

Terminology used in describing different types of virtual operators is still somewhat ambiguous. For the purposes of this study, terminology and definitions shown in Table 1 apply. For further clarification, the positions of different types of virtual operators in the mobile network operator value chain are illustrated in Fig. 2.

As described in Table 1, virtual operators have to make a strategic "make-or-buy" choice regarding the level of investments to the mobile network infrastructure. This separates them into two different categories: Mobile Virtual Network Operators (MVNO) and SPs. The choice between the MVNO and SP models has an effect on both the revenues and costs of the operators. The differences between these two models are further explained in Section 3.

2.2 Cost leaders and differentiators

Besides the level of network investments, an important strategic decision for virtual operators is whether to provide only basic services with low costs or to aim for higher margins with differentiated service offerings.

According to Kiiski and Hämmäinen [9], the level of service differentiation is often based on earlier operations of the company, and depends on their

Table 1 Definitions

Term	Definition	Owned network/service components
MNO	An operator that owns a spectrum license, radio access network, and mobile core network. Sells capacity and services to SPs and MVNOs, not to end users.	Spectrum license; Radio access network equipment: e.g. base station transceivers, antennas, base station controllers; Core network equipment: e.g. MSC + VLR, HLR, packet data networks; Service platforms: e.g. short message service center, multimedia messaging center, Intelligent network platform
SP	An operator that sells subscriptions to customers and bills the customers. Can be independent or integrated with an MNO.	Billing system Customer resource management/service management systems
MVNO	An SP that has also its own mobile core network (at least MSC and HLR) and is independent in making interconnection agreements with other MNOs/MVNOs	Core network equipment; Service platforms Billing system Customer resource management/service management systems
MVNE	A player that facilitates the launching and operations of MVNOs and SPs, and to whom the MVNO/SP can outsource different parts of its business	Varies

MSC mobile switching center, VLR visitor location register, HLR home location register, MVNE mobile virtual network enabler

strategic position (brand, sales channels) and internal resources (business synergies between different operations, multi-channel operations). Ulset [15] compares cost leader and service differentiation strategies and suggests a logical scenario where mobile network operators (MNOs) focus on basic network services and MVNOs on value-added innovated services and branding.

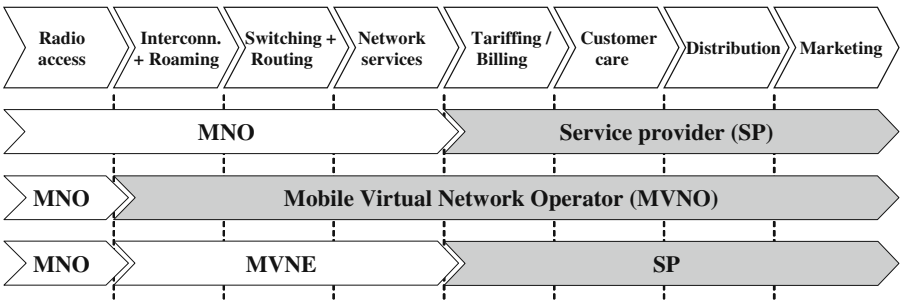


Fig. 2 Mobile operator value chain possibilities

Further, Olla and Patel [13] encourage operators in general and SPs/MVNOs in particular to diversify based on innovative new mobile data services.

By far, the majority of virtual operators have selected a cost leader strategy, focusing on low-cost voice calls and SMS messages. Service differentiation has also been driven by some operators, with offerings including e.g. exclusive content or bundles of multiple services.

2.3 Regulatory situation in Europe

The separation of network and service operations is based on the EU legislation [1, 4, 5] but the specific role of virtual operators still remains somewhat undefined. The main focus of regulation has been to increase competition by obliging MNOs to lease out capacity from their networks to all service operators at a fair price, consisting of appropriate investment, operating costs, and modest return on the investment. MNOs proven by regulator to have Significant Market Power (SMP) must provide fair access to their networks. Furthermore, they are obliged to provide the financial information of transmission services to the regulator so that the fairness of their network tariffs can be estimated. To make the mobile communications market more accessible, national regulators may impose MNOs to lower the barriers to enter the market, e.g. by enforcing mobile number portability and by regulating interconnection and termination fees.

Many national regulators have found that their existing regulations cannot be applied to virtual operators without amendment. Also virtual operators find regulation often inadequate. An example of this is the Finnish Communications Market Act, which obliges MNOs to relinquish access rights to its network to SPs [11]. However, the law does not define the access rights for MVNOs with own mobile switching centers, which has caused problems for Finnish MVNOs.

Most countries have defined both MNOs and MVNOs as SMPs regarding mobile call termination. The resulting obligations are operator-specific and typically easier for MVNOs than MNOs. For instance, call termination charging of MVNOs does not usually need to be cost-oriented because cost-orientation would give an advantage to MNOs.

The general sentiment in the EU is favorable to the business opportunity of new virtual operators. However, the regulatory situation concerning different types of virtual operators is not yet harmonized between the EU countries. This may have effects on the viability of certain virtual operator business models in certain markets, and successful concepts from one market cannot be necessarily repeated on another.

2.4 Virtual operator strategy options

As shown in Fig. 1, there are numerous virtual operators in the Western European mobile market. These include both MVNOs and SPs, driving both cost leader and differentiator strategies.

Before advancing into the techno-economic modeling work, we analyzed the current market situation in order to have an overview of the virtual operators' levels of network investments and service differentiation. Based on publicly available information (i.e. company web pages, press releases) we analyzed their operations and service offerings, and classified them in two dimensions, firstly either to SPs or MVNOs, and secondly to cost leaders or differentiators.

For our market analysis, we selected a number of European virtual operators, briefly introduced in Appendix 1. For our selection of operators, we tried to include operators with diverse strategies, resulting in a list where many of the operators are from the Nordic countries. Virtual operators from the Central Europe have often driven very uniform strategies (SPs with low costs, no network infrastructure owned, low-priced, pre-paid services) and consequently have relatively less visibility in Appendix 1. Based on our market study, we mapped the selected operators in a 'virtual operator strategy matrix' (Fig. 3).

The horizontal axis in Fig. 3 represents the level of service differentiation, whereas the vertical axis represents the level of network infrastructure investments. The MVNOs/SPs listed in Appendix 1 were plotted on the matrix as circles. The size of the circle corresponds to the MVNO's or SP's relative market share and the location to its strategy, as interpreted by the authors. Unknown subscriber bases have been estimated.

The lower left cell includes "discount SPs", providing services that are simple to purchase and pay mainly via Internet. The operational costs are kept down by not offering differentiated services or selling subscriptions extensively

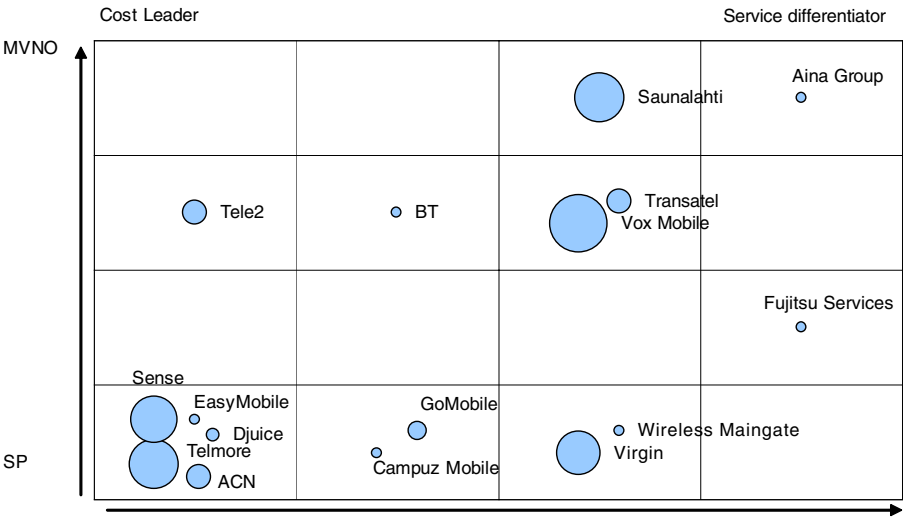


Fig. 3 Virtual operator strategy matrix

via retail chains. New customers are acquired via Internet (GoMobile, Easy-Mobile, Sense, etc.) or via a direct selling network (ACN).

In the lower right cell there are two types of SPs providing differentiated services, namely 1) SPs whose services are targeted for business users or companies (Fujitsu Services, Wireless Maingate) and 2) SPs that rely heavily on their existing brand and/or offer mobile as one channel of their multi-channel operations (Virgin, Vox Mobile).

MVNOs in the upper left cell offer mainly low cost services for consumers. As an example, Tele2 is a subsidiary of a MNOs operating in another geographical market, and its costs are kept low by using existing service infrastructure abroad. In this case, the MVNO model is seen as a cost-effective way for an MNO to expand its operations abroad.

Finally, the upper right cell includes MVNOs offering differentiated services for both consumers and business use. These services can include e.g. localized content (Aina Group), video calls, push-to-talk, and instant messaging (Saunalahti), as well as differentiated voice services (Transatel).

The two dimensions of the matrix, i.e. the levels of investments and service differentiation, may have some correlation with each other, as e.g. the ownership of service machinery creates more opportunities for differentiation. However, several examples of service differentiation without large network infrastructure investments have also been identified. Therefore, we consider the dimensions to be sufficiently orthogonal to allow for meaningful strategy scenarios to be distinguished for techno-economic modeling purposes.

3 Techno-economic model and scenarios

3.1 Techno-economic modeling

Techno-economic modeling methods are typically used to evaluate the economic feasibility of new technologies and services. Telecommunications industry specific methodology and tools have been developed in a number of European research projects (e.g. [3, 14]), and applied to analyze and forecast the evolution of both fixed and mobile networks (e.g. [6, 8, 12]). Techno-economic modeling combines forecasting, network design, and investment analysis methods, typically utilizing a spreadsheet-based tool.

In this paper, techno-economic modeling methods are used to analyze and compare four different virtual operator scenarios, in order to better understand the position of virtual operators in the mobile communications industry.

3.2 Scenario definition

Based on the findings of the market analysis in the previous section, we have defined four different scenarios to be modeled and analyzed. The differentiating factor between the scenarios is the selection between the cost leader and

service differentiator strategies, as well as between the SP and MVNO models. Accordingly, the four scenarios are named as follows:

- SP/CostLeader
- SP/Differentiator
- MVNO/CostLeader
- MVNO/Differentiator

The objective when creating the scenarios was neither to accurately model certain real-life companies, nor to create averaged examples of the most typical virtual operator profiles. Instead, the aim was to create four clearly different scenarios, each representing one of the four cells of the matrix in Fig. 3. The differences between the scenarios are introduced in the following subsections.

3.3 Logic of the model

Figure 4 shows the logic of the techno-economic modeling work done in this study.

Many assumptions are required regarding the service usage and tariffs, resulting in per-user billing and revenue numbers. Parameters such as mobile service penetration and operator's achievable market share are then used to calculate the total revenues. Service usage is also input to network dimensioning, required to calculate the amount of network equipment and resulting

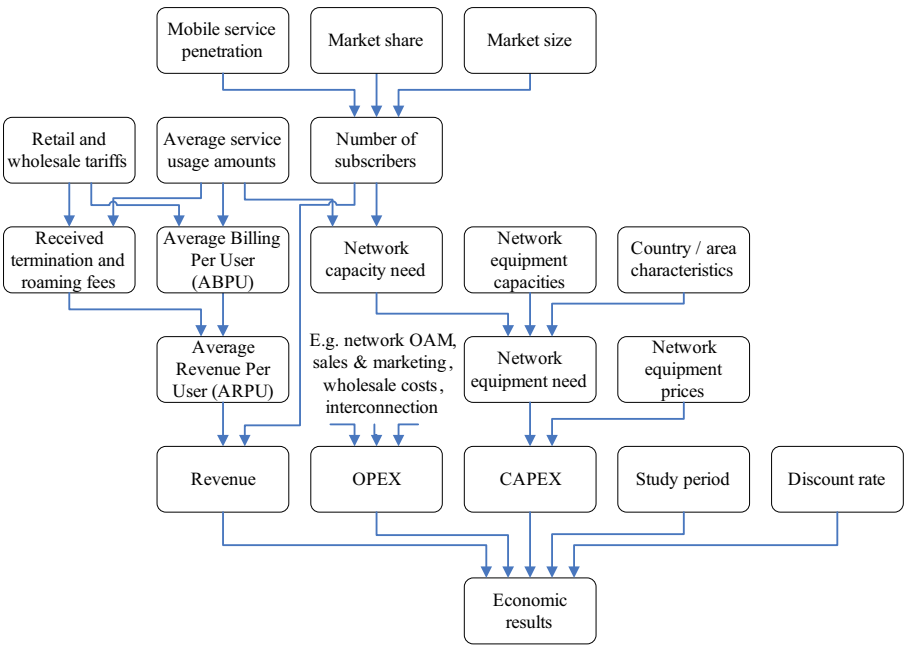


Fig. 4 Logic of the techno-economic model

CAPEX. The main inputs to OPEX calculations include numbers of existing and new subscribers, amount of equipment to be operated and maintained, and amount of traffic transmitted via the MNO's network.

The actual techno-economic model was constructed with the aid of MS Excel™-based tool created in the IST-TONIC [14] research project, and advanced further in the CELTIC-ECOSYS project [3]. The model is linear and deterministic, i.e. it includes no feed-back loops and no randomness is involved in the calculation of future states of the model. The model assumes a study period of 5 years and a discount rate of 10%.

3.4 Services and revenues

The revenue streams of the operator are assumed to differ between the SP and MVNO models, as well as between the differentiator and cost leader strategies. In the SP model, the revenue streams consist only of retail service incomes, whereas in the MVNO model also interconnection (i.e. voice call termination) generates revenue.

Incomes from retail services are modeled as the product of service tariffs and usage amounts. For the analysis, four different service classes are assumed: Calling, Messaging, Data, and Content. In the SP/CostLeader and MVNO/CostLeader scenarios, the Average Billing Per User (ABPU) is assumed to stay in the level of 24 €/month for the whole study period. In the two Differentiator scenarios, the ABPU is assumed to grow linearly from 26 to 30 €/month, as a result of increasingly higher revenues from content and data services.

In addition to the service revenues charged directly from the subscribers, interconnection with other operators' networks generates both revenues and costs in the MVNO scenarios. The logic is that if a subscriber in operator A's network is placing a call to a subscriber in operator B's network, operator A has to pay termination fees to operator B. Assuming the termination fees of all the operators would be the same, and that incoming and outgoing call distribution would follow the market shares of the operators, the interconnection fees would cancel out each other, leading to a zero-sum game. In reality, however, there is a significant difference in mobile-to-fixed and fixed-to-mobile termination fees, resulting in fixed-line operators paying clearly more termination fees to mobile operators than vice versa. In some markets, also the mobile-to-mobile termination fees of different MNOs and MVNOs are different, meaning that operators with higher termination fees receive net income from the interconnection arrangements. In this study, interconnection revenues and costs are modeled using the assumptions summarized in Table 2 and further explained in Appendix 2.

International roaming could also be a possible source of extra revenue for MVNOs, whereas SPs must rely on the agreements made by the host MNO. In this case study, however, both SP and MVNO are assumed to rely on the international roaming contracts of the host MNO, and to receive no extra revenue from their customers' mobile usage abroad.

The revenue breakdown of the two MVNO scenarios, calculated using the above-mentioned assumptions, is depicted in Fig. 5. In the MVNO/CostLeader scenario the ARPU is calculated to decrease from a level of 44 Eur/month to less than 35 Eur/month, as a result of decreasing mobile termination rates and decreasing number of fixed-to-mobile calls. In the MVNO/Differentiator scenario, the ARPU decreases less dramatically, from the level of 46 Eur/month to 41 Eur/month, as a result of higher data and content revenues.

In the SP scenarios, the calling, messaging, data, and content revenues are the same as in the MVNO scenarios, but no termination revenues are collected. Although the ARPU in MVNO scenarios is significantly higher, a major part of the "extra revenue" is paid back to other operators as termination fees. The received and paid mobile-to-mobile terminations cancel out each other completely, whereas in fixed-to-mobile/mobile-to-fixed terminations there is a clear unbalance.

Table 2 OPEX and interconnection tariff assumptions

OPEX item	Assumption	
1. Network OAM		
Network operations and administration	10% of cumulative investments	
Network maintenance	5% of cumulative investments	
Equipment installations	25% of equipment cost	
2. Sales, marketing, and customer care		
Sales and marketing	100 € per new and churned customer	
Customer care	20 € per customer per year (using average number of customers in each year)	
Charging and billing	50 € per customer per year	
3. Wholesale tariffs		
Originated calls, percentage of retail price	SP: 50%,	MVNO: 35%
Terminated calls, percentage of retail price	SP: 0,	MVNO: 35%
Originated messages, percentage of retail price	SP: 50%,	MVNO: 35%
Terminated messages, percentage of retail price	SP: 0,	MVNO: 0
Outgoing data, percentage of retail price	SP: 50%,	MVNO: 35%
Incoming data, percentage of retail price	SP: 50%,	MVNO: 35%
Content, percentage of retail price	SP: 85%,	MVNO: 85%
4. Other OPEX		
General & Administration	5% of revenues	
5. Interconnection tariffs (includes both OPEX and revenue components)		
Percentage of mobile-to-fixed calls out of all mobile-originated calls	2006: 35%,	2010: 20%
Percentage of fixed-to-mobile calls out of all mobile-terminated calls	2006: 35%,	2010: 20%
Fixed-to-mobile termination fee (Revenue), percentage of retail call price	2006: 100%,	2010: 70%
Mobile-to-fixed termination fee (OPEX), percentage of retail call price	2006: 20%,	2010: 20%
Received Mobile-to-mobile termination fee (Revenue), percentage of retail call price	2006: 100%,	2010: 70%
Paid Mobile-to-mobile termination fee (OPEX), percentage of retail call price	2006: 100%,	2010: 70%

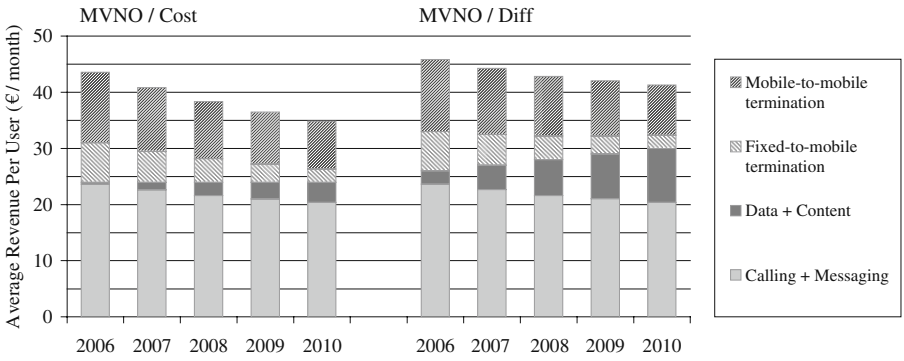


Fig. 5 ARPU breakdown in the two MVNO scenarios

3.5 Investments

The SP and MVNO scenarios differ also in terms of investments. In the SP scenarios, the costs are mainly OPEX as most of the network equipment and service machinery is outsourced to the MNO. In the MVNO scenarios, the level of outsourcing is lower and CAPEX is higher due to higher level of investments. The CAPEX elements taken into account in the analysis are shown in Fig. 6. The only investments in the SP scenarios are the Billing system and the Customer Resource Management system. For the MVNO scenarios, an Operations and Maintenance Center, Mobile Switching Center, Home Location Register, and Intelligent Network platform are required, as well as a number of value-added service specific network elements. In this study, the packet switched core network (including Serving GPRS Service Node SGSN and Gateway GPRS Service Node GGSN) is considered to be outsourced to the MNO also in the MVNO scenarios.

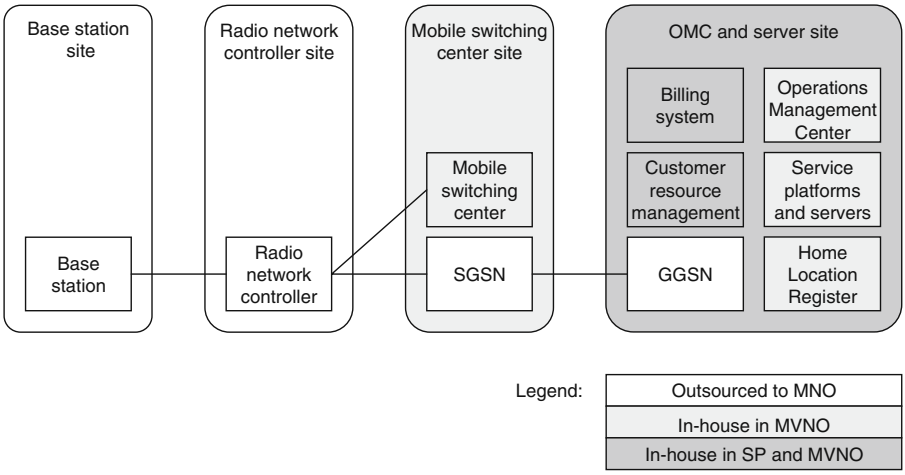


Fig. 6 Outsourcings and investments in SP and MVNO models

Using available information on equipment prices, collected in the ECOSYS project [3], the total investments were calculated to be 28 Million euros in the MVNO scenarios, and 9 Million euros in the SP scenarios.

3.6 Operational expenditures

A significant part of operational expenditures consists of the outsourcing of the network infrastructure. In the case of SP, these costs are higher, as a result of higher degree of outsourcing. The wholesale tariffs of these outsourcing contracts are usually negotiated between the SP/MVNO and the MNO on a commercial basis, without regulator intervention. Generally, the tariffs can be assumed to be somewhere between the MNO's cost of providing the network services and SP/MVNO's (and MNO's) retail prices. As the contracts can be freely negotiated, there are many options and possible revenue sharing models that could be applied.

In this case study, a simple 'retail-minus' pricing model is assumed, meaning that the wholesale prices between SP/MVNO and MNO are calculated as a percentage of the retail prices. The base assumptions for the wholesale tariffs are listed in Table 2.

Table 2 summarizes also the other assumptions regarding operational expenditures. Possible handset subsidies are assumed to be fully collected as higher monthly fees (i.e. higher ARPU), and thus have no net effect on the scenarios.

3.7 Market conditions and competition

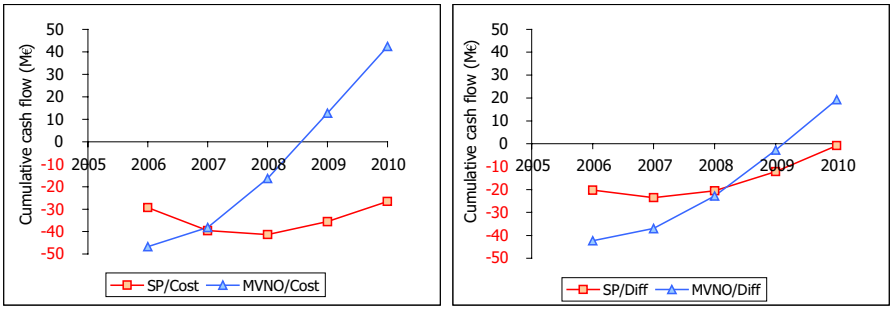
In our model, the operator is assumed to enter a market with a population of 6 million people. The market conditions are assumed to be competitive and mobile subscription penetrations already at a mature level of 92%, growing 2% annually. Therefore, the majority of the virtual operator's customers are assumed to be acquired from other operators. The market share of the analyzed operator is assumed to grow faster in the early years, and to slow down in the later years. The market share is assumed to reach a level of 10% in the CostLeader scenarios, and 5% in the Differentiator scenarios at the end of the study period, the smaller number resulting from a narrower market focus. Churn, defined here as the number of terminated subscriptions as a percentage of the average subscriber base during a year, is assumed to be 25% for the CostLeader scenarios and 15% for the Differentiator scenarios.

3.8 Results

3.8.1 Economic results with base assumptions

Figure 7 shows the results for the four different scenarios.

The left-hand graph of Fig. 7 shows the results for the two CostLeader scenarios. Here, the MVNO performs significantly better compared to its SP counterpart, having clearly positive NPV and IRR of 19.3 M€ and 26.1%. The



Scenario	NPV (M€)	IRR	Payback (yrs)
SP/Cost	-27,0	-	>5
MVNO/Cost	19,3	26,1 %	3,6

Scenario	NPV (M€)	IRR	Payback (yrs)
SP/Diff	-6,1	-1,0 %	>5
MVNO/Diff	4,0	13,8 %	4,1

Fig. 7 Economic results for the four scenarios

payback time for the MVNO/CostLeader scenario is 3.6 years, whereas in the SP/CostLeader scenario the cumulative cash flow does not turn positive during the whole study period.

The right-hand graph of Fig. 7 shows the results for the two Differentiator scenarios, respectively. Again, the MVNO scenario turns out to be more profitable, but the difference is not as significant as in the CostLeader scenarios. Notably, the MVNO/CostLeader performs better than MVNO/Differentiator, whereas the SP/CostLeader shows clearly worse performance than SP/Differentiator.

Figure 9 (Appendix 3) illustrates the revenues and cost breakdowns of all the scenarios. Compared to the SP scenarios, in the two MVNO scenarios the margin between revenues and costs becomes clearly larger already in the second year of operation, which more than compensates the higher investments and operational costs. The higher margins result directly from the termination fees received by the MVNO, and more precisely from the fixed-to-mobile termination revenues which are clearly higher than mobile-to-fixed termination costs.

Interesting observations can be made also by comparing the CostLeader and Differentiator strategies for both SPs and MVNOs. In the SP case, the Differentiator strategy gives better results than the CostLeader strategy, whereas in the MVNO case the CostLeader strategy is more profitable. In the two cases, the relevance of ARPU and subscriber base is different.

For the MVNO, the revenue margin is sufficiently high for both the CostLeader and the Differentiator strategies. In this case, the higher achievable market share (10% vs. 5%) of the CostLeader strategy turns the business case more profitable, although the ARPU and per-subscriber revenue margin are better for the Differentiator strategy.

For the SP, the tighter revenue margins turn the positions around. In the CostLeader strategy, the higher subscriber base is not helpful as the per-subscriber revenue margins are thin. The Differentiator strategy turns out to be more profitable because of the higher ARPU level.

3.8.2 Sensitivity analyses

Many of the base assumptions in our model are forward-looking, and therefore by definition uncertain. The constructed model allows for sensitivity analyses to be done on the input parameters, helping to deal with the uncertainty and giving more insight to the dynamics and critical inputs of the model. As shown in Fig. 9 (Appendix 3), OPEX clearly dominates the costs side of this business, whereas investments are in a smaller role. OPEX is therefore also at the focus of the sensitivity analyses.

Sensitivity analyses revealed that the most NPV-sensitive input parameters are the following: 1) ABPU, 2) MNO's share of the retail revenues, 3) Sales and marketing costs, 4) Customer care costs, 5) Achievable market share. The effect of changes in these five key parameters were analyzed by changing them one at a time, between the minimum and maximum values of 60% and 140% of their base values. The results were plotted in sensitivity graphs (i.e. spider charts) shown in Fig. 10 (Appendix 4).

The results of the sensitivity analysis show that in every scenario, the MNO's share of revenue and the ABPU are the most critical input parameters, although their relative importance differs slightly between the MVNO and SP scenarios. A decrease of 7.7% and 2.9% in ABPU will turn the MVNO/CostLeader and MVNO/Differentiator NPVs negative, respectively. Correspondingly, ABPU increases of 15.8% and 6.5% are required to turn the SP/CostLeader and SP/Differentiator scenarios profitable.

MNO's share of revenue is the most crucial single parameter in both of the two SP scenarios. To be profitable, the SP/CostLeader scenario requires the MNO's wholesale tariffs to be less than 43% of retail prices, whereas in the SP/Differentiator scenario the level of 47% is sufficient. For the MVNO/CostLeader and MVNO/Differentiator scenarios, the respective values are 45% and 42%. As already discussed, in reality the wholesale tariffs for MVNOs are likely to be lower than those for SPs.

Customer care as well as sales and marketing costs have rather similar weight in all the scenarios. The effect of changes in the Achievable Market Share input parameter, however, differs clearly between the scenarios. In the MVNO scenarios the effect of higher subscriber base is clearly positive, whereas in the SP scenarios the effect is less significant. In the SP/Cost scenario, the effect is actually negative, due to thin revenue margins per customer and relatively high customer acquisition costs.

4 Summary

4.1 Conclusions and discussion

In this paper, we have analyzed four generic virtual operator scenarios, each one of which is visible in the mobile communications industry today. The findings of our analysis are summarized in Table 3.

In all scenarios, the tariffs negotiated between the SP/MVNO and an MNO play a crucial role in the quest for profitability, and even more so for the SP scenarios. This highlights the importance of negotiation power when agreeing on the contract terms with MNOs. By keeping the wholesale tariffs sufficiently high, MNOs can effectively block competition and successful entrance of new players to the market.

In the economic analysis, the MVNO/CostLeader scenario shows the best profitability, whereas the SP/CostLeader scenario is the least profitable. However, in the real world most virtual operators belong to the latter group and there are only few MVNOs driving either the cost leader or differentiator

Table 3 Summary of results

MVNO / Cost leader		MVNO / Service differentiator	
Market analysis:	Techno-economic analysis:	Market analysis:	Techno-economic analysis:
Not many players active in the market	Very good profitability	Not many players active in the market	Good profitability
Basic service set for consumers	Very sensitive to changes in ARPU	Targeting both consumers and business users	Sensitive to achievable market share
Subsidiary companies of MNOs operating on other geographic markets		Differentiation e.g. by different kinds of content (local/ regional services, entertainment) and voice call solutions	High margins >> less sensitive to changes in ARPU and MNO's revenue share
Costs kept low with own network infrastructure abroad		Players' market share small	

SP / Cost leader		SP / Service differentiator	
Market analysis:	Techno-economic analysis:	Market analysis:	Techno-economic analysis:
Many players active in the market	Lowest profitability	Many players active in the market	Low profitability
Simple pre-paid voice and SMS services for consumers	Thin margins make ARPU and MNO's revenue share crucial to profitability	Targeting both consumers and business users	Very sensitive to ARPU and MNO's revenue share
Products sold via Internet/direct sellers, no retail chains		Often concentrated on very narrow markets	
		Mobile as one channel of multi-channel operations, often combined with exclusive content	

strategy. This raises some questions about the reasons behind the unpopularity of the 'full' MVNO model. One possible reason is that incumbent MNOs are willing to let low-profitability SPs enter the market more easily than players that might be threatening their market shares more seriously. By making the contract terms more favorable to SPs than MVNOs, MNOs could affect the investment strategies of market entrants. Another possibility is that there is no will from the virtual operator's side to move to the MVNO level, possibly due to lack of technical competence or because the mobile operations are only supporting the company's core business.

4.2 Future work

This paper has demonstrated the usefulness of techno-economic modeling methods in analyzing the complex business of virtual operators. However, modeling always requires simplifications to be made, and in that sense our study is not an exception. The scenarios presented in this paper can only partly capture the dynamics and the complexity of the business models and operations of current virtual operators. Even as such, however, the use of techno-economic modeling methods has proved to give valuable insights to the virtual operator business environment, and provides a concrete basis for more detailed analyses.

Interesting topics for future work include e.g. more detailed analysis of the contract terms between virtual operators and MNOs in different market settings. The possibilities to negotiate sufficiently good wholesale deals with MNOs are certainly different in markets with equally strong MNOs (e.g. UK) and in markets with clear MNO leaders (e.g. Finland). Our hypothesis is that virtual operators can bargain more efficiently with MNOs if the inter-MNO competition is even. Although examples are still rare, it is possible for some virtual operators to contract with two or more MNOs simultaneously and thus become more powerful (see e.g. [7]). These types of multi-MNO virtual operators would increase both service and network competition thus weakening the position of vertically integrated mobile operators.

The impacts of 3G and IP-based services on the virtual operator opportunity are also an interesting area for further research. 3G will probably give better differentiation possibilities for focused virtual operators, and increased competition in the network level should increase the SP's/MVNO's negotiation power. A possible initial overcapacity due to 3G coverage deployments could make the SPs and MVNOs look more interesting from the MNOs' viewpoint.

Appendix

Appendix 1: Examples of virtual operators in Europe, 1998–2005

Table 4

Table 4 Examples of virtual operators in Europe, 1998–2005

Operator (Country/Launch year)	MVNO/SP	Customer base/ market share in 2005	Strategy (Cost leader/ Differentiator)	Other
ACN (Sweden, Norway, Finland/2004)	SP	200,000/4% (Finland 2004)	Cost leader (utilizes network marketing and selling)	Ended operations in Finland in 2005
Aina Group (Finland/2005)	SP, MVNO	–	Differentiator (local content, multi-channel operations)	Own content
BT (UK/2004)	SP	300,000/0.5% (2004)	Differentiator (converged landline/ cellular/WLAN handset Bluephone)	
Campuz Mobile (Sweden/2001)	SP	–	Cost leader (focused on young people)	Co-operation with Sony Ericsson
Chess/Sense (Norway/2004)	SP	405,000/9%	Cost leader	Acquired by TeliaSonera 2005
Djuice (Sweden/2001)	MVNO	$\sim 80,000/1\%$	Cost leader (private consumers & SMEs)	Owned by the Norwegian MNO Telenor
EasyMobile (UK, Denmark/2005)	SP	UK: 15,000	Cost leader (low price, simple product)	
Fujitsu Invia (Finland/2004)	SP	–	Differentiator (mobile business solutions)	Co-operates with two MNOs
GoMobile (Finland/2004)	SP	80,000/1.6%	Cost leader	Operates via MVNE Spinbox
Saunalahti (Finland/1998)	MVNO	500,000/10%	Mixed, Cost leader/service Differentiator	Acquired by MNO Elisa in 2005
Tele2 (Norway, Denmark, Austria, France, Netherlands/2000 – 2006)	MVNO	150,000/3% (Denmark)	Cost leader	MNO in Sweden

Table 4 (Continued)

Operator (Country/Launch year)	MVNO/SP	Customer base/ market share in 2005	Strategy (Cost leader/ Differentiator)	Other
Telmore (Denmark/2001)	SP	500,000/10% (2003)	Cost leader	Acquired by TDC 2004
Transatel (France, Belgium, Netherlands/2002)	MVNO	–	Differentiator (multi-country operations and service offerings)	Local call rate in France, Belgium, Luxemburg, Netherlands.
Virgin Mobile (UK/1999)	SP	4,600,000/8%	Differentiator (content, pricing packages)	
Vox Mobile (Luxembourg/2004)	SP	85,000/∼14%	Differentiator (bundles of fixed and mobile subscriptions, content)	Owns a 3G license
Wireless Maingate (Norway, Sweden, Finland/1998)	SP	–	Differentiator (machine-to-machine and messaging services for companies)	Co-operates with several MNOs

MVNE mobile virtual network enabler

Appendix 2: Calculation of revenues and costs related to phone calls

Figure 8 illustrates the different types of phone calls taking place between a virtual operator (SP/MVNO) and other operators. Firstly, some of the calls are both originated and terminated by the subscribers of the virtual operators (1). Secondly, some of the calls are made between the virtual operator and another service operator in the same network (2, 3). Thirdly, some of the calls are made between the virtual operator and another service operator in another mobile network (4, 5). Finally, rest of the calls take place between the virtual operator and a fixed line operator (6, 7).

In our calculations, we assume that originated calls (types 1, 2, 4, and 6) generate retail revenues for both SPs and MVNOs, whereas terminated calls (types 3, 5, and 6) generate interconnection revenues only for MVNOs. Accordingly, SPs pay wholesale fees for MNO1 only for originated calls, whereas MVNOs pay also for terminated calls.

In the calculations, we assume that the termination fees of the MVNO, MNO1, and MNO2 are the same, and that the termination fees between these cancel out each other. Termination fees of the fixed-line operator are, however, assumed to be clearly lower than that of MVNOs, resulting in net incomes for the MVNO.

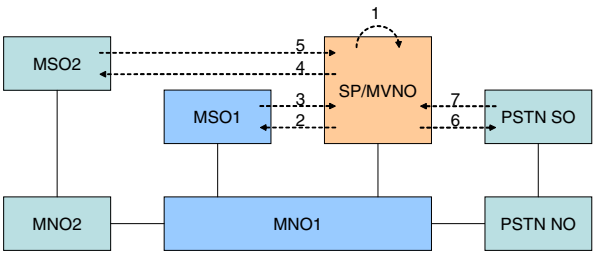


Fig. 8 Call types between SP/MVNO and other networks

Appendix 3: Revenues and cost breakdowns for the different scenarios

Figure 9

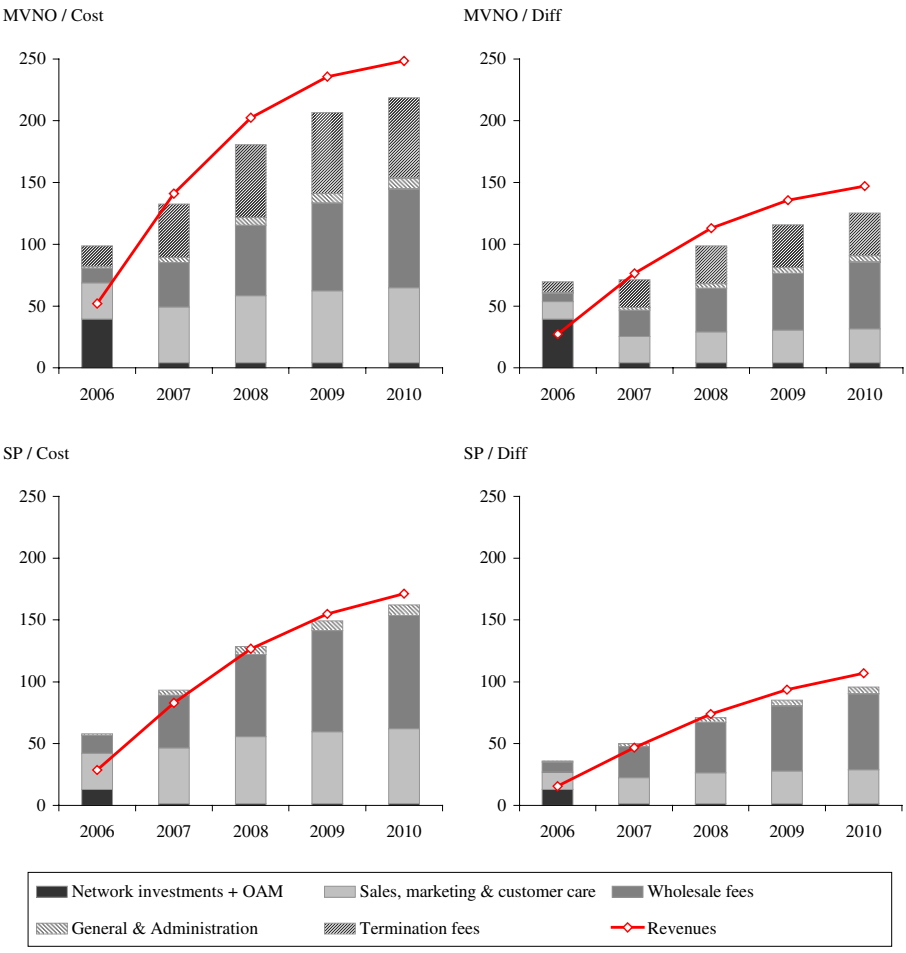


Fig. 9 Revenues and cost breakdowns for the different scenarios

Appendix 4: Sensitivity graphs for the different scenarios

Figure 10

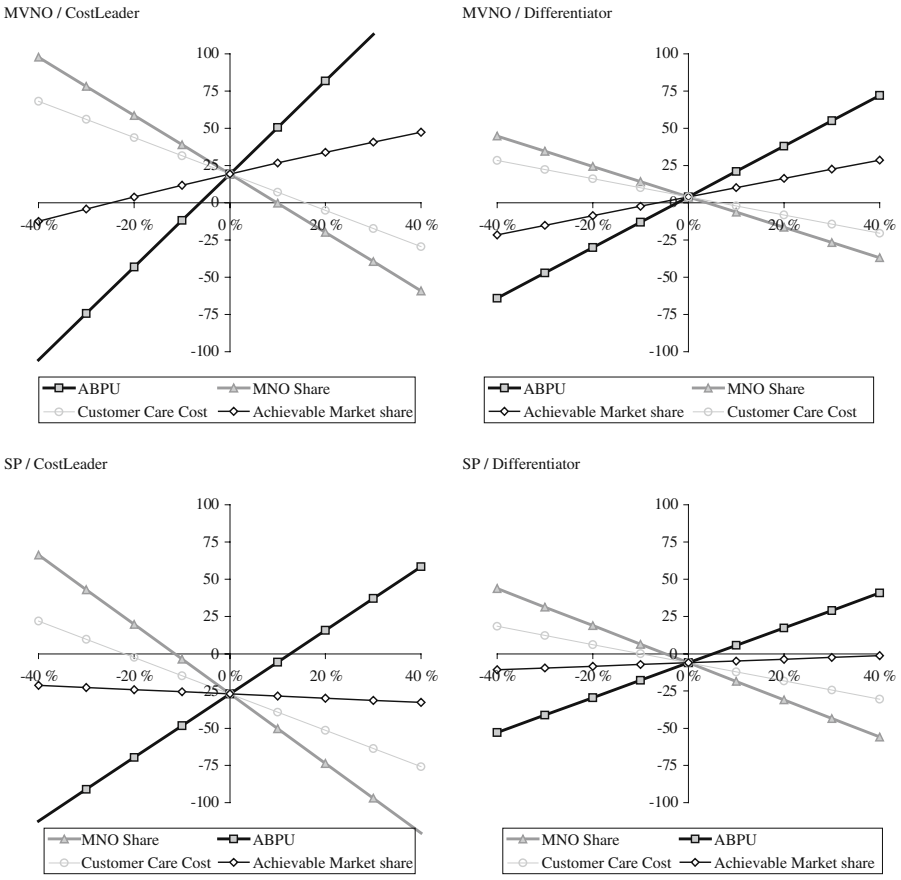


Fig. 10 Sensitivity graphs for different scenarios

Appendix 5: Model Inputs for Different Scenarios

Table 5

Table 5 Model inputs for different scenarios

	SP		MVNO	
	SP/Cost	SP/Diff	MVNO/Cost	MVNO/Diff
Market size	6060000			
Mobile subscriber penetration, 2005	92%			
Mobile subscriber penetration annual growth	2%			
Scenario name	SP/Cost	SP/Diff	MVNO/Cost	MVNO/Diff
Achievable market share	10%	5%	10%	5%
Churn	25%	15%	25%	15%
ABPU 2006, €	24	26	24	26
ABPU 2008, €	24	28	24	28
ABPU 2010, €	24	30	24	30
Service1 name	Calling			
Service1 share of ABPU 2006	83.50%	77.08%	83.50%	77.08%
Service1 share of ABPU 2008	75.00%	64.29%	75.00%	64.29%
Service1 share of ABPU 2010	70.00%	56.00%	70.00%	56.00%
Service2 name	Messaging			
Service2 share of ABPU 2006	15.00%	13.85%	15.00%	13.85%
Service2 share of ABPU 2008	15.00%	12.86%	15.00%	12.86%
Service2 share of ABPU 2010	15.00%	12.00%	15.00%	12.00%
Service3 name	Data			
Service3 share of ABPU 2006	0.50%	3.03%	0.50%	3.03%
Service3 share of ABPU 2008	3.33%	7.62%	3.33%	7.62%
Service3 share of ABPU 2010	5.00%	10.67%	5.00%	10.67%
Service4 name	Content			
Service4 share of ABPU 2006	1.00%	6.05%	1.00%	6.05%
Service4 share of ABPU 2008	6.67%	15.24%	6.67%	15.24%
Service4 share of ABPU 2010	10.00%	21.33%	10.00%	21.33%

Table 5 (Continued)

	SP		MVNO	
	SP/Cost	SP/Diff	MVNO/Cost	MVNO/Diff
MNO revenue share, Calling	50%		40%	
MNO revenue share, Messaging	50%		40%	
MNO revenue share, Data	50%		40%	
Content provider revenue share, Content	85%		85%	
Handset subsidy, € per new subscriber	0			
Sales & Marketing Cost, € per customer per year	100			
Customer Care + Charging & Billing Cost, € per customer per year	70			
Network Administration Cost, % of cumulative investments	10%			
General Administration Cost, % of revenue	5%			
Equipment Maintenance Cost, % of cumulative investments	5%			
Equipment Installation Cost, % of annual investments	25%			
Equipment Price Erosion, % per year	15%			
Fixed Calls share 2010, % of calls	N/A		35%	
Fixed Calls share 2006, % of calls	N/A		20%	
Own Mobile Termination fee 2006, % of retail price	N/A		100%	
Own Mobile Termination fee 2010, % of retail price	N/A		70%	
Other Mobile Termination fee 2006, % of retail price	N/A		100%	
Other Mobile Termination fee 2010, % of retail price	N/A		70%	
Fixed Termination fee 2006, % of retail price	N/A		20%	
Fixed Termination fee 2010, % of retail price	N/A		20%	

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