

**DOES REGULATION IMPACT THE ENTRY IN A MATURE REGULATED INDUSTRY?  
AN ECONOMIC ANALYSIS OF THE MVNOS**

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## Abstract

Since 1998, the European telecommunications industry is entered into a liberalization phase. In mobile markets, the liberalization policy induces the introduction of competition between a larger number of competitors and a decrease in retail prices. However, the assessment of national markets reveals insufficient competition between network operators and a new regulation was proposed to facilitate private investments into this mature industry.

This paper investigates the determinants of the fringe entry into European mobile telecommunications markets between 1998 and 2005. More precisely, we intend to answer the following question: *how do cross-national differences in the market structure and the regulatory design (regulatory incentives and governance) affect the number of Mobile Virtual Network Operators' (MVNOs) in mobile markets?*

We test a set of hypothesis using internationally comparable variables of economic and regulatory determinants and allowing for 10 European Member States and temporal fixed effects on 8 years. We infer the hypotheses to predict cross-national variations in the number of MVNOs entries. We then control for the potential effects of the contractual governance of the MVNOs' access to the incumbents' mobile networks.

We demonstrate that the amount of fringe entry into a mature industry is the result of both the strategic behavior of the incumbents towards hosting MVNOs on their networks and the adoption of credible regulations to prevent the exercise of strategic entry-deterring activities. Our findings are salient for policymakers and practitioners alike.

Keywords: Regulation, Market entry, Telecommunications industry, MVNO.

## Introduction

In economics, an important question about regulation is appropriate incentives and efficiency. For a regulated industry, a key point relies on the capability to attract investors and new entrants able to compete with historical monopolies or incumbents.

Two contradictory forces interact. First, the regulation must protect private investment in infrastructure through limiting the number of competitors. Second, the level of competition must be high enough for obtaining a sustainable market growth and a price decrease for customers.

So, since the enlargement of market is obtained and maturity stage reached, the key question is to know whether market does need a further step in regulation to attract extra new entrants or private contracts between players are enough. Theoretically, the key question is about the best way to implement new offers: new regulation or private ordering?

In this article, we aim to explain why new competitors entered a mature industry, such as the European mobile telecommunications industry, when other competitors did not?

Until 1998, the European telecommunications regulatory policy focused mainly on the liberalization of fixed –line telephony. After 1998, the regulators concentrated on the liberalization of the mobile industry as well. Granted with strengthened powers, they adopted three main pro-competitive economic incentives with expected impacts on prices and mobile market growth: the introduction of the dial number portability, the regulation of interconnection charges and the presence of airtime resellers. (Grzybowski, 2005) Number portability should reduce consumer-switching costs and decrease prices (Klemperer, 1995; Buehler, Dewenter and Haucap, 2006); the regulation of interconnection charges should decrease marginal costs of providing mobile services in the industry and lower prices. (de Bijl and Peitz, 2002 and 2004) Finally, the presence of airtime reseller should increase the number of competitors, lower prices and promote innovative service offerings that benefit mobile users. (Valletti, 2003: 9) At the very end, the so-called “*ladder investment theory*” suggests that resellers may invest into their own infrastructures in order to be less dependent on the incumbent and offer a wider range of services. (Cave and Vogelsang, 2003)

Due to the scarcity of the available radio spectrum capacity, allocating traditional mobile licenses was impossible so that new mobile competitors would have to negotiate access to the networks of the incumbents and eventually to ask for relevant regulatory assistance. Despite the absence of a common definition<sup>1</sup>, Mobile Virtual Network Operators (MVNO) are characterised by being operators who provide mobile communications services to users without its own airtime and government-issued licenses. Following Dewenter and Haucap (2006), we must acknowledge that this broad definition of an MVNO does not completely cover all MVNO business models deployed in diverse European States with different regulations. Adopting a differentiation proposed by the business literature we distinguish between three types of MVNOs models (IDATE, 2006<sup>2</sup>):

- Full MVNOs, which provide their own network core including a mobile switching center (MSC)<sup>3</sup>;

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<sup>1</sup> For a survey on MVNOs definitions, see Dewenter and Haucap, 2006.

<sup>2</sup> Some business studies have argued that the definition by the ownership of certain key assets was flawed because it assumes that the use of these assets can only be achieved by acquiring them entirely. MVNOs are ranged according to the degree of control over some aspects of service design. (Analysys paper, 2005, “The future of MVNOs”).

<sup>3</sup> Tele2 (Denmark, Finland or Sweden), or BT (UK) or Saunalahti (Finland) belong to the "full MVNO" type.

- Intermediate MVNOs, which acquire a switched service, but either provide their own home location register (HLR) or share a jointly owned HLR with and Mobile Network Operator<sup>4</sup>;
- And Thin MVNOs, which only provide additional applications and content and which are little different from pure resellers or service providers (they are also called “*enhanced service providers*”, Kiesewetter, 2002)<sup>5</sup>.

To date, the number of entry has been very different from one European Member State to another. (Figure 1) This lack of convergence in European markets development is related to many factors, such as the legal and contractual difficulty of negotiating and then implementing an access agreement with an incumbent or the wrong choice of business strategies. IDATE (2006) identified two main threats related to MVNOs strategies: first, the destruction of value if the pricing pressure is too high (switching to the low-cost model), and second, the prohibitive cost of building whole or parts of mobile networks.

The purpose of this research is to provide an empirical investigation on the impact that market structure and regulations may have on the amount of fringe entry into a mature industry. For this purpose, we use a panel of entry data for 10 European Member States spanning the period of 1998-2005. We use both the individual and time dimensions of our dataset, given the time series of consistent data available. We demonstrate that the amount of fringe entry into a mature industry is the result of both the strategic behavior of the incumbents towards hosting MVNOs on their networks and the adoption of credible regulations to prevent the exercise of strategic entry-detering activities. We organize our paper in the following manner. The first section discusses the previous literature. The second section describes our data and variables and the third one describes the empirical models we test in this paper. The last section presents the results and discusses conditions that promote competition in mobile markets.

## **Section 1: Regulation, new institutional economics and fringe entry into a mature industry**

The scholarly literature that underpins our hypotheses falls into two categories: the literature on fringe entry into a mature industry and the new institutional economics. We begin by summarizing the primary insights of each body of literature as they relate to the expected determinants of the number of entrants into newly liberalized European mobile markets.

During the 1990’s European Member States gradually started to liberalize their telecommunications markets by promoting service competition and access to network infrastructure. For the mobile industry, this has led to a decrease of retail prices, an increase in the number of competitors and a mobile diffusion reaching a near saturation point. To date, the European mobile market can be qualified as a highly mature voice market with a regulated framework, a competitive dynamics operated by mobile network incumbents and a fringe entry of airtime resellers (some retailers but mainly MVNOs).

This competitive dynamics is explained by the literature related to fringe entry into a mature industry. Industry maturity is often synonymous with a few dominant firms, high barriers to entry and a low rate of entry. “*However, mature industries often show a dramatic increase on*

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<sup>4</sup> Virgin Mobile (UK) belongs to the "intermediate MVNO" type.

<sup>5</sup> Telmore, Tesco Mobile or Sun Telecom is belonging to the "thin MVNOs" type.

*the number of the firms. Typically, this occurs as a result of the founding of new kinds of organizations that are different from incumbent firms.*" (Swaminathan, 1998: 389) Two alternative explanations for firm entry into new market segments in a mature industry have been proposed: the resource-partitioning model and the niche formation process. (Swaminathan, 1998):

- Some authors refer the resource-partitioning model (Carroll, 1985). As industries mature they come to be dominated by a few generalist firms. These generalist firms attempt to maximize their performance by drawing on the largest possible resource space, the centre of the market, opening up resources on the periphery of the market segmentation to specialist new entrants (Beesley and Hamilton, 1984);
- Other authors argue that new market niches may emerge as a result of discontinuities in an industry's environment: for example changes in government policy or in regulatory regimes may open oligopolies and create competitive opportunities for new entrants (Abernathy and Clark, 1985: 18).

We argue that MVNOs' entry in the European mobile markets may be driven by both a resource-partitioning process as a result of non-targeted mobile consumers (2.1) and a niche formation process as a result of the adoption of entry regulations (2.2) when new entrants perceive those regulations as credible commitments (2.3).

### **1.1 Competitive entry, resource-partitioning and market concentration**

Following the resource partitioning model, MVNOs' entry into mature mobile markets may be due to the degree of market concentration, mainly oligopolies.

Resource partitioning model describes a marketplace as being made up of multi-dimensional service space, with each dimension representing a distinctive customer attribute. Organizations align themselves within such market topography by targeting their services at the various resource spaces or market segments. (Mainkar *et al.*, 2006: 1068)

At the early stage of market's evolution, the market is characterized by a low degree of concentration<sup>6</sup>. More specifically, the market is composed of a large number of generalist firms, each of which cannot individually affect prevalent price levels. The market coverage overlaps near the centre but a large proportion of the total market is covered by differentiated services so that the resource space available for specialists is smaller. (Swaminathan, 1998: 393)

Once a few generalists are concentrated in the centre space, predictions from industrial organization economics and resource-partitioning differ. Industrial organization economics (Schmalensee, 1978; Judd, 1985) predicts that the benefit continue to accrue to the incumbents due to the scale economies, collusion and credible commitment. In contrast, resource partitioning model predicts that with a higher level of concentration, the generalist firms are fewer in number and larger in size so that the total resource space covered is smaller than in the case of a concentrated market with differentiated services. Specialists have access to greater resource that they exploit at the fringe market segments without entering into direct competition with the larger generalists. (Swaminathan, 1998: 393) High concentration in the market implies that specialists can draw upon fringe resources without entering into direct competition with generalists. (Freeman and Lomi, 1994; Lomi, 1995; Swaminathan, 1995 and 1998; Dobrev and Swaminathan, 2002)

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<sup>6</sup> Concentration refers to the aspect of the competitive process that is driven by the size distribution of the dominant incumbent firms within a given resource space.

At the advanced stage of market's evolution, Dobrev (2000) applies the resource partitioning model in periods of a decrease of market concentration following market liberalization and deregulation. In such context, it is showed that declining market concentration has a negative effect on the founding of generalists and a positive effect on the entry rate of specialists. (Dobrev, 2000: 401) This results from the fact that the observed overall disintegration in industry consolidation actually conceals increasing local concentration. Swaminathan (2001) offers an explanation related to the fact that the generalist can appropriate a portion of the resource space by developing an ability to operate in both the generalist and specialist segments. Generalists will operate either by copying specialist's routines or by extending their product lines into specialists' space so that some resemble the service features offered by specialists, albeit at a lower cost.

Recent MVNOs' studies confirm that the incumbents' incentives to voluntarily provide network access critically depend on the degree of service differentiation: "*Generally, MNOs will voluntarily provide network access if the services offered by the candidate MVNOs are sufficiently differentiated, as with a high degree of product differentiation the revenue effects outweigh the competition (cannibalization) effects.*" (Dewenter and Haucap, 2006: 2; Greenstein and Mazzeo, 2006; Ordober and Shaffer, 2007) Following MVNOs' access to mobile networks, market's evolution can be translated into a two-stage process:

- A first stage characterized by a high degree of market concentration and MVNOs' entry with differentiated services (full and intermediate types) that do not enter into direct competition with generalists;
- A second stage characterized by a lower degree of market concentration and MVNOs' entry with differentiated services (full and intermediate types) imitated by generalists.

So, the hypothesis 1 follows:

*Hypothesis 1: The decrease of market concentration induces an increase in the amount of fringe entry (MVNO) if new entrants deliver differentiated services into European mobile telecommunications markets.*

## **1.2 Competitive entry, entry regulation and asymmetric regulation**

MVNOs' entry into mature mobile markets may be also due to the emergence of a niche as a result of changes in access price and entry regulations.

Initial competition took the form of competitive access providers, companies (like Sense in Sweden) that allowed customers to bypass the incumbents' mobile network and the associated expenses. Fearing the cannibalization of their own customers, many incumbents then refused to grant access to their network or negotiated lengthy contracts with restrictive terms and conditions.

Some EU Member States decided to assist MVNOs' entry by adopting favorable access price regulation. Furthermore, as of July 2003, European Union asked for a national assessment of the competition level on the market for the wholesale mobile access and call origination. Depending on national mobile markets, regulators adopted or threatened to adopt formal decisions that designated incumbents with significant market power and that proposed regulatory remedies to correct it. One of the proposed remedy was a regulation of entry by mandating MVNOs' access to incumbents' mobile networks. As a result, national regulatory policies vary between mandatory and non-mandatory access and the mobile

telecommunications industry has become one industry consisting of incumbent facing competition from a competitive fringe, the MVNOs.

When competitive fringe firms enter the mobile telecommunications industry, national regulators must decide whether to impose access price, mandatory access on the network operators, maintain or remove them. *'Asymmetric regulation occurs when a single firm, or group of firms, is subject to differential regulatory oversight'*. (Abel and Clements, 2001: 229) We classify access price and entry regulation as asymmetric when those policies apply only to network operators and not to MVNOs. Access price and mandatory access are asymmetric regulations as they concern only incumbents.

In contrast, the mobile number portability regulation cannot be qualified as an asymmetric regulation as it concerns all the mobile operators (the network and the virtual operators). However, the portability regulation is usually considered as a regulation aiming at lowering the entry barrier related to customer inertia (Armstrong and Sappington, 2006). Therefore, the mobile number portability corresponds to an entry regulation.

The impact of an asymmetric regulation on the amount of entry can be illustrated as a two-stage game. (Schankerman, 1996) In the first stage, potential competitors make independent decisions on whether to enter a market. In the second stage, firms engage in price competition or services differentiation. By altering competition and expected profitability in the second stage, asymmetric regulation can impact competitive entry in the first stage. The existing literature addresses asymmetric regulation in the telecommunications industry, especially that pertaining to asymmetric price regulation (de Bijl and Peitz, 2002 and 2004; Kim and Park, 2002; Armstrong and Sappington, 2006: 33), carrier of last resort obligations (Weisman, 1994; Schankerman, 1996), and quality of service regulation (Abel and Clements, 2001). The general consensus is that asymmetric regulation is associated with a significant higher amount of entry.

Consistent with other forms of asymmetric regulation identified in the literature, asymmetric access price and entry regulations should induce high amount of fringe entry into mobile markets.

### **1.3 Regulatory design: the assessment of the regulation credibility as a factor of private investments**

One of the main insights of the NIE literature relates to the assessment of the state's ability to commit to a utilities-specific regulatory schema. To apprehend this ability, the NIE literature analyzes regulation via a "design" construct whose two components are "regulatory incentives" and "regulatory governance" (Levy and Spiller, 1994; 1996). The former refers to the rules governing pricing, subsidies, competition and market entry, networks infrastructure interconnections, etc., and therefore applies to the utilities themselves. The latter refers to the mechanisms by means of which the state restrains a political organization's ability to reform the regulatory framework that applies to the utilities sector and the mechanisms for settling any subsequent conflicts. Following this literature, a regulatory design should be qualified as a credible regulation depending on the extent to which institutional safeguards increase the costs of reneging on previous commitments in place.

From the perspective of private investors, the same literature emphasizes the extent to which the political institutions in place support political actors' commitments not to expropriate the property or rent-streams of investing firm increases the incentives of telecommunications firms

to invest. (Henisz and Zelner, 2001 and 2004) In other words, private investors in regulated markets will only believe government pledges regarding future economic incentives to the extent that they are credible.

We argue that the assessment of credibility is a question of primary importance in the case of MVNOs' entry. In order to facilitate new entries, the introduction of asymmetric regulations reformed the current regulatory framework based on the allocation of spectrum. Some incumbents have indeed complained that the introduction of further competitors would be a violation of their license conditions and that it should be regarded as a hold-up on their specific investment in network infrastructure. (Dewenter and Haucap, 2006)

Accordingly, the MVNOs' incentives to invest in mobile markets will depend on the credibility of those asymmetric regulations: access price and entry regulations. More particularly, entry decisions will depend on the institutional safeguards that increase the costs of reforming those asymmetric regulations.

A theoretical result arising from both the literature on niche formation process and the NIE literature would be that:

*Hypothesis 2: The existence of a credible regulation (access price and entry regulations) induces a high amount of fringe entry (MVNOs) into European mobile telecommunications markets.*

## **2 Model, Data Collection and Variables**

In order to unravel the determinants of MVNOs' entry, we propose a model relying on the previous literatures. We settle a distinction between economic and technological factors that may give way to regulatory intervention. Economic factors of MVNOs' entry are related to market structure whereas technological factors depend on the level of dependence between the MVNO and the incumbent, which is translated into contractual governance. Regulation may impact both economic and technological factors in order to assist new entries; the nature and strength of the impact depend on the credible commitment of a regulator.

### **2.1 The dependent variable**

In the empirical analysis described below, we examine a dependent variable which is the cumulative number of entrants (MVNO) at the end of each year. We define an entry as the launch of a mobile communications services, excluding the mere announcement of commercial relationships in press releases. The dependent variable is constructed from the European Commission's report on implementation of the regulatory framework dated of 2005<sup>7</sup> and from the Telecom paper Mobile MVNO/SP List<sup>8</sup> with verification on each MVNO website.

### **2.2 The explanatory variables**

We group the explanatory variables used in our empirical analysis into the following three categories for the purpose of description and discussion: (1) variables related to market structure; (2) variables related to contractual governance; (3) variables related to regulation.

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<sup>7</sup> European Commission, 2005, 11th report on implementation of the regulatory framework, Annex 1, p.22.

<sup>8</sup> The Telecompaper Mobile MVNO/SP List was previously called the "Takashi Mobile MVNO/SP list" and is accessible on : <http://www.telecompaper.com/research/mvnos/>

### **2.2.1. Variables related to mobile market structure**

This first category includes several measures that we use to control for variations in market structures across European Member States and the level of market competition.

The first variable (COMP) is the degree of competition by new entrants which is defined by the annual level of market shares of all MVNOs. (OECD, 2000 and 2003) We expect a high degree of competition by new entrants to reflect high level mobile market competitiveness so that we anticipate a positive correlation between this variable and MVNOs' entry. (Gruber and Verboven, 2001)

The second variable (CONC) controls for the degree of concentration in the mobile telecommunications markets, as measured by the HHI (Herfindhal-Hirschman Index) that is the sum of the squares of the market shares of all mobile networks operators (MNOs). We must acknowledge that our data only take into account the market shares of the incumbents excluding those of new entrants. Following Hazlett and Muñoz (2004), we endorse the fact that the number of mobile operators is most often fixed externally, by spectrum licensing so that we expect the magnitude of concentration (HHI) to be largely the result of regulatory design. We expect that the evolution of the HHI level is linked to the credible commitment of a European Member State to improve competition because a high degree of concentration may lead to a regulatory decision on individual or collective dominance with compulsory obligations for MNO(s) which may be favorable to MVNOs. We then anticipate that the degree of concentration is positively linked to MVNOs entry.

The third variable (MNO) represents the number of mobile incumbents and most often corresponds to the number of mobile networks accessible for MVNOs. We recognized that we do not distinguish the incumbents' technologies that are 2G or 3G and that some national 3G licenses included obligations to give access to MVNOs. Nonetheless, we argue that 3G was very partially rolled-out during the studied period. Moreover, this paper is related to the potential impact of access regulation that is supposed to be technologically neutral.

The fourth variable (P) relates to the penetration rate, which is the number of connections to a service divided by the population.

The fifth variable (ARPU) represents the mobile network operator's average revenue per user. ARPU is usually related to the level of prices and/or the level of minutes of use. National regulators often relied on the ARPU level to conclude on the market competitiveness. Higher ARPU would be linked to the existence of MNOs' market power eventually due to the market concentration. However, McCloughan and Lyons showed that no evidence was found that European mobile markets concentration had any influence on ARPU. (McCloughan and Lyons, 2006) Depending on country and operator, we expect ARPU to be weakly related to MVNOs entry.

The sixth variable (CHURN) measures how many customers are disconnecting from the network. Churn is calculated by the formula: gross connections minus net new connections, divided by customer base at the end of the previous year.

### **2.2.2. Variable related to contractual governance**

This variable is (CONTRACT) and control for the different types of MVNOs business models according to their contractual integration with the network operators: full, intermediate and thin MVNOs. This distinction between MVNOs is based on the degree of control of some network elements and it results in a differentiation between mobile services. The classification into the "thin" type does not allow any distinction between MVNOs based on trademark, pricing policy or distribution networks.

### 2.2.3. Variables related to regulation

The third category includes several variables that we use to control for the nature of the regulatory incentives and the credibility of the regulatory commitment, which is translated into the variations of regulatory governance.

The first regulatory variable (PRG) is a dummy variable related to the access price regulation (Sappington and Weisman, 1996) that equals 1 if the regulator uses either traditional rate-of-return regulation,<sup>9</sup> or a price-cap regulation, a policy that allows for limited price flexibility. PRG equals 0 if the regulator adopts complete deregulation so that the access price is the result of commercial negotiation between MNO and MVNOs without any regulatory intervention.

The second regulatory variable (PORT) is related to the mobile network portability (MNP) and aims at allowing customers to retain their assigned mobile telephone numbers when changing the subscription from one mobile network operator to another. While reducing switching costs of mobile users and facilitating new entries, MNP may lead to high costs of implementation, reduction in tariff transparency. (Buehler and Haucap, 2004) Depending on the commitment by regulators to implement MNP regulation, it is possible to assume that this variable may have a significant impact on MVNOs' entry.

The third regulatory variable (FD) is a dummy variable related to the formal decision that a national regulator may have adopted when assessing market competition for “wholesale mobile access and call origination” (also classified as “market 15” by the European commission). Following the revision of the European framework in 2002, the national regulators have had to conduct market analysis in order to control for the competition degree that is designating undertakings with significant market power and eventually proposing *ex post* regulatory remedies. FD equals 1 if the national regulator has adopted a formal decision with or without regulatory remedies. FD equals 0 either if the national regulator has not adopted any decision or if a formal decision was withdrawn or cancelled by national courts. We anticipate that a formal decision is a signal for new entrants of the commitment for a credible regulatory environment. Therefore, it is possible to assume that this variable is correlated with the dependent variable. However, the impact of this variable remains uncertain as the adoption of a formal decision can be very different from its implementation in time and constraints on incumbents so that the impact may also depend on the extent of the national judiciary control.

The fourth regulatory variable (INDEP) is an aggregate governance indicator of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government’s commitment to such policies. It measured the policy consistency and forward planning. (Kaufman, Kraay and Mastruzzi, 2006)

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<sup>9</sup>It means that prices are set close to costs and the incumbent only earns at some competitive return.

The fifth regulatory variable (REGQ) is an aggregate governance indicator of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. (Kaufman, Kraay and Mastruzzi, 2006)

The regulatory governance variable are both extracted from the same source, the World Bank's research project on governance indicators, that provides for data between 1996 and 2005. We rely on this source because, to our knowledge, it is the only one providing for indicators over time.

### Section 3: Empirical test

In this section, we provide an empirical analysis of economic and regulatory factors that may have important and/or significant effect on the cumulative number of entrants in the mobile market. We estimate the impact of mobile market structure and regulatory framework policy on the total cumulative number of Mobile Virtual Network Operators entry at the end of each year of the sample period. Our econometric framework is closed to Alexander and Feinberg (2004). The number of entrants is of count data type. This implies a Poisson or negative binomial distribution for the dependent variable of our model. As the Huber-White estimator is used to correct for heteroscedastic structure of residuals, all estimations are supposed to provide robust standard errors for coefficient estimates.

To take account of potential over-dispersion arising in the context of a Poisson distribution and in order to obtain consistent and valid estimates, we also provide a negative binomial framework estimation. In order to fully account for the panel structure of our database, individual and time fixed effects are then considered. In order to capture the lagged effect of the determinants of entry, some explanatory variables are lagged one period. Furthermore, all regulatory variables are lagged one period, while on the market structure side, competition degree and market concentration indicator (HHI) are kept in levels<sup>10</sup>. Given the relatively small sample size and panel data structure, we adopt a generalized linear model and maximum likelihood estimators which allow controlling for specific cross-sectional countries fixed effects<sup>11</sup> in the modeling of entry. Huber and White estimator is used to provide robust estimation in the context of Poisson regression.

We run a first set of regression that offset the impact regulatory design in the dependent variable. In this case, the cumulative number of MVNOs at the end of each period. The number of entries is exclusively explained by the market structure<sup>12</sup>. The results are presented in the table I. It is shown that the mobile market structure has important and significant effects on the total cumulative number of MVNOs' entries, both in the Poisson and negative binomial models. The models only differ in the impact of *ARPU*, which is only significant in the negative binomial framework, while the impact is negative in both models and coefficient estimates are the same. The competition index *COMP* measured by the level of market shares of all MVNOs

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<sup>10</sup> The dynamic panel approach is ruled out, as we do not suppose correlation between explanatory variables and residuals. This allows ruling out Arellano-Bond estimator as the lagged endogenous variable is not included in the set of regressors. In this context, there is no persistence effect arising from the total number of mvnos

<sup>11</sup> The unobserved international differences across countries are captured by the fixed effects. A random structure for individual and time effects is also tested, but the results are not reported. Besides, Poisson fixed effect model can also be properly estimated by adding individual or time dummies to the set of explanatory variables. It is not the case, however, for a negative binomial distribution

<sup>12</sup> Even in the absence of explicit regulatory framework variable in the first test, regulation is not neutral as the related effect may be embodied in the market structure itself. Adding these variables to the test leads to the estimation of the combined effects of regulation and market structure on entry.

have a positive impact of relatively high magnitude and high significance on the dynamics of entry. The *CHURN* rate has also expected positive sign with high significance level, as a high disconnecting rate may foster entry of new virtual mobile competitors. We observe that a high number of incumbent operators (*MNO*) may hinder the incentives to enter. The impact is negative with a lower significant level but still, a relatively higher magnitude. Another variable of interest is the degree of market concentration, i.e. the Herfindahl Index. Its impact on MVNO's entry appears to be negative, which is counter-intuitive as a high number of existing operators in the mobile market may discourage entry of new potential competitors. The results, however, clearly show that the magnitude of market concentration effect is very low, while it still differs from zero. Besides, potential over-dispersion in the Poisson model does not seem to induce bias in the estimation of the market structure impact, as the results derived from the negative binomial model are quite similar in significance, magnitude and sign.

The regulatory variables are then included in the regressions, to provide an estimation of the combined effect of mobile market structure and regulation on entry. Interestingly, we observe little differences between both Poisson and negative binomial models, which tend to prove that over-dispersion may not induce important overestimation of covariates' impact in terms of statistical significance within our test. Both the results show evidence of ambiguous effects of regulatory decisions on MVNOs entry. The ability of government to foster private sector incentives, captured by the regulation quality variable (*REGQ*), appears to have a negative impact on entry, which is statistically significant at 1% confidence level in both Poisson and negative binomial models, while the regulatory independence variable (*INDEP*) has a positive effect on entry, which is only significant in the negative binomial model estimation, at 1% confidence interval. The adoption of a mobile network portability regulation, (*PORT*), has a negative impact on entry but is only significant in the Poisson model, at a relatively low confidence level (10%).

The quality of public services, the quality of public policy and the degree of government's commitment as well as regulatory independence are important determinants of the total number of entries; while the respective impact of independence slightly differ across models. The adoption of a formal market decision by a national regulator, (*FD*), may foster entry while the existence of access price regulation (*PRG*) is a barrier to entry. Both variables have respectively strong and significant positive and negative impact on entry at high confidence level ( $Pr(>|z|) = 0$ ). Regulatory policies that set access price and have direct impact on the mobile market structure are relevant factors that determine the number of entrants in each country. Further research may lead to the estimation of the probability of MVNOs entry according to both the type of their business model and their specific core business or industrial background. Using a mixed effect probit model, as well as a mixed effects negative binomial equation, we estimate the impact of our set of explanatory variables on the proportion of min, medium or full sized potential entrants. In particular, a general non linear framework accounting for within group heterogeneity and unobserved correlated random effects will allow capturing the marginal effects of regulatory decisions and market structure components on the chosen entrants' type of business model. The results of estimation for both the Poisson and negative binomial regressions are reported in the following tables:

**Table I: Poisson fixed effects model with robust standard errors**

Variable	Estimate	Std.Error	z value	Pr(> z )
<i>(Intercept)</i>	7.33832470	1.70817271	4.2960	1.739e-05 ***
<i>lag(ARPU)</i>	-0.01298053	0.01524310	-0.851	0.3944543
<i>lag(CHURN)</i>	0.03326780	0.00561420	5.9256	3.111e-09 ***
<i>lag(P)</i>	-0.03566585	0.01406217	-2.536	0.0112032 *
<i>lag(MNO)</i>	-0.26998101	0.08292783	-3.255	0.0011315 **
<i>CONC</i>	-0.00076775	0.00017663	-4.346	1.382e-05 ***
<i>COMP</i>	0.09956811	0.01406355	7.0799	1.443e-12 ***

Significance codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Chi-Square=157.0006

**Table II: Poisson fixed effects model with robust standards errors**

Variable	Estimate	Std.Error	z value	Pr(> z )
<i>(Intercept)</i>	6.3077e+00	1.9635e+00	3.2125	0.0013156**
<i>lag(MNO)</i>	-2.8643e-01	9.0227e-02	-3.1745	0.0015007**
<i>lag(CHURN)</i>	2.5360e-02	5.8803e-03	4.3127	1.613e-05***
<i>CONC</i>	-7.6252e-04	1.7832e-04	-4.2761	1.902e05***
<i>COMP</i>	1.1739e-01	2.0201e-02	5.8111	6.207e-09***
<i>lag(P)</i>	-1.0405e-02	1.3799e-02	-0.7540	0.4508294
<i>lag(INDEP)</i>	6.8873e-01	6.7682e-01	1.0176	0.3088671
<i>lag(REGQ)</i>	-1.4363e+00	6.1362e-01	-2.3407	0.0192481 *
<i>lag(M)</i>	1.5934e+01	1.1275e+00	14.1329	< 2.2e-16 ***
<i>lag(PORT)</i>	-4.6337e-01	2.4203e-01	-1.9145	0.0555549 .
<i>lag(PRG)</i>	-1.6021e+01	1.1382e+00	-14.076	0 < 2.2e-16 ***
<i>lag(ARPU)</i>	-1.1848e-02	1.7031e-02	-0.6957	0.4866402

Significance codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Chi-Square=119.4003

**Table III: Negative binomial fixed effects model**

Variable	Estimate	Std.Error	z value	Pr(> z )
<i>(Intercept)</i>	9.09348631	2.10121036	4.3277	1.506e-05 ***
<i>lag(MNO)</i>	-0.27146245	0.09801229	-2.7697	0.0056112 **
<i>CONC</i>	-0.00097029	0.00017735	-5.4711	4.473e-08 ***
<i>COMP</i>	0.11784117	0.01416493	8.3192	< 2.2e-16 ***
<i>lag(CHURN)</i>	0.03811287	0.00791921	4.8127	1.489e-06 ***

<i>lag(P)</i>	-0.04362990	0.01850027	-2.3583	0.0183569 *
<i>lag(ARPU)</i>	-0.02718362	0.01554952	-1.7482	0.0804299 .

Significance codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Log Likelihood = -283

AIC: 319.00

**Table IV: Negative fixed effects model**

Variable	Estimate	Std.Error	z value	Pr(> z )
(Intercept)	7.3960e+00	2.0396e+00	3.6262	0.0002876 ***
<i>lag(MNO)</i>	-2.7776e-01	9.8573e-02	-2.8178	0.0048354 **
<i>CONC</i>	-8.3144e-04	1.7568e-04	-4.7328	2.215e-06 ***
<i>COMP</i>	1.1465e-01	2.0686e-02	5.5424	2.984e-08 ***
<i>lag(PORT)</i>	-1.8382e-01	2.6879e-01	-0.6839	0.4940528
<i>lag(PRG)</i>	-3.7190e+01	1.3198e+00	-28.1787	< 2.2e-16 ***
<i>lag(CHURN)</i> )	3.2066e-02	7.4824e-03	4.2855	1.823e-05 ***
<i>lag(M)</i>	3.6900e+01	3.3785e+00	10.9221	< 2.2e-16 ***
<i>lag(P)</i>	-2.8792e-02	1.6009e-02	-1.7984	0.0721065 .
<i>lag(REGQ)</i>	-1.2746e+00	6.0665e-01	-2.1010	0.0356371 *
<i>lag(INDEP)</i>	1.1377e+00	6.3955e-01	1.7790	0.0752422.
<i>lag(ARPU)</i>	-2.1010e-02	1.7239e-02	-1.2187	0.2229477

Significance codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Log Likelihood = -300

AIC: 324.74

## Section 4: Results and discussion

In this section, we discuss our results by comparison with our hypotheses and then we distinguish new entry without and with regulatory assistance.

### 4.1. New entry into a mature regulated industry without any regulatory assistance

In this first part, we focus on the impact of the market structure factors on MVNO's entry while excluding an impact from specific regulatory policies.

Part of those market structure factors, our results show that the degree of concentration has a negative impact but very small effect on the number of MVNOs' entries. This impact is reinforced by the negative but strong impact of the number of mobile network operators (MNOs).

In contrast, the churn rate (CHURN) between the incumbents, and the degree of competition between MVNOs (COMP) have both a positive and strong impact on MVNOs' entries. These results are aligned with the resource-partitioning model's predictions.

At the early stage of market evolution, the market structure is characterized by a large number of incumbents (MNOs) and a high degree of concentration (CONC) for those generalists. As a large proportion of the total market is covered by differentiated services, the resource space available for MVNOs is small. At this stage, the market structure has a negative impact on MVNOs entry.

Following the predictions of the resource-partitioning model, a high degree of market concentration should be followed by a decrease in the number of generalists and an increase in

their size<sup>13</sup>. The total resource space covered by incumbents is smaller so that specialists have access to resource located at the fringe of the market. Our results clearly show that the evolution of the market structure depends on the strategic behavior of incumbents towards hosting (or not) MVNOs on their network. More specifically, this market evolution depends on the consequences of the competitive dynamics between incumbents characterized by the churn rate (CHURN).<sup>14</sup>

The migration of customers from one incumbent to another initiates a strategic reaction from the incumbents. The initial difficulty about hosting MVNOs evolved and wholesale revenues from new entrants were considered significant enough to compensate the decrease of retail revenues resulting from the increase in the churn rate. MNOs started to host MVNOs.

Following the resource partitioning model, the resource space depends on the fringe entry by specialists rather than generalists firms. MVNOs should exploit resource at the fringe of the market segments without entering into direct competition with the large specialist incumbents.

Dobrev (2000) shows that the decrease of the market concentration promotes fringe entries by specialists. Regarding the mobile telecommunications services market, the question is then related to the qualification of MVNOs as specialists or generalists.

Our data do not provide us with an empirical measure of the differentiation degree between the mobile services. However, in our context, the differentiation degree is analysed as the way of delivering services adapted to specific customers and different from services delivered by incumbents.

Drawing on our distinction between MVNOs, we can limit the ability to differentiate as a function of the control of specific network elements such as Home Location Register, Commutation Centres... Controlling or not those network elements falls into the scope of the access contract between MVNOs and mobile carriers. That is why empirical reports usually link the degree of network integration to the ability to differentiate the mobile service. (OMSYC, 2005; IDATE, 2006) Drawing on this relationship, we use contractual integration between MVNOs and network incumbents as a proxy of the service differentiation. Access contracts between mobile carriers and MVNO have been classified into three categories ranging from the minimum integration (contract 1) to a medium integration (contract 2) and a maximum integration (contract 3).

Appendix on the entry differentiation by contract presents that result of a second test related to the impact of contractual governance type onto the causal relationship between market concentration and fringe entry. It results from the second test that the impact of market concentration is negatively related to MVNOs' entry and the significance of the relationship is stronger in the case of contract 1 (low differentiation degree) than in the case of contract 3 (high differentiation degree) and stronger in the case of contract 3 than in the case of contract 2 (medium differentiation degree).

In a context of a slight market de-consolidation, mobile carriers have decided to grant network access to new entrants whose services are characterized by either a very low or a high differentiation degree. In order to explain why incumbents have opened their networks to MVNOs with non-differentiated services, we might refer to the existence of network over-capacity that had to be exploited without any fear of cannibalization. In contrast, MVNOs entry with differentiated services can be explained by the resource-partitioning model as

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<sup>13</sup> We must acknowledge that our data do not allow us to control for this prediction. Due to the specificity of spectrum licensing process, the market concentration is fixed externally so that the number of MNOs has not really decreased as their licenses have been renewed between 1998 and 2005. However, European Commission regularly stresses the distinction between active and non-active licenses. We can not exclude the decrease in the number of active MNOs.

<sup>14</sup> We do not take into account other factors of churn variation as independent variables.

specialists exploit the fringe market segments without entering into competition with incumbents. This explanation of fringe entry is supported by the impact of the concentration degree, the impact of the penetration rate and the impact of the MVNOs market shares level.

In conclusion, our results show a two-sided evolution of the mobile market concentration:

- on one hand, two market structure variables (CONC and MNO) show resistance to market de-concentration resulting in barriers to MVNOs' entries;
- on other hand, two market structure variables (COMP and CHURN) show positive strengths of market de-concentration facilitating MVNOs entries.

#### **4.2. New entry into a mature regulated industry assisted by entry regulations**

In this second part of the discussion, we examine the impact of the regulatory determinants on the rate of fringe entry into a mature industry. The dependent variable remains the rate of MVNOs' entry at the end of each year. The set of explanatory variables includes the market structure factors and the variables related to regulation. Those regulatory variables are to be ranged between economic incentives (PORT, PRG and FD) and regulatory governance (INDEP and REGQ).

Our results show that regulation has had some impacts on the MVNOs' entry. While signs and amplitude of the market structure variable remains the same than in the first test, the impact of the regulation is balanced between variables:

- the impact is positive in the case of the adoption of formal decision and the independence of the regulator;
- and the impact is negative in the case of the number portability regulation, the access price regulation and the regulation quality.

Globally considered, the signs and amplitudes of the regulatory impacts are neutralized for both the economic incentives and the regulatory governance. From this result, we can infer that entry regulations did not significantly impact the MVNOs' entries.

From the previous part of the discussion we know that the market structure mainly depends on the MNOs' strategic decision to host MVNOs. Therefore, we must conclude that the regulation did not impact MNOs' ability to grant access to MVNOs. Depending on national cases, MNOs' bargaining power was only limited by the level of regulated access price. One of the reasons for this result may be the inability of the regulation to promote the entry of MVNOs specialists. The regulation would have eased the market de-concentration by promoting commitments to invest in mobile networks. Such commitments would have induced the adoption of the full MVNOs contractual governance type and limited the adoption of the thin type. This would have increased the differentiation between mobile services. We have empirical confirmation of such an impact. In Germany, the formal decision promotes MVNOs' investments in mobile networks with a result of entry by full MVNOs.

Besides this general discussion, we can further analyze the impact of each regulatory variable. Considering firstly the impact of economic incentives, our results show that the number portability regulation has had a negative but minor impact on MVNOs entry. This conclusion is not very surprising as the efficiency of such a regulation is strictly conditioned by the timing of the switching process. Mc Cloughan and Lyons (2006) showed that the mobile number regulation has an impact on prices and churn when the switching process is less than 5 days but it has no impact when it is slower. During our studied period, mobile number portability was barely quicker than 5 days so that this economic incentive has no significant impact on the

churn between MNOs and has therefore a limited impact on the competitive dynamics of the market structure and MVNOs entry.

Our results also show that the access price regulation has had a negative impact on MVNOs entry. Following Valletti (2003) and Sarmiento and Brandao (2006), the choice between retail minus and cost-based methods has an impact on competition in the downstream market; retail-minus being more efficient during a transitional period towards the full liberalization of the market. Depending on the choice made by national regulators, our data show that the access price regulation did not succeed in impacting competition in the downstream market. (see Appendix 1)

Our results finally show that the adoption of a formal decision has had a positive impact on MVNOs entry. Formal decisions have taken different features: either excluding designation of any significant market power within the analyzed market (5 Member States belong to this category) or designating significant market power and imposing remedies (2 Member States are in this case). A final case is related to Member States still investigating market analysis (3 Member States are in this last case). None of the national regulator which has adopted remedies has imposed access obligations to any MNO. In such circumstances, we can not conclude on the regulatory commitment towards mandatory access. Nevertheless, it seems that the process of adoption of a formal decision has induced MNOs strategic analysis about the regulatory commitments. Threatening an unfavorable decision, MNOs have been invited to reconsider MVNOs' entry.

Considering secondly the impact of the regulatory governance on MVNOs entry, we can observe different signs related to the impact of independence and regulation quality on the MVNOs entry. Our results clearly show that the independence has a positive impact on MVNOs entry, whereas the regulation quality has a negative impact on MVNOs entry. Regarding independence, our variable is related to the degree of independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. The positive impact of such a variable on MVNOs entry suggests that private investors gave credit to a regulatory independence and quality. Those potential entrants positively assessed the ability of the regulator to commit itself with credibility.

However, the negative impact of the variable related to regulatory quality neutralized the previous impact when it deals with the promotion of private sector development. MVNOs negatively assessed the soundness of economic incentives adopting to give assistance to new entries. More precisely, national regulators have been considered as being unable to formulate and implement MVNOs' entry regulations. Behind those results, we must insist on some factors of regulatory efficiency: clarity of assignment of functions, regulatory autonomy, accountability and transparency. (Smith, 1997; Stern and Holder, 1999; Noll, 2000; Kessides, 2004)

## Appendix: Entry differentiation by contract

### *Dependent variable: contract 1*

Variable	Estimate	Std. Error	z value	Pr(> z )
(Intercept)	2.8004e+00	1.8349e+00	1.5262	0.1800730
lag(g\$mno)	-2.6267e-01	1.1547e-01	1.1547e-01	-2.2748
lag(g\$arpu)	-3.9553e-03	1.7947e-02	-0.2204	0.8255632
g\$conc	-7.3495e-04	2.0244e-04	-3.6305	0.0002829 ***
g\$comp	1.2475e-01	2.3871e-02	5.2259	1.733e-07 ***
lag(g\$port)	-3.9800e-01	2.8248e-01	-1.4089	0.1588557
lag(g\$prg)	-4.1698e+01	3.8686e+00	-10.7787	< 2.2e-16 ***
lag(g\$churn)	1.1294e-02	5.4149e-03	2.0857	0.0370098 *
lag(g\$m)	4.1225e+01	2.8654e+00	14.3872	< 2.2e-16 ***
lag(g\$p)	3.3345e-02	1.0883e-02	3.0640	0.0021842 **
lag(g\$regq)	-6.3112e-01	6.1389e-01	-1.0281	0.3039190
lag(g\$indep)	-2.0538e-01	6.4603e-01	-0.3179	0.7505532

**Significance codes: '\*\*\*':0%; '\*\*': 1%; '\*': 10%; '.': 5%**

### *Dependent variable: contract 2*

variable	Estimate	Std. Error	z value	Pr(> z )
(Intercept)	-2.4487e+01	9.9488e+00	-2.4613	0.013843 *
g\$mno	1.9946e-01	3.6226e-01	0.5506	0.581909
lag(g\$arpu)	1.9060e-01	7.1532e-02	2.6645	0.007710 **
g\$conc	1.3731e-04	9.0653e-04	0.1515	0.879611
g\$comp	-1.9355e-01	8.7358e-02	-2.2156	0.026716 *
lag(g\$port)	2.3840e+00	7.4138e-01	3.2157	0.001301 **
lag(g\$prg)	-1.5729e+01	1.0688e+00	-14.7165	< 2.2e-16 ***
g\$churn	-1.6467e-01	6.5570e-02	-2.5114	0.012027 *
lag(g\$m)	1.4911e+01	9.2201e-01	16.1724	< 2.2e-16 ***
lag(g\$p)	1.6923e-01	5.4478e-02	3.1064	0.001894 **
lag(g\$regq)	-5.3133e+00	1.9112e+00	-2.7800	0.005435 **
lag(g\$indep)	7.4523e+00	2.6473e+00	2.8151	0.004876 **

**Significance codes: '\*\*\*':0%; '\*\*': 1%; '\*': 10%; '.': 5%**

### *Dependent variable : contract 3*

Variable	Estimate	Std. Error	z value	Pr(> z )
(Intercept)	2.6489e+00	1.7753e+00	1.4921	0.1356719
g\$mno	-2.9988e-01	1.5537e-01	-1.9302	0.0535880 .
lag(g\$arpu)	-4.6447e-02	2.4192e-02	-1.9199	0.0548647 .
g\$conc	-5.4189e-04	2.5470e-04	-2.1275	0.0333766 *
g\$comp	1.8425e-01	3.1656e-02	5.8204	5.869e-09 ***
lag(g\$port)	-1.3617e+00	3.7298e-01	-3.6508	0.0002614 ***
lag(g\$prg)	-1.6057e+01	1.3489e+00	-11.9041	< 2.2e-16 ***
g\$churn	1.4152e-02	9.2983e-03	1.5220	0.1280012
lag(g\$m)	1.5266e+01	1.2753e+00	11.9701	< 2.2e-16 ***
lag(g\$p)	4.0667e-03	1.7324e-02	0.2347	0.8144084
lag(g\$regq)	3.8315e-01	1.0557e+00	0.3629	0.7166542
lag(g\$indep)	-7.7939e-01	8.3168e-01	-0.9371	0.3486938

**Significance codes: '\*\*\*':0%; '\*\*': 1%; '\*': 10%; '.': 5%**

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Figure 1: MVNOs' cumulative total number per country.

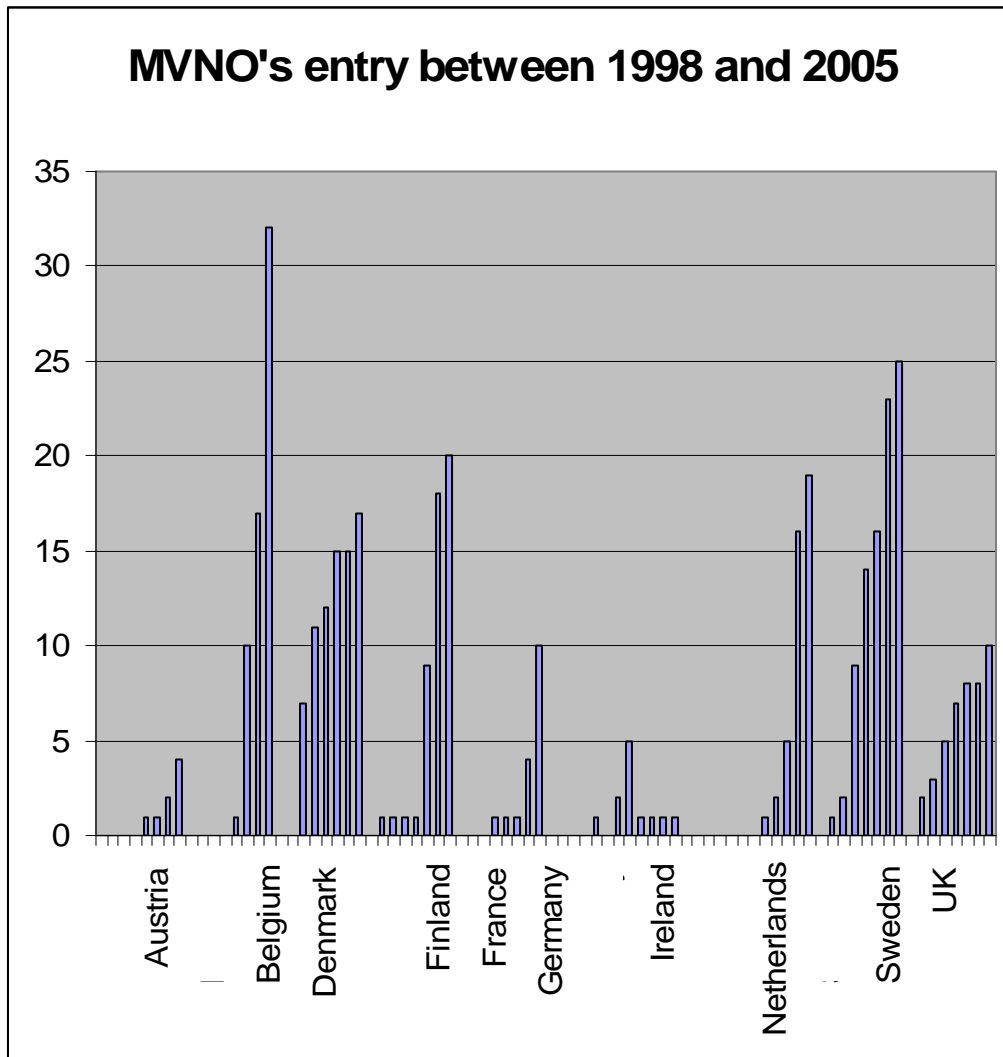


Table 1: variables descriptions and sources

<b>Variable</b>	<b>Variable description</b>	<b>Sources</b>
<b>MVNO</b>	The cumulative number of entrants (MVNO) in each national mobile market (i) at the end of each year (t)	- The European Commission's report on implementation of the regulatory framework dated of 2005 - the Telecompaper Mobile MVNO/SP List - the verification on each MVNO website
<b>COMP</b>	The annual level of market shares of all MVNOs	- National regulators' websites - OMSYC, "MVNO in Europe, benefits and risks of co-competition" (2004 and 2006)
<b>CONC</b>	HHI that is the sum of the market squares of all competitors	OVUM, 2005. «Regulatory status of mobile access in Europe».
<b>MNO</b>	The number of Mobile network operators in each national mobile market (i) at the end of last year (t-1)	- The European Commission's report on implementation of the regulatory framework dated of 2005 - OVUM, 2005. «Regulatory status of mobile access in Europe».
<b>P</b>	The number of connections to a service divided by the population.	Analysys, Mobile Networks and Services-Country reports
<b>ARPU</b>	Average revenue per unit (ARPU): A mobile network operator's average revenue per connection.	- Analysys, Mobile Networks and Services-Country reports - ABN-AMRO, 2005. Pan European Telecoms, Wireless Model Builder.
<b>CHURN</b>	A measure of how many customers are disconnecting from the network. Churn is calculated by the formula: gross connections minus net new connections, divided by customer base at the end of the previous year.	- Analysys, Mobile Networks and Services-Country reports - ABN-AMRO, 2005. Pan European Telecoms, Wireless Model Builder.
<b>CONTRACT</b>	The types of MVNOs business models according to their contractual integration with the network operators.	- OMSYC, "MVNO in Europe, benefits and risks of co-competition" (2004 and 2006) - the verification on each MVNOs' website
<b>SECTOR</b>	The MVNOs' core business or industrial background	- OMSYC, "MVNO in Europe, benefits and risks of co-competition" (2004 and 2006) - the verification on each MVNOs' website
<b>PORT</b>	The existence of a regulation on mobile network portability (MNP)	- OVUM, Country Regulation Review - IDC, European Wireless and Mobile Communications: Country and operators profiles - - Analysys, Mobile Networks and Services-Country reports
<b>PRG</b>	The existence of any access price regulation	- OVUM, Country Regulation Review - IDC, European Wireless and Mobile Communications: Country and operators profiles - NCB, 2005, MVNOs: virtual barbarians at the gates of the mobile arena
<b>FD</b>	The adoption of a formal decision on market 15 analysis by a national regulator	- The European Commission's report on market analysis under article 7 - Communication from the Commission on Market reviews under the EU regulatory framework, COM (2006) 28 final; annexes I and II - OVUM, 2005. «Regulatory status of mobile access in Europe».
<b>INDEP</b>	The quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies	Kaufman, Kraay and Mastruzzi, 2006. "Governance Matters V", the World Bank
<b>REGQ</b>	The ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development	Kaufman, Kraay and Mastruzzi, 2006. "Governance Matters V", the World Bank