

A collection of Essays on

# COMPETITION AND REGULATION

WITH **ASYMMETRIES IN MOBILE**

# MARKETS

Edited by

**Laurent BENZONI**

**Patrice GEOFFRON**

Foreword by **NICOLAS CURIEN**



**QUANTIFICA**

**A COLLECTION OF ESSAYS ON**  
**COMPETITION AND REGULATION**  
**WITH**  
**ASYMMETRIES IN MOBILE MARKETS**

Edited by

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# Foreword

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&

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“Competition with asymmetries in the mobile markets” first provides the reader with a comprehensive analysis of the nature of asymmetries that arise in the development of mobile markets. In a second step, the impact of these asymmetries on market performance and regulatory policy is discussed. The book includes theoretical approaches as well as empirical evidence, at both market and micro levels. It also reflects different contexts currently encountered in different countries with different regulatory environments, across Europe and Asia. As the main focus is placed on the influence of termination rate regulation on market growth, operator’s profits and global welfare, only the CPP (*Calling Party Pays*) setting is considered here, a setting in which the call termination cost is paid by the caller’s operator and not by the called party, as it is conversely under the RPP (*Receiving Party Pays*) which has been adopted in North America.

The numerous models and empirical surveys presented in the book generate a variety of interesting and rather consistent results, giving robust guidelines to design and assess regulatory policies. To my sense, three major lessons may be learnt from the reading.

## **NETWORK EFFECTS DO MATTER.**

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Mobile technology adoption, operator choice and usage patterns are indeed influenced by intrinsic network effects. While mobile adoption pace is clearly stimulated by global market growth, it seems that subscription and usage are more sensitive to “local” network effects than to “global” ones: the behaviour of an individual, when selecting a particular operator, or when making on-net *versus* off-net calls, is mainly conditioned by family and friends, rather than by the operator’s network size. Two consequences derive from these observations: on the one hand, operators have a strong incentive to reinforce club effects by price differentiating on-net and off-net calls, a strategy which may well be a source (as much as a result) of a strong market power for the larger operators, especially when switching costs are high in the retail market; on the other hand, smaller operators, especially MVNOs, may enjoy

niche markets, taking advantage of local club effects among specific communities, such as young people, ethnic groups, etc.

Besides direct effects, indirect network effects may also stem from the greater ability of a large scale network operator to provide a wide range of services. Such indirect effects, which were not very significant up to now as far as 2G networks are concerned, could play a more important role in shaping the growth of future 3G networks, for which data and content services become a major motivation factor in purchase and usage decisions.

### **DATE OF ENTRY GENERATES ASYMMETRY**

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Even if not the reader does not fully buy into the theory of the “later entrants’ curse”, one must certainly acknowledge that first movers in the mobile market do benefit from technological leadership, better commercial awareness, prior use of scarce assets such as spectrum, accumulated scale economies and network effects, and so on. Given this context, an infrastructure-based competition (with site sharing to avoid unnecessary duplication) is clearly preferable to service-based competition, in terms of competitive pressure, as well as product and service innovation, lower retail prices, and some degree of regulatory asymmetry favouring late entrants, at least for a while, may offer the latter the opportunity to catch up with their entry delay and thus be improve welfare while securing long run competition.

Regulatory asymmetry takes different forms: it can rely upon differentiated termination charges, as is presently the case in Europe; it could also be based on an “investment ladder” policy inspired by fixed broadband market regulation, in which new entrants would “climb” the ladder step by step, first buying wholesale access to incumbents to experience the market before rolling out their own infrastructure; or it may even be reflected in the gradual reduction of switching costs in the retail market as experienced in Korea, where incoming portability was first opened in 2004 to the smallest and last entered operator only, then to the two later entrants after a delay of six months, and then extended to all three operators after one year.

## **ASYMMETRIC REGULATION OF TERMINATION RATES NEEDS CAUTION AND ADJUSTMENT**

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A rather simple theoretical analysis shows that where consumers are perfectly ignorant about termination rates and operators are free to set their respective termination rates, then the smaller the network size, the higher the termination rate. Moreover, a “totally asymmetric” regulation, *i.e.* applying to larger operators only, would lead the smaller ones to raise their termination rates, resulting in a welfare loss. Total asymmetry should be avoided and termination rates of all operators in the market should be regulated on the basis of a common cost standard and methodology, which does not necessarily mean symmetric levels of termination rates: differentiation may occur on the basis of exogenous factors of cost differentials.

Although theoretically justified, termination rate asymmetry proves very delicate to implement in practice and to adjust over time, as it must promote competition while mitigating the incumbents’ market share advantage and avoid rent-seeking strategies from the later entrants. To this regard, the situation in Taiwan is of a particular interest, since such rent-seeking behaviour was adopted by the latest entrant at the expense of the incumbents’ growth, calling for the adoption of a sunset clause in asymmetric regulation. Moreover, considering that the incumbent’s brand awareness advantage may be partially offset by a lower cost of service, and benefit the later entrants who deploy a more advanced technology, then regulatory asymmetry could be reversed, granting the incumbents a termination rate mark-up and not the opposite!

The issue of regulating termination rates, as concerns their average level, their temporal trend as well as their degree of asymmetry is rendered more complex by the so-called *waterbed effect*, according to which all rates in the market, *i.e.* termination rates on the wholesale market and on-net and off-net rates in the retail market, are closely interrelated. Any variation in any of these rates induce a simultaneous variation of another one, to restore the operator’s profits. These concomitant rate variations must be taken into account by the regulator when aiming for a proper control of welfare improvement. For instance, asymmetric regulation of termination rates forces the incumbent operators to raise their retail prices; hence, a decrease in consumer surplus and a reduction of the global quantity supplied in the market. This generates a welfare loss in the short run as compared to the long run benefit of an increased competition. In the same vein and now looking at regulatory dynamics, decreasing termination rates certainly

promotes efficiency on the one hand, by achieving cost orientation; on the other hand, a too strong and too rapid decrease would harm the retail market performance by reducing operators' incentives to compete for incremental subscribers and, through the waterbed effect, it would push retail prices up or pull handset subsidies down, to the detriment of consumer surplus.

\*\*\*\*

To conclude, this book really gives an in depth insight into the economics of the mobile industry, through the angle of market and regulation asymmetries. From the regulator's point of view, the good news about market asymmetry is that this is certainly a factor that makes collusion between firms less sustainable and thus less likely. The bad news is that regulating first and later entrants asymmetrically yields tricky implementation difficulties and leaves very critical stakes wide open in terms of the criteria to be used to set an adequate balance between short and long run considerations, to arbitrate between static and dynamic efficiency and to decide on the proper timing for a transition from an asymmetric towards a symmetric regulation framework. Although it does not give all the answers, thus fortunately leaving some room for operators' and regulators' initiative, at least the book asks all the right questions and I am quite sure that it will soon become a robust and precious reference for both academics and practitioners.

# Introduction

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In 2007, Europe's mobile markets count 480 million subscribers, making mobile telephony a dynamic economic area, so much so that non-voice services are constantly being introduced (video-phoning, mobile TV, etc.). Despite these dynamics, the resulting industrial structure presents asymmetries of size partly due to the "first mover advantages" (FMAs) (brand-loyalty or recognition, club effects, ...) of the early entrants, leading to a phenomenon of "non-catching-up" for the last operators to enter national markets. And these firms are neither less efficient nor less innovative.

The economic theory of FMAs predicts that a firm which enters a new market first accumulates so many advantages that later entrants will have difficulties competing on equal terms. FMAs stem from early adoption by users which allow a firm to capture a large market share early on. By the time competitors enter the market, the first-mover will, ideally, have already established advantages, such as cost advantages in distribution and/or infrastructure systems (and will often be reinforced by specific switching costs).

Although the specific features of European mobile markets are obviously impacted by FMAs, case studies are not specifically developed and diffused and related risks are not "common knowledge". A study published by the Bijwaard & alii (2005) concludes that *"Depending on specific entry conditions, it seems fair to conclude that the first entrant may still gain a large market share, and that subsequent entrants encounter more difficulties in gaining market share."*<sup>1</sup> In another study, for the Swiss regulatory authority – which compares the development of the Swiss telecommunications market with the rest of Europe – the WIK institute (2003) also stated that a sequential award of mobile licences negatively impacts competition dynamics, because of major disadvantages of later entrants (especially linked to network coverage and to the high switching costs for business

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<sup>1</sup> Bijwaard, E.G., Janssen M.C.W, Maasland E., (2005), *Early Mover Advantages : An Empirical Analysis of European Telecom Markets*, Tinbergen Institute, TI 2005-007/1.

customers of early entrants) compared to early entrants<sup>2</sup>. On a wider basis, an empirical study ordered by the International Telecommunications Society and based on a panel of 94 mobile operators in 27 OECD member states over the years 1998-2003 shows that the “maturity” of an operator positively impacts its market share<sup>3</sup>.

The persistence of FMAs is a collective problem across the EU as it leads to a “fringe oligopoly” with, at the core, a predominant number of pan-European players present across several national markets and usually opposed to small and fragile local players (forming a “fringe”). Consequently, a main issue for European regulation will deal with such asymmetries of size in light of future market development, to preserve the consumers’ interests in terms of future prices, innovation, quality, diversity or access to services,... One shall notice the remarkable stability to leaders’ market shares underlined by the European Commission: « *The actual decrease in the market share of the leading operators was relatively small between 2004 and 2006. In percentage terms, the decrease in the leading operator’s market share in terms of subscribers between 2005 and 2006 was only 0.2%, while main competitors increased their market share by 0.1% between 2005 and 2006* » [European Commission 2007]<sup>4</sup>.

Given this context, the present project intends to contribute to understanding the specific FMAs and asymmetries of size in the field of mobile telecommunications and to the related key regulatory issues. No document currently compiles papers analysing the mechanisms related to asymmetries in mobile networks and which is accessible to a wide readership. The present collection of essays is, therefore, dedicated to presenting ideas regarding the various dimensions of asymmetry in mobile markets and to propose international highlights. We have decided to invite European and non-European scholars to publish a didactic version of their published works for wide circulation amongst regulatory authorities (both national and European), as well as industrial players (fixed-line and mobile operators, equipment manufacturers,...) and, for debate, in the telecommunications research community.

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2 WIK Consult, (2003). *Stand des Schweizer Telekommunikationsmarktes im internationalen Vergleich*.

3 Sung, N. (2005). *The Determinants of Market Share for Mobile Telecommunications Operators*. University of Seoul, Department of Economics, International Telecommunications Society, 16th European Regional Conference.

4 European Commission (2007), “European Electronic Communications Regulation and Markets” European Commission, “European Electronic Communications Regulation and Markets.

# Network effects in mobile telephony

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## ABSTRACT

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*This paper explores the role of network effects in the consumer's choice of mobile phone operators in the UK. It contributes to the existing literature by taking a new approach to testing for direct network effects and by using individual level data, which allows to analyse the impact that the immediate social network has on consumer choice in network markets. For our empirical analysis we use two sources of data: market-level data from the British telecommunications regulator OFCOM and micro-level data on consumers' usage of mobile telephones from the survey, Home OnLine. We find that the proportion of off-net calls falls as mobile operators charge a premium for off-net calls, but even in the absence of any price differential between on-net and off-net, there is still a form of pure network effect, where a disproportionate number of calls are on-net. There is also some evidence that individual choice of operator is influenced by the total number of subscribers for each operator, but a much stronger effect is the operator choice of other household members.*

## INTRODUCTION

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The literature on the economics of networks usually distinguishes between two types of network effects: direct network effects that arise in *horizontal networks* and indirect network effects that arise in *vertical networks*. Direct network effects are present if the quality of a good is directly linked to the number of other consumers of the same good. In that case, an individual's utility function is not independent of other individuals' consumption choices, but utility increases with other individuals' presence in the same "network". The classic example of a direct network effect is a telecommunications network, in which the utility is usually zero if one is the only user of a technology. Being the only person using fax or e-mail is obviously of little value and only if there are other people using the technology can value be derived from use.

Indirect network effects, on the other hand, arise because bigger networks support a larger range of complementary products and services. In 2nd generation mobile networks, indirect network effects are only of second-order significance, but they will play an increasing role after the introduction of 3G networks, where usage will be more heavily influenced by the availability of data services.

Network effects can be very strong for interactive technologies and companies like Skype or myspace.com have been able to expand very rapidly to global companies serving tens or hundreds of millions customers. Research on network effects has frequently shown that network effects can lead to an increase of diffusion speed once a tipping point is reached, but can also lead to a slowing of diffusion speed if network externalities are not internalised.

In contrast to Internet companies like Skype or myspace.com which each operate their own network, which is incompatible with that of their competitors, traditional telecommunications companies mainly operate compatible networks. Most consumers, indeed, do not even realise when they make phone calls from one operator to another.

However, although mobile phone and fixed-line networks are by and large compatible from a technological point of view, network effects still exist. This is because network effects are often induced by network operators through higher prices for off-net than for on-net calls. This can take the form of a general discrimination between on- and off-net calls or can be through discounts for certain types of on-net calls. Probably the most famous example of such a scheme is MCI's Friends & Family plan, which was introduced at the beginning of the 1990s and allowed MCI customers to call up to 20 other MCI customers at a cheaper rate. In most European countries such price differentiation is commonplace, but there are also exceptions like the Netherlands where operators do not charge different prices for calls to the same network and calls to other networks.

In the following, we present results from three research streams in which we estimate the size and nature of network effects in the mobile telecommunications market. A market-level model focuses on technology usage - rather than on technology adoption, as most of the existing literature - and shows that differences in prices for on- and off-net calls strongly influence consumer behaviour. Using a consumer-level model, we then look at household coordination of mobile phone operators in the UK and ask whether consumers are more interested in overall network size or in consumption decisions made by other household members. The answer to this question has profound policy implications. Finally, we present results from a study directly measuring network effects in social networks in several

European and Asian countries. More detailed treatments of the topics can be found in Birke & Swann (2005) and Birke & Swann (2006).

## **NETWORK EFFECTS AND NETWORK USAGE**

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The analysis of this section was conducted using data from the UK telecommunications industry and, more specifically, data from the four main GSM-operators Vodafone, O<sub>2</sub>, T-Mobile and Orange. The market data comes from UK telecommunications regulator OFCOM and consists of quarterly time-series data on number of subscribers, call volumes and revenues, and average prices for on- and off-net calls.

Especially interesting for our analysis is the development of market shares in the UK market (*see figure 1*). At the end of 1998, the market was dominated by the incumbent operators O<sub>2</sub> and Vodafone, which together accounted for almost 70% of the market. However, by the beginning of 2001 this lead has dissipated and subscriber market shares have been levelled. Today, the market is about equally split between the four GSM operators<sup>5</sup>.

The ability of T-Mobile and Orange to catch up with the incumbent operators is unique to the UK market and is different, for example, from the German market in which the two biggest operators (T-Mobile and Vodafone) still control about 80% of the market and reported stable market shares for the last few years. In most European markets, the number of subscribers shows a slight tendency towards convergence. However, this has not resulted in a complete levelling of market shares as in the UK and in some cases, for example Blu in Italy, smaller companies have stopped operating altogether.

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*5 Note that this holds for subscriber market shares. Although there has been a similar trend in revenue market shares, Vodafone still boasts the highest revenue, as its customers generate a higher ARPU.*

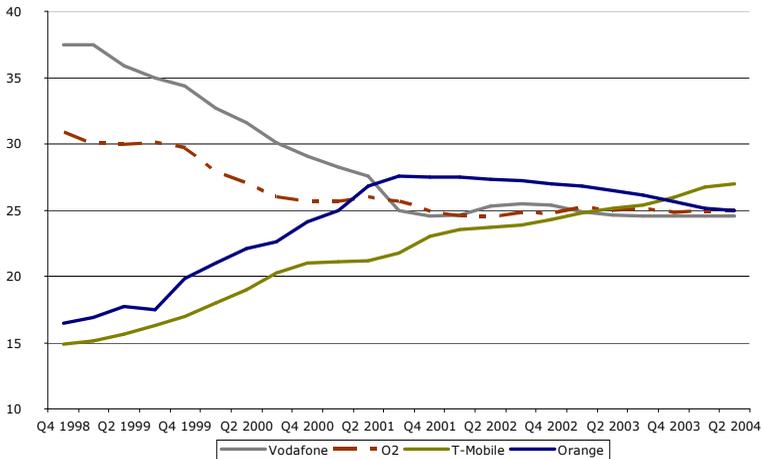


Figure 1. Development of subscriber market share

With strong network effects present in the market, the development observed in the UK is unlikely, because network effects result in a strong tendency towards higher market concentration. It could be argued that the development in the UK market is due to the high compatibility between networks. But, as our analysis will show, network effects do play an important role in the adoption of mobile telephones and in operator choice.

In our model, we analysed how the difference between the observed and expected ratio of the volume of off- to on-net calls is influenced by the price ratio between off- and on-net calls<sup>6</sup>. Intuitively, we would expect that there is no difference between the observed and expected ratio of call volumes, if there is no price difference, but that with rising costs for off-net calls more and more people will tend to make on-net calls rather than off-net calls. Consumers can lower their volume of off-net calls for example by choosing the same operator as the people they intend to call or by simply decreasing the frequency and length of off-net calls.

Visual inspection of the results from our regression model confirms that there is a very close relationship between the prices for on- and off-net calls and the respective call volumes and consumers indeed react to increases for off-

<sup>6</sup> The expected ratio of the volume of off- to on-net calls is calculated using operator market shares and assuming that consumers make calls to different networks in proportion to these market shares.

net call prices by lowering their demand for such calls. The graph shows fitted values from the regression. Data points are numbered from 1 (2<sup>nd</sup> quarter 1999) to 20 (1<sup>st</sup> quarter 2004).

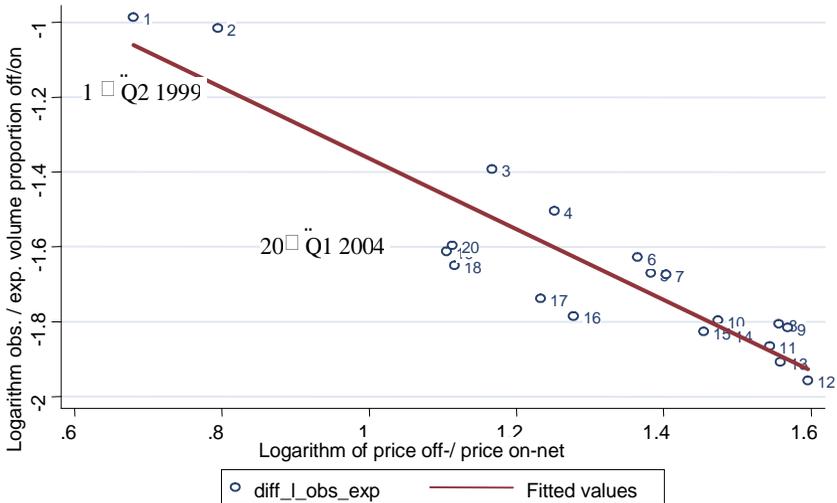


Figure 2. Price for on- and off-net calls and their impact on the volume of off-net and on-net calls

In general, there is a very good correlation between the fitted and the observed values for the period during which the price ratio increases and for the period during which the price ratio falls again. However, most of the early values lie above the fitted line and most of the later values below, which suggests that there is an additional time trend at work here. We find a significant and negative time coefficient, which means that the ratio between off-net and on-net calls is falling. In other words, over time we expect the volume of on-net calls to grow faster than the volume for off-net calls. The time coefficient can be seen as a proxy for an underlying process of users aligning their operator choice with their peers. We cannot forecast for how long this process will work, but it might not be easily reversible because of the switching costs present in mobile telecommunications. In other words, even after the price differential has vanished, we would expect a far higher share of calls to be on-net than off-net.

## NETWORK EFFECTS AND HOUSEHOLDS

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After looking at network effects at the market level, we now turn our attention to local network effects – that is, to network effects between people who are closely related with each other. Although our everyday experience suggests that people around us have a strong influence on our decisions, this perspective has been largely neglected by the economics literature. This is mainly due to the necessity for simplification and abstraction in theoretical models, as there are myriads of possible ways in which consumers interact with each other. However, policy and marketing implications largely depend on the relative importance of local and global network effects.

We use two sources of data for the empirical analysis: price and market share data from the British telecommunications regulator OFCOM and micro-level data on consumers' usage of mobile telephones from the survey, *Home OnLine*. The *Home Online* survey (Brynin, 2002) was conducted in three waves (October to December 1998, January 2000 and February 2001) by the Institute for Social and Economic Research, University of Essex and was sponsored by BT. It consists of data on information and communications technology (ICT) access and usage by households and individuals. A subsection of the survey focuses on mobile phone usage and attitudes towards mobile telephony.

Our model predicts operator choice using three different types of variables. First, operator choice might be influenced by individual consumer characteristics. We find, for example, that younger people tend to choose T-Mobile rather than Vodafone. Second, we include operator-specific variables such as price and the number of subscribers. As predicted by the network effects literature, consumers prefer to join larger networks, all else being equal. Third, we add variables capturing the effects of other household members on an individual's operator choice and find that the more other household members already use a particular operator, the higher the probability that another household member chooses the same operator.

There is a wide variety of possible combinations of operators used in the same household, but to get a more intuitive idea of how we can interpret the results, the next table shows the predicted probabilities for a household member choosing  $O_2$  depending on the number of other household members using  $O_2$ . The results for other operators are very similar.

	O <sub>2</sub>	Orange	Vodafone	T-Mobile
No other O <sub>2</sub> users in household	23,4%	27,6%	27,7%	21,3%
One other O <sub>2</sub> users is household	52,2%	17,2%	17,3%	13,3%
Two other O <sub>2</sub> users in household	79,6%	7,3%	7,4%	5,7%
Three other O <sub>2</sub> users in household	93,3%	2,4%	2,4%	1,9%

Table 1. Predicted probabilities of operator choice<sup>7</sup>

If there is no other O<sub>2</sub> user in the same household, we predict that a respondent chooses O<sub>2</sub> with a probability of 23.4%. If there are three more O<sub>2</sub> users in the same household, this predicted probability increases to 93.3%. The variation within the first row (due to price and number of subscribers) is far lower than the variation within the first column (due to the choice of other household members). This indicates that operator choice of other household members has a much stronger influence on operator choice than overall network size and prices.

We further analyse how this coordination of operators depends on the relationship of household members to each other. We aggregate the original data into four different relationship types: partner-partner, parent-child, child-child, other. Although all types of relations coordinate operator choice to a far higher degree than we would expect by chance (25.6%)<sup>8</sup>, coordination is strongest between partners. More than two thirds of all partners use the same mobile phone operator. For the other three types, about half of the dyads use the same operator – still a considerably higher percentage than we would expect by chance.

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<sup>7</sup> The example shows the probabilities, if no other operator apart from O2 is used in the household and if the household member newly adopted a mobile.

<sup>8</sup> This calculation is based on the market shares as observed in the sample at the beginning of 2001.

	Partner/ Partner	Partner/ Child	Child/ Child	Other
Same network operator	165	90	16	6
Not same network operator	79	87	16	6
% same network operator	68%	51%	50%	50%

Table 2. Coordination of operator choice by type of relationship

## NETWORK EFFECTS AND SOCIAL NETWORKS

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We have extended the analysis of operator coordination within households to more general social networks as well. In these networks, we have taken links between consumers directly into account. For this purpose, we conducted surveys of classes of students at Nottingham University Business School (twice), the University of Nottingham's campus in Malaysia, the University of Utrecht (the Netherlands) and the University of Brescia in Italy. We asked students for information on their use of mobile phones and, with the help of a class roster, asked them to identify the people they communicate with.

Social networks can very usefully be analysed by graphical representation, in particular in the case of medium-sized networks with a couple of hundred nodes. Figure 3 depicts the social network within the UK 2005 class of students, based on their stated communication patterns.

It is a directed graph and arrows depict the direction of the nominations from the roster. The algorithm used to generate this graph is based on the idea of representing the social network graph as a system of mass particles. Nodes are the mass particles that repel each other and the edges are springs that exert an attractive force between nodes. Connected respondents will therefore be grouped together, whereas unconnected respondents will be separated.

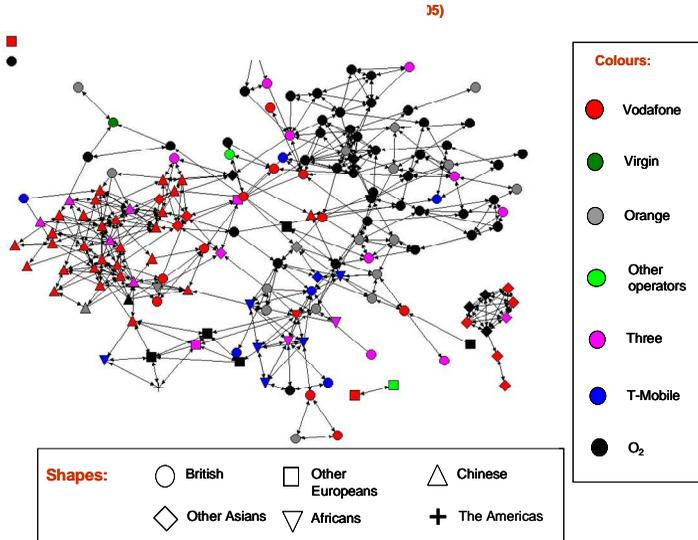


Figure 3. Interaction network of students (UK 2005)

Some form of clustering is immediately obvious. First, the shapes of the objects, depicting nationalities, are highly clustered. To facilitate interpretation of the results, the original 27 nationalities are grouped together into six groups. The two largest nationalities, British (50%) and Chinese (25%), form their own groups, while all Europeans, Asians, Africans and Americans are grouped into continental groups.

Chinese students (up triangles) communicate almost exclusively with other Chinese students, but also Asian and African students tend to cluster together quite strongly. At the bottom right of the graph, there is a group of Asian students who form a distinct component and only have communication links within the group. Two Spanish students also communicate only between each other and can be found at the bottom right of the graph as well. Finally, there are two isolated points at the upper left who do not communicate with other students in the same class.

Second, the graph shows a clustering of shadings, which depict the main operator chosen. This clustering of shadings clearly shows a national pattern. The majority of Chinese students use Vodafone and similar patterns can be observed for other nationalities as well. However, there also is coordination of operators within nationalities. Within each national group, students who call each other tend to use the same mobile phone operator.

These visual results are confirmed in more formal statistical analysis, which can be found in Birke and Swann (2005). The key finding is that local network effects are very strong and that consumers coordinate their operator choice not only within households, but within their wider social network as well.

## CONCLUSIONS

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The results obtained from the previous sections give a strong indication that network effects play an important role in mobile telecommunications. Network effects not only have an impact on adoption of the technology per se, but also on usage patterns and on operator choice. The results from the market-level model and the similar quality levels of the four operators further suggest that it is induced network effects rather than information contagion that leads to the coordination of operator choice. Furthermore, whereas learning effects have been found to play an important role in computer adoption (Goolsbee & Klenow 2002) and might also be important for the *adoption* of mobile phones, it is not clear why they should significantly affect *operator choice*.

Network effects in the mobile telecommunications market seem to work both at the aggregate level (overall network size matters) and at the micro-level (peers' choice matters) with the latter being the stronger effect. Based on our results, we estimate that ten million subscribers to a network have the same impact on consumer choice as one additional member from the same household being on the same network. This casts doubt on an equivalence between indirect network effects and direct network effects. Whereas in markets with *indirect* network effects, consumers do not care who in particular is on the same network, we have shown that in this case of *direct* network effects, consumers do care who is on the same network.

The results are also especially interesting for network operators rolling out third generation mobile networks. Although network effects will be even more complex for these networks and will include indirect network effects arising from services offered, the strong reaction from consumers to changes in the price ratio of off- and on-net calls suggests that inducing network effects has been a successful strategy on the part of operators. It can, in particular, be used by incumbent operators to fend off challenges by new entrants, such as "3" in the UK and also by any operator gaining a lead over the other operators. Furthermore, we have shown how strongly operator choice is coordinated within households. This suggests that operators gaining an early lead in the 3G market have an advantage over later entrants and that it is

important for operators to support this choice behaviour by their customers through appropriate pricing strategies.

From a regulatory perspective, network effects are seen as a reason for higher termination charges, as users of mobile networks benefit from additional users in every other network (Competition Commission 2003). The UK regulator, OFCOM, recently ruled that high termination charges and high costs for off-net calls can be regarded as evidence that operators have significant market power in their individual networks. As our results suggest, the high price of off-net calls can not only be a *result* of market power, but can be a significant *source* of market power, which can especially be used to pre-empt entry by new competitors. If high switching costs are present in mobile telecommunications, these asymmetries in market power can be highly stable once consumers have aligned their operator choice and can continue to exist even after the price differential between on- and off-net calls has been lowered.

On the other hand, when network effects are local in nature, multiple networks can more easily co-exist than in cases where only overall network size matters. This should reduce the need for policy intervention. The results also suggest targeting of specific niches as a viable marketing strategy to overcome the disadvantage of smaller network size. Members of ethnic groups, for example, are often tightly integrated with each other, but less so with the rest of a country's social network. For members of these local clusters, the distribution of operators within the cluster is the relevant network measure and new entrants can choose to target such sub-groups. Similar sub-groups can be expected to exist in different social strata and early adopters do not necessarily interact with later adopters, which mitigates against network effects leading to highly concentrated markets.

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# The “curse of the later entrants”: the case of the European mobile markets

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## ABSTRACT

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*Analyses of mobile markets in Europe show a major gap between operators' performances, and more precisely between first entrants and later entrants. In this article we propose to explain this gap, and use a sequential-entry model applied to the European mobile markets. In accordance with the economic literature, we confirm the existence of later entrants' inherent disadvantages in a fixed-cost industry with fast growing demand. We share the view of the European Regulators Group (ERG, 2004) that stated: "Without on-going vigilance new entrants may never be able to develop a sufficient market presence to justify making investments and the long-term vision of investment-based competition will never emerge".*

## ECONOMIC LITERATURE ON “FIRST MOVER ADVANTAGES”

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The economic theory of “first mover advantages” predicts that an early entrant will accumulate so many advantages that later entrants will have difficulties competing on equal terms. First mover advantages stem from early adoption by users, allowing a firm to capture a large market share early on. Thus, by the time competitors can enter the market, the first-mover will have already established advantages in brand-loyalty or awareness as well as cost advantages in distribution and/or infrastructure systems.

The value of being first has been a prominent concept in economic literature for many years. As of 1934, Von Stackelberg, showed that considering quantify-setting firms, the leader, i.e. first-mover, is able to get a larger market share and higher profits than the follower, i.e. second-mover or later entrant. Lieberman and Montgomery (1987, 1998) defined first-mover advantages in terms of the “ability of pioneering firms to earn positive economic profits (i.e. profits in excess of cost of capital)”(1987), and developed the idea of a first-mover advantage that protects pioneers from competition (1998).

Advantages of main first-movers:

- Technological leadership.
- Pre-emption of scarce assets.
- Modification of customers’ preferences.
- Brand awareness.
- Switching costs.
- Network effects.

Disadvantages of main first-mover:

- Free-rider effects.
- Resolution of uncertainty.
- Shift in consumers’ need and first-mover inertia.

While some studies underline that pioneering advantages diminish over time (Brown and Lattin 1994; Kalyanaram & al. 1995; Shankar & al. 1998), or is not consistent (Tellis et Golder 1996), the analysis of European mobile markets shows a persistent gap in terms of performance e.g. market share and profits, between first and later entrants. This phenomenon of “non catching up” leads to investigate whether sequential market entry could be an explanation for such different performances.

### **“CURSE OF LATER ENTRANT”: AN APPLICATION TO MOBILE MARKETS**

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The purpose of this paper is to highlight that it is almost impossible for a later entrant (or follower) to catch up with the early entrants (or movers). Considering a sequential market entry model, we can determine the impact of entry delay on a firm’s performances in a market characterized by high fixed costs and fast growing demand, and show that the longer the entry delay, the worse the performances of later entrants. This model provides a good explanation of the differences in economic performances of mobile operators in Europe.

The first-mover analysis can be formalized by the Stackelberg model (1934), in which two firms (Leader-Follower) compete with a sequential delay. As the first on the market, the leader chooses its level of output. The follower observes the choice of the first-mover and then determines its own level of output. In conclusion, the leader has a higher market share, as well as higher profits. The purpose of the sequential market entry model is to understand the impact of entry delays on a firm's performance in a market characterized by high fixed costs and fast growing demand.

Model hypotheses:

- Hypothesis 1: Product life cycle: evolving market following the four phases of a typical life cycle.
- Hypothesis 2: Sequential entry: two firms enter the market sequentially.
- Hypothesis 3: Same budget constraints.
- Hypothesis 4: Existence of incremental fixed costs.

The application of the model shows that:

- The more the "later entrant" delays market entrance, the greater the difference between the early and the later entrants is at the time of investment catching-up.
- At the time of market entry, investments required are huge for the later entrants.
- At market entry, there is a major difference in profits between first and later entrants.
- This difference increases with entry delay.

The results of our model fit with empirical observations summarised in the following figure which shows that later entrants (in brown) are mainly minor players with low market shares and low profitability.

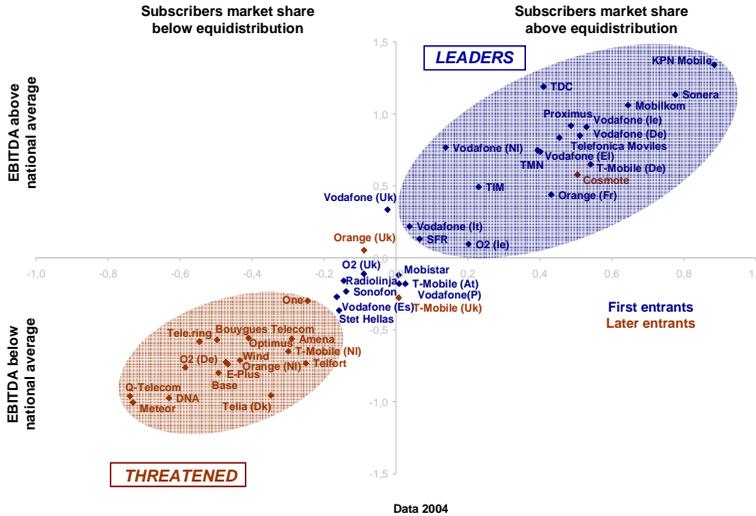


Figure 1. Market share/profitability mapping for European mobile operators

## THE RISK OF "WAR ATTRITION"

The first entrants are therefore always one step ahead due to accumulated investments in advertising, in acquisition, in quality of service, in technological leadership, etc.<sup>10</sup>.

These market dynamics are known as "war of attrition". The "war of attrition" concept<sup>11</sup> was first introduced in biological literature by Smith (1974) and later applied to economic analysis by Tirole (1988).

In a war of attrition, there are two options for the later entrant:

- Either the later entrant does not play the war of attrition game: the later entrant makes lower investments than the first entrant and ends up being less competitive than the first entrant which posts higher market shares.

<sup>10</sup> It must be noted that, by spreading its investments over several years, first-entrants may lower both the risk associated and its financial costs, which later entrants cannot do. This would make the "profit advantage" even higher.

<sup>11</sup> Originally, the war of attrition describes two animals fighting over a prey.

- Or the later entrant plays the war of attrition game: due to the same budget constraints and the relationship ( $\pi_{\text{first entrant}} > \pi_{\text{later entrant}}$ ), whereby the first entrant has a “deeper purse” than the later entrant and will eventually win the war of attrition. The later entrant will stop investing before the first entrant to avoid bankruptcy. This allows the first entrant to make higher investments and get higher market shares.

There is a high probability that later entrants know they will lose the attrition war. Later entrants cannot compete on equal terms without facing the risk of being evicted, or admit to being less competitive than the first entrant (even though it has the same cost structure). The first entrant gains higher market shares and revenues while the later entrant is unable to match the first entrant’s financial outspend.

From this analysis, it might be inferred that the first entrant can evict later entrants in case of sequential market entry. The “long-purse theory of predation”, originally proposed by Telser (1966), indeed states that an incumbent firm with large financing resources may prey upon a rival with limited resources until these resources are exhausted, the rival exits the market, and the incumbent is left to earn monopoly profits. But, knowing this, later entrants may be reluctant to initiate a war of attrition. Secondly, ( $\pi_{\text{first entrant}} - \pi_{\text{later entrant}}$ ) may be not high enough to force the later entrant out of the market, but may be sufficient enough to weaken it.

Finally, it must be stated that neither later nor first entrants seek to evict competitors. Due to the importance of fixed costs on the considered market, the eviction of one competitor could imply a write-off of the other, meaning that a new entrant could launch activities on the market by using the evicted firm’s infrastructures and without bearing fixed costs. Therefore, the surviving firm would compete with a stronger competitor. Subsequently, the best choice for the first entrant is to prevent the competitor’s eviction and thus avoid a war of attrition.

Because of the first entrant’s “longer purse” and because none of the firms want to evict the other, the first entrant is mechanically more competitive than the later entrant, thereby gaining more market share.

## **CONCLUSION**

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In accordance with economic literature, we confirm the existence of later entrants’ inherent disadvantages in a fixed-cost industry with fast growing

demand. The later a firm enters such a market, the higher its initial investment must be. As the later entrant cannot spread its investments over several years, it must immediately offer the same quality of service as an early entrant, and will consequently face a financial abyss at entry, leaving it with no room to manoeuvre to develop its commercial strategy.

In a way, competition begins with a real “asymmetry of purse”: the first entrant made profits while it was a monopoly and could spread its investments over years, whereas the later entrant starts with a huge loss, and must realise its investments very quickly. Financial constraints (a firm cannot have an infinite budget to launch its service), mean the later entrant cannot compete on equal terms with the first entrant: it cannot afford the first entrant’s commercial expenses (advertising, distribution, special offers) and as a result, the first entrant acquires more consumers than the later entrant.

In terms of market shares and profits, the gap between the two competitors gets wider and wider, and since they compete in a fixed-cost economy, the first entrant keeps on being more and more profitable, while the later entrant has difficulties providing a return its initial investment.

The hypotheses of our model match the characteristics of European mobile markets: in almost all mobile markets in the EU 15, early entrants are very profitable whereas later entrants lag behind. And yet, European mobile markets have been regulated since the beginning, which tends to prove that National Regulatory Authorities have not appropriately addressed the inherent disadvantages suffered by later entrants in such markets, that we point out here.

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# First mover advantage in mobile telecommunications: the Swiss case

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## ABSTRACT<sup>12</sup>

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*This paper analyzes the causes and the extent of first mover advantages in the Swiss mobile telecommunications market. The late licensing of the competitors of Swisscom (the incumbent mobile network operator), switching costs and price induced network effects have led to considerable disadvantages for the entrants. Based on our qualitative and quantitative analyses, we find strong evidence for a persistent and significant dominance of the incumbent operator, Swisscom Mobile. Implications for both competition policy and regulatory issues will be discussed.*

## INTRODUCTION

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First mover advantages (FMAs) usually refer to economic advantages derived from early market entry. More exactly, a firm enjoys a first mover advantage vis-à-vis its competitors if (a) the firm provides goods or services before potential newcomers can enter the market and (b) these advantages persist (at least temporary) even after one or more competitors have entered the market. The incumbent firm is then able to realize excessive profits and to sustain a high market share, which in turn may lead to inefficiencies. From a theoretical point of view, first mover advantages arise if firms enter the market sequentially, and either structural, institutional, or strategic barriers to entry exist, which hinder competitive entry.

FMAs that stem from exogenous market interventions are of particular importance from a competition policy perspective. In contrast to endogenous advantages that result, for example, from innovation or marketing, exogenous FMAs, which, e.g., arise from sequential licensing policies, induce unavoidable disadvantages for followers, which may lead to both higher production cost and lower willingness to pay on the demand side.

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<sup>12</sup> This paper is based on Dewenter & Haucap (2006).

Therefore, regulatory authorities should take an entrant's disadvantageous cost structure into account when regulating prices.

This paper analyzes causes and the extent of first mover advantages in the Swiss mobile telecommunications sector and discusses implications for regulatory and policy interventions. We therefore (i) discuss the theoretical background of first mover advantages, (ii) analyze causes of first mover advantages, (iii) determine the existence and strengths of first mover advantages in the Swiss mobile market and (iv) offer some implications for competition policy and regulation issues.

### **FIRST MOVER ADVANTAGES, CAUSES AND EFFECTS**

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As mentioned above, first mover advantages arise from the ability of an incumbent to enter the market before other firms do. They enable the first mover to realize profits on top and above its cost of capital (see, e.g., Mueller, 1987; Lieberman und Montgomery, 1988). However, the possibility of early market entry ahead of other firms does not necessarily constitute first mover advantages. In contrast, when a newcomer firm is able to observe first movers' behaviour and strategies, it can avoid the incumbents' failures (this is typically referred to as second mover advantage). Moreover, it may also be easier for newcomers to benefit from former adoptions of new products and technologies (see Lieberman und Montgomery, 1988). However, most frequently first mover advantages outweigh the existence of any second mover advantages.

Roughly speaking, there are three different causes for the existence of first mover advantages: *cost advantages of the first mover* (e.g., due to exclusive access to best suited positions for base stations for mobile communications), *demand-side implied disadvantages of the second mover* (e.g., due to switching costs), and *positive network effects* (such as price induced network effects with on-net tariffs). First mover cost advantages typically result from structural advantages, such as economies of scale and learning curves, higher degrees of advertising appeal, or better access to input markets. Demand-side implied disadvantages are frequently caused by switching cost, product differentiation strategies or customers' uncertainty about qualities. Last not least, network effects can stem from incompatibilities and pricing strategies.

FMA's tend to reinforce market concentration, and the incumbent's dominance is likely to persist not only in the short run but also for a longer period. Market shares, therefore, only adjust slowly. While FMA's that stem

from innovations or endogenous cost advantages are less problematic since (a) (b) FMAs are a reward for efficient behaviour, and (b) competitors may catch up with dominant firms by imitating their behavior, a higher risk for competition is produced by exogenous FMAs. All factors that cannot really be influenced by competitors (such as institutional barriers to entry as, for example, monopoly rights), switching costs, consumers' uncertainty and exogenous cost advantages are likely to allow the first mover to set higher prices both in comparison to the followers and in comparison to a situation without FMAs. In the case where followers face inevitable disadvantages due to exogenously granted advantages, such as sequential licensing, an efficiency oriented regulation should therefore take into account the disadvantageous situation of later entrants.

### **FIRST MOVER ADVANTAGES IN SWISS MOBILE TELECOMMUNICATIONS**

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Most empirical studies on FMAs find a positive correlation between the sequence of market entry and firms' market share, in various industries. According to this, early entrants have higher market shares in comparison to late entrants, not only in the short-run but also in the long-run. The constancy of FMAs strongly varies with industries, however, first mover advantages may last over decades. Empirical studies for mobile telephony markets are rare, exceptions are Benzoni (2007), Gruber (2005) and Sarkar, Cavusgil and Aulakh (1999). By and large, however, the existence of FMAs in mobile telephony is well accepted in the literature.

Analyzing the Swiss mobile telecommunications sector one can find at least four important causes for possible first mover advantages:

- Cost advantages
- Product differentiation and consumers' uncertainty
- Switching costs, and
- Price-induced network effects.

Cost advantages are driven by three different factors: (i) economies to scale, (ii) access to advantageous spectrum, and (iii) cost-efficient installation of transmitters. Particularly the latter factor is of special importance in Switzerland, since both the late licensing of the competitors and restrictive laws on radiation protection led to significant FMAs for the incumbent *Swisscom* (see also WIK, 2002).

The two late entrants Orange Switzerland and sunrise/diAx face a further disadvantage caused by the exclusive application of GSM 1800 MHz technologies in contrast to hybrid (GSM 900 MHz and GSM 1800 MHz)

technologies applied by Swisscom. With the early licensing of Swisscom only a limited amount of spectrum was available in 1998 when Orange and sunrise entered the market. As GSM1800Mhz technologies demand a much higher density of antennas, they are therefore associated with higher costs.

Product differentiation also plays an important role in Swiss mobile telecommunications. The usual Swiss term for mobile handsets, "Natel", was originally introduced by Swisscom for car phones in the mid 1970s. Today, it is still commonly used for mobile handsets. At the same time, "Natel" is a registered brand name of Swisscom, which produces significant marketing advantages for the incumbent.

Early licensing of Swisscom also led to an unequal distribution of customers over the network provider. While especially in the beginning of mobile telephony Swisscom was able to attract customers with a high willingness to pay, the later entrants Orange and sunrise had to face the residual demand. Late adopters, in contrast, are typically less disposed to pay high prices. At the same time, the existence of switching costs makes it difficult for customers to change to a different provider and demand high price cuts.

A further first mover advantage of Swisscom stems from customers' uncertainty about late entrants' network coverage and quality. While Swisscom enjoys a high reputation for its quality and coverage the customers' appraisal of the competitors' quality is still relatively low. To outweigh such apparent differences in quality Orange and sunrise have to provide much lower tariffs. Swisscom, in contrast, is able to set higher prices due to this uncertainty.

As mentioned above, switching costs also play an important role. Apart from uncertainty about quality switching costs appear in following ways:

**Contract duration:** The typical contract durations in Swiss mobile telephony are 12 and 24 months. Within these periods customers cannot switch to another provider. Customers have to cancel contracts at the end of the contract period and within the cancellation period of usually two months. In the case that customers do not cancel within this period the contract will be automatically renewed. Thus, transaction costs increase. In the case that consumers wish to change providers, customers also have to request the porting of their mobile number two months before a contract expires. As a consequence, this practice most likely reduces churn rates. Empirical evidence on a relatively low amount of ported mobile numbers (in comparison to other European countries) underpins these findings.

**Complex tariff structure:** In addition, a complex tariff structure exacerbates this problem. When comparing prices consumers have to be aware of both

their current and their future calling behavior to choose adequate tariffs. For this reason, further transaction costs hinder a changeover to a different provider and strengthen first mover advantages.

Last not least price induced network effects also produce first mover advantages in Swiss mobile telephony. As prices for off-net calls are differentiated from prices for on-net calls, a provider's subscriber base becomes an important factor. Both late entrants have considerable cost disadvantages and are not able to reproduce Swisscom's off-net tariffs without facing losses. Thus, a large provider as Swisscom is able to set prices for off-net calls such as to initiate network effects. Customers are therefore more likely to join the incumbents' network.

To summarize, three major causes can be identified to be responsible for the existence of significant first mover advantages in the Swiss mobile telephony:

- Swisscom benefits from exogenous cost advantages, which stem from a long lasting monopoly position and therefore Orange and sunrise in reverse face inevitable cost disadvantages.
- Product differentiation and switching costs led to lock-in of customers with a high willingness to pay.
- Price induced network effects reinforce existing first mover advantages.

## **EMPIRICAL ANALYSIS**

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In order to analyze the strength of first mover advantages in the Swiss mobile telecommunications market we have applied both qualitative and quantitative techniques. The quantitative analysis has revealed that (i) licensing of Orange and sunrise has been accomplished rather late in comparison to other European countries. (ii) At this point of time, the penetration rate of Swiss mobile telephony was relatively high (21.63%) and (iii) up to now an obvious asymmetry between Swisscom, Orange and sunrise exists (by means of market shares). Therefore, it is assumed that Swisscom benefits from considerable first mover advantages not only in 1998 when Orange and sunrise entered the market but also nowadays. Moreover, significant first mover advantages are responsible for a high concentration in the Swiss mobile telephony market and low market entry. Even though in 2002 two mobile providers (In&Phone and Tele2) entered the market, neither operates as a national provider but offer either regional or firm-specific services.

Using data from 14 European mobile telephony markets we have furthermore analyzed whether and at what rate subscriber bases of the Swiss provider converge both over time and compared the results with those from the other European countries. Using both seemingly unrelated regressions and panel techniques to estimate a growth model (see Barro et al., 1991) of subscriber numbers, we find evidence for converging subscriber bases in all of the 14 countries. However, Switzerland (1.90) showed (with Portugal, 1.39 and Finland, 1.51) one of the slowest speeds of adjustment. The speediest adjustment processes can be observed in countries such as Spain (8.54), the Netherlands (5.62) and Belgium (4.19).

At the same time, we find that slow convergence is highly correlated with late licensing of competitors. Countries, which have introduced competition when penetration rates have still been small or at most moderate, are likely to adjust at a higher rate. We interpret these results as evidence for the existence of significant and persistent first mover advantages.

Overall, also our statistical results support the assumption of large first mover advantages in Swiss mobile telecommunications. Both entrants, Sunrise as well as Orange, had and still have to face considerable disadvantages when competing for mobile telephony subscribers.

## CONCLUSIONS AND IMPLICATIONS

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First mover advantages usually refer to economic advantages from early market entry of an incumbent firm in association with late entry of competitors. Most mobile telephony markets are characterized by exactly such market entry processes, whereby incumbent mobile telephony providers have long been left in monopolistic positions. Meanwhile, most of these markets have been liberalized and deregulated and (with respect to Europe) in most countries at least two or three competitors have been licensed since then. Since the Swiss mobile telephony market is an example for an extremely late liberalization first mover advantages are considerably high and market shares are extremely sticky.

Each policy or regulatory intervention which conserves the dominant position of the incumbent is not suitable to foster competition or even to facilitate market entry. Regulation of, e.g., mobile termination rates, should therefore take into account *unavoidable* disadvantages of late entrants<sup>13</sup>. Even though

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<sup>13</sup> However, avoidable costs have, of course, to be excluded.

an asymmetric regulation of termination fees can also be problematic (see Haucap, 2007) unavoidable disadvantages of small should be taken into account.

A too strong drop in termination rates decreases the incentives to aggressively compete for subscribers, since new customers are less valuable as they would be with higher mobile termination rates. Moreover, due to the waterbed effect mobile providers are likely to raise other parts of the tariffs, such as prices for on-net calls, or to lower handset subsidies. A too strong downward regulation of mobile termination rates has also negative impacts on market entry when potential newcomers would not be able to generate enough surpluses for their investments.

Apart from market size and cost structure it is particularly the existence of first mover advantages which is responsible for market entry. The absence of market entry of a fourth GSM network provider in Switzerland and also the late entry of firms with different business models (such as In&Phone and Tele2) seem to indicate significant FMA in favour of Swisscom. Regulatory authorities should therefore be careful when regulating small mobile network providers' termination rates.

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# Infrastructure-based competition versus service-based competition in the European mobile market

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## ABSTRACT

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*Since 1995, in the specific context of mobile telecommunications, both the European Commission and the Member States have favoured “infrastructure-based competition” over “service-based competition”. While the duplication of infrastructures can create inefficiencies, infrastructure-based competition remains more beneficial than service-based competition. Our arguments are based on the analysis of types of technology and the cost structure of mobile networks across Europe (GSM technology). We find that the cost of inefficient duplication is largely compensated by site sharing benefits, and all advantages induced by infrastructure-based competition: innovations in products and services, lower prices and reduced need for regulatory intervention. We conclude that differences between mobile operators in terms of performances are not due to the inefficient duplication of infrastructures (infrastructure-based competition), but much more to entry delays, which can be compensated by the “investment ladder strategy” on the regulatory level.*

## INFRASTRUCTURE-BASED VERSUS SERVICE-BASED COMPETITION

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In telecommunications markets, where infrastructure is a key part in the cost structure, two means have been considered to introduce competition:

- Service-based competition, whereby several service providers use a unique infrastructure of a network operator to provide their services.
- Infrastructure-based competition, whereby network operators duplicate the infrastructure so that they can compete on all levels of the market, infrastructure and services.

Infrastructure-based competition presents a wide range of advantages:

- Stimulates more variety and quicker innovation in service offerings.
- Provides lower prices.
- Attracts investment in and modernization of mobile markets, which may bring above-average economic returns.
- Enables less regulatory intervention.

Currently, the main drawbacks of infrastructure-based competition are:

- A slower introduction of competition.
- The risk of inefficient duplication of infrastructures due to the role of returns to scale and returns to density.

The aim of this paper is to point out the benefits of infrastructure-based competition in telecommunications markets and to highlight that the mechanisms behind it are still relevant in the present context of European mobile markets.

## **APPLICATION OF INFRASTRUCTURE-BASED COMPETITION IN MOBILE MARKETS**

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Across the telecommunications market, there is a large consensus between economists and European or global authorities on the benefits of infrastructure-based competition over service-based competition.

Since 1995, in the specific context of mobile telecommunications, both the European Commission and the Member States have favoured “infrastructure-based competition”, the limited number of competitors (between 3 to 5 mobile network operators in EU15 countries) being mainly explained by the scarcity of radio spectrum.

As OECD (2001) indicates: *“in the longer term facility-based competition brings more benefits to consumers while service competition has merits in that it allows for a rapid introduction of competition, reduction of prices, and an increase in consumer choice” and thus that “competition at the infrastructure level should in turn feed through to competition in the provision of services, providing consumers with a choice of packages, pricing structures and customer service options.”*

In much same way, European Regulatory Group (ERG, 2004), states that: *“In order to promote sustainable, infrastructure-based competition, NRAs have to set investment incentives such that the dominant undertaking’s infrastructure is replicated wherever this is technically feasible and economically efficient within a reasonable period of time “.*

Thus, service competition based on regulated access at cost-oriented prices can be (and in general is) the vehicle for long-term infrastructure competition. With this, new entrants can decide on their investment step-by-step and can establish a customer base (critical mass) before they go to the next step of deploying their own infrastructure. In areas where infrastructure based competition is feasible, the long-term objective of these interventions is the

emergence of self-sustaining effective competition and the ultimate withdrawal of regulatory obligations [ERG, 2004].

Following Bergman's study (2004), it is useful to distinguish between returns to scale and returns to density as clearly perceived in the dynamics between service and infrastructure: *"There are returns to density when, on a given route or line or within a given geographical area, average cost falls as traffic on that route or line increase or as transaction volumes in that area grow. There are returns to scale when average costs fall as the number of routes or lines served by one company increase or, as the firm expands into a larger geographical area"*.

In the presence of substantial returns to scale (cost of building infrastructures) and returns to density (sparsely populated areas) the duplication of infrastructure is relevant, if and only if the firm can reach the critical mass which allows a return on investments (i.e. be profitable). Service-based competition, however, allows the industry to realize greater returns to scale: the fact that all customers are connected to the same infrastructure maximizes the level of returns to scale (network externalities). *"In particular, returns to scale (or density) may be very large in providing infrastructure, while the returns to scale in service provision may be much smaller, or even negative"* (Bergman, 2004).

### **IS THERE A RISK OF INEFFICIENT DUPLICATION FOR THE MOBILE MARKETS?**

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GSM mobile networks can be divided into two parts:

- The local loop, which is composed of transmitters that manage the physical and logical communications between mobile networks and users. These transmitters are called TRX and are installed on antennas (themselves installed on sites). "Sites + antennas + power equipments" are called BTS (Base Transceiver Station). Sometimes, TRX are said to be part of BTS, but here they are considered separately. As for costs, BTS are the main component of the local loop, as 1 TRX costs 50 times less than one BTS.
- Core network: it is made of linked nodes that are located at a regional or national level. These nodes are BSC (Base Station Controller that can manage several BTS, typically 40), MSC and TMSC (which are regional and national network equipment).

We have analysed the following question: is the duplication of GSM networks efficient or inefficient<sup>14</sup>? General networks are naturally duplicable, as they were in fixed telecommunications networks:

- Costs generated by links between users and BTS are variable and not subject to returns to scale.
- TRX, which is a strategic element of a network, does not introduce any risk of inefficient duplication of introduction.
- Finally, even if there is a risk of inefficiency in duplication of BTS, it can be balanced by site sharing.

At the highest level of GSM networks (general network), infrastructure-based competition cannot be questioned as it is as legitimate as infrastructure-based competition in fixed telecommunications networks. However, at the lowest level (local network), the efficiency of duplication might be questioned as duplicating BTS can be inefficient. In this instance, site sharing offers an opportunity to inhibit the possible inefficiency of BTS duplication. All the more so since site sharing doesn't concern "intelligent" components of the network, that is to say, components which enable the introduction of new services. Given the increase in the number of BTS with UMTS, the relevance of site sharing should be even greater.

Further, the duplication of local networks in mobile networks is more relevant than in fixed networks as the link between consumers and networks is wireless, that is to say variable. In fact, if returns to scale are relatively small in all production stages, at least compared to regulation costs, then it may indeed be a good policy to stimulate competition in all stages (with site sharing when necessary).

However, even if the level of competition across EU15 GSM mobile markets is currently high, observations reveal that the later entrants have difficulties in posting profits and in building a large client base. More, there is a true risk of a pan European oligopoly emerging. This "curse" of the later entrants (see Benzoni in this volume) has re-opened a debate on the respective merits of infrastructure vs. service-based competition, the proponents of the latter advocating for a strong support to the development of "Mobile Virtual Network Operators" (MVNO).

But, today in Europe, the real impact of service competition is rather marginal. Compared to the previous year, the number of mobile service providers in EU (mobile virtual network operators, enhanced service

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*14In fact the structure of GSM and UMTS networks remains the same. Therefore we assume that the same reasoning could be applied to 3rd generation technologies (e.g. UMTS), with the same conclusions.*

providers or simple resellers) has risen to 290 in 2006, an increase of 76. Nevertheless « *the actual decrease in the market share of the leading operators was relatively small between 2004 and 2006. In percentage terms, the decrease in the leading operator's market share in terms of subscribers between 2005 and 2006 was only 0.2% while the main competitors increased their market share by 0.1% between 2005 and 2006* » [European Commission 2007].

## CONCLUSION

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The consensus between economists and European and global authorities in favour of infrastructure-based competition and against service-based competition is due to the higher level of competition that the former enables. Service-based competition does not offer enough opportunities to service providers to actively compete with firms that own and manage infrastructure.

In the telecommunications market, it is indeed at the infrastructure level that major innovations can be introduced. Moreover, infrastructure costs remain an important part of operators' cost structure. However, the main risk of infrastructure-based competition is that duplication of infrastructure may be inefficient, that is to say duplication of infrastructures may be more expensive for the market than the presence of a single infrastructure. There is a trade-off between returns to scale and competition.

Regarding mobile markets, the additional costs generated by duplication of infrastructure does not seem to overpass benefits of infrastructure-based competition in comparison with service-based competition: employments due to investments, innovations (that require modifications at the infrastructure level), correct investments incentives, higher competitive pressure on infrastructure costs. For these reasons, and considering the marginal impact of service competition in Europe, infrastructure competition appears to still be the most relevant option for mobile markets.

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# Interchange flow between mobile network operators: asymmetry and discrimination

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## ABSTRACT

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*For the time being, the mobile telecommunications sector is characterized by asymmetric conditions. Operators acting in this market strongly compete to maintain acquired positions or to conquer a higher market share. The entrants, in general, and the MVNOs, in particular, cope with asymmetry which leads them to bridge the gap with the incumbents. Attaining incumbent level is difficult to reach: its consolidated size in terms of market share, profits, technological awareness, and experience in the market, produces further advantages in scale economies and network externalities.*

*Higher competitiveness has increased the complexity of the strategic interactions among operators. Structure of the market, dimension of operators, interconnection charges, and pricing discrimination policies cause a different impact on the results of the competitive pressure. The consequences of the various strategies implemented by operators in the competition have been examined through the analysis of the variables behaviour, such as interconnection charges, retail prices, profits, and market share, with a focus on the entry strategies of the Mobile Virtual Network Operators.*

## INTRODUCTION

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In the last years, the development of mobile telecommunications has extended significantly in most industrialised countries. The mobile telecommunication industry has changed from a traditional monopoly into a highly competitive market, where an increasing number of players showed are eager to find their space.

The struggle for market success is not only based on user satisfaction and the differentiation of the service offered, but also on the conditions established for the employment of the infrastructural networks: in mobile telecommunications, as in other sectors characterized by infrastructural networks, growing competitiveness has led companies to interconnect each other, thereby, increasing the complexity of their strategic interactions (Katz and Shapiro, 1994). Conditions and levels of interconnection have compelled operators to make strategic choices (Laffont, J-J. and Tirole, J., 1996; Economides, N., 1998). Asymmetric market conditions mark behaviours of the incumbent and the entrants, revealing how much their different power can influence their interaction. The situation has become far more complex at the entry of a new kind of operator, the Mobile Virtual Network Operators, which can be defined as operators offering mobile voice and data services without owning the access rights to the spectrum they use (Smura, 2003). In addition, several companies are offering their users not only mobile telecommunication services, but also a wide range of appealing supplementary benefits.

## **INTERCONNECTION**

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It is well known that from a monopoly perspective, the interconnection model is unidirectional (one-way), as only one company is the owner of the infrastructural network. Instead, interconnected networks exhibit a more complex structure, as it is necessary to allow the connection to other operators: in this case, data flows are bidirectional and “two-way” is the form of the access. By this kind of access, a company admits other companies to offer final users their services, remaining obliged to ask them for the permission of access to guarantee its users full services. All kinds of arrangements presume that operators can compete for subscribers, without any limitations so that all end users can express their preference indifferently among the carriers. But, at the same time, consumers are tightly subject to the interconnection agreements among operators; in fact, a subscriber to an operator can call other subscribers of different operators only if their operators are interconnected. Consumers’ choices will be focused on the highest net utility in terms of retail price and quality of services offered by one operator in respect to other operators. So, arrangements between two or more operators stimulate the competition in a mobile telecommunications market. But it is not necessary for an operator to conquer the whole market, as consumers’ taste is highly differentiated.

All the above means that the decisional variables of the competition, the price to impose on final users and the interconnection charges, become strategic elements for companies operating in interconnected networks. As a

consequence, the interconnection agreement constitutes a relevant topic of scientific investigation, as modalities of adopting interconnection charges are differentiated and depend on the relative dimensions of the market (symmetric or asymmetric), and on infrastructural aspects of the interconnection: the level at which operators connect each others (peripheral or central zone of the network); the typology of services (quality and capacity of interconnections); and the typology of basic infrastructure (essential facility or bottleneck facility).

Interconnection is not only considered as a structural need for call terminating, but also as a competitive strategic feature. Interconnection charges can be used as an anti-competitive tool by operators, thus representing an element to be regulated (Armstrong, 2002 and 2004). It is clear that, since the first transformation of the market from its monopoly characteristics to those of competition with several operators, asymmetric conditions mark interactions among the incumbent and the entrants; as a matter of fact, the incumbent still detains a competitive advantage for its nature respect to entrants. Studies carried out so far show that asymmetric or symmetric conditions affect the level of the interconnection charges. In a market structure with symmetric conditions and linear pricing, high interconnection charges, fixed in a reciprocal way, are considered both as a cost and a revenue for interconnected operators, keeping retail prices high (Armstrong, 1998; Laffont, Rey and Tirole 1998a); in the same way, with symmetric conditions and under two-part pricing, both operators are indifferent over the reciprocal interconnection charge (Carter and Wright, 2003). Instead, in a market structure with asymmetric conditions and under two-part pricing, Carter and Wright show that reciprocal interconnection charges represent the most efficient solution, but operators' concerns differ: the incumbent has preference for cost-based interconnections; while the entrant has preference for non cost-based interconnection if its market share is more than one third, and for cost-based interconnection if its market share is less than one third.

As the interconnection charge is increased above cost, the incumbent has a net outflow of calls; if the interconnection charge is set below cost, the incumbent has an unprofitable inflow of calls: thus the incumbent always prefers cost-based interconnection. For the entrant, if market share is more than one third, since the interconnection charge is increased above cost, its gain in interconnection revenue - due to the growth of incumbent call volumes - outweighs its loss of market share: entrant's profit increases with not cost-based interconnection. If, however, the entrant has less than one third of the market, the gain in interconnection revenue is not sufficient to balance the market loss: in this case, the entrants' interests are aligned with those of the incumbent for cost-based interconnection charge (Carter and Wright, 2003).

Moreover, assuming that reciprocity of interconnection charges is not imposed, both different-sized operators would unilaterally raise the access price they charge and would lower the access charge they face; in consequence of its market power. The incumbent could raise interconnection charges and turn them into a barrier-to-entry tool (Carter and Wright, 2003). For these reasons, most European regulators have focused management's attention on convergence from asymmetric towards symmetric interconnection charges, and on the possibility of establishing an upper bound for their value.

## **PRICE DISCRIMINATION**

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For each operator, the mobile telecommunications market is outlined by the number and typology of calls. They can be divided into "on-net" and "off-net" calls, the former referring to calls originated and terminated within the operator's network, the latter terminating on the competitors' networks. On the base of this distinction, it is possible to affirm that the traffic of on-net calls, originating from incumbent's end-users, is larger than that originating from followers' end-users. As a consequence, the size of operators and interconnection charges are two levers for an operator to receive a competitive advantage over the competitors and to realize large profits so as to obtain a significant market share (SMP). According to EC guidelines, an SMP operator is an operator who maintains a durable market share over time.

The mobile telecommunications sector shows a high penetration rate and is characterized by saturation. Network operators can compete by maintaining or increasing their market share, by concentrating on customer retention, and by attracting competitors' subscribers. These objectives can be pursued through price discrimination strategy, which allows carriers to set different retail prices for on-net and off-net calls. However, the implementation of price discrimination strategy causes a different impact in terms of profits and market shares, according to relative dimensions of incumbent and followers: the incumbent would obtain share erosion on followers' market, by taking advantage of its network externalities in respect to the other smaller network operators. At the same time, the price discrimination regime of on-net and off-net calls could induce the incumbent, through an anti-competitive behaviour, to build entry barriers, by fixing an high interconnection charge; in addition, two or more joined operators, which total a SMP, could reach tacit agreements against other players of the market by magnifying the effects of price discrimination strategies.

An operator can adopt a price discrimination strategy to preserve its customers and to entice competitors' subscribers into migrating to its network. Changing operators is a choice justified by two main causes: the advantages derived from a tariff system, and the market dimension. There is no doubt that a subscriber would migrate towards the operator with more convenient retail prices. But, migration would no longer be convenient anymore if relatively low on-net retail prices are fixed by a carrier of a small dimensioned market share, due to the minimal possibilities for the migrants to make on-net calls (Laffont et al., 1998b). Therefore, the incumbent benefits from lowering its on net retail prices for two reasons: it favors its end users and, most of all, boosts followers' subscribers to migrate towards its domain.

From the above mentioned considerations, it results that the price discrimination strategy is more efficient for the incumbent than for followers and entrants, as a consequence of their different market size: the former's potential subscribers, , are indeed attracted by the possibility of making a larger number of on-net calls at a lower retail price.

### **NEW COMPETITION CHALLENGES: THE MOBILE VIRTUAL NETWORK OPERATORS**

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In the mobile telecommunications industry, services must be supplied through an access network, which can be owned or provided by an operator. Networks require the availability of a limited resource, as is spectrum; as a consequence, the number of network operators is limited. Market saturation, expectation of profits, and technology developments have encouraged the entrance of new players, which provide cellular services without owning the radio infrastructure. These "virtual operators" challenge the market by introducing into the competition a further and more consistent element of asymmetry. They are atypical operators, having different backgrounds and coming from differentiated fields of activities, such as multinational consumer brands, media companies, large-scale retail trade firms, financial institutions or content providers, and compete and interact alongside traditional network operators. They offer mobile voice and data services without owning the access rights to the spectrum they use (Smura, 2003), and the radio capacity used to provide these services is gained through commercial agreements with licensed Mobile Networks Operators (MNOs) (Kiiski and Hämmäinen, 2004). A Mobile Virtual Network Operator (MVNO) has to establish an agreement with a network operator from whom it buys a wholesale network capacity to essentially obtain the same possibilities to offer mobile services to end-users as an MNO. To the customer, an MVNO is just another mobile operator, notwithstanding it does not own any telecom network infrastructure.

MVNOs differ from one another in the levels of investment and service differentiation: the level of control of products, services, channels and customers will determine the level of investment that is necessary to develop initiatives regarding organization, processes, systems and products. Then, they can be classified into categories based on the amount of network components they own and operate. A range of four different business structures of mobile service operators can be identified: resellers, service providers, “wholesaling” MVNO and “full” MVNO.

This division is based on the make-or-buy adopted decisions and on service implementation and differentiation.

- Services Reseller (or Brand Operators): Sells pre-packaged services.
- Service Provider: Offers distinctive brand; controls customer care but has neither control on tariffs neither influence on service design.
- “Wholesaling” MVNO (or Enhanced Service Provider): Holds the necessary equipment to issue and to personalize SIM cards; controls tariffs and service design, but works under some network-imposed constraints on service design.
- “Full” MVNO: Owns the switching network, beside the characteristics of the “wholesaling”; controls all aspects of service design and implementation and holds a fully independent branding and manages a full customer ownership.

Referring to the previous classification, indeed, the level of technical independence defines the services and the level of the offer differentiation that MVNO is able to provide. The maximum technical independence corresponds to the minimum use of MNO facilities and to the MVNO's maximum economic and infrastructural investments.

To understand how a “full” MVNO operates, it is useful to identify the constituent parts of its mobile network (Fig. 1). The Base Transceiver Station (BTS) and the Base Station Controller (BSC) of the MVNO allow the identification of its subscriber through the Home Location Register (HLR) and the Visitor Location Register (VLR). The Mobile Switching Centre (MSC) of the MVNO is connected to that of the MNO and provides the connection to the Public Switched Telephone Network (PSTN).

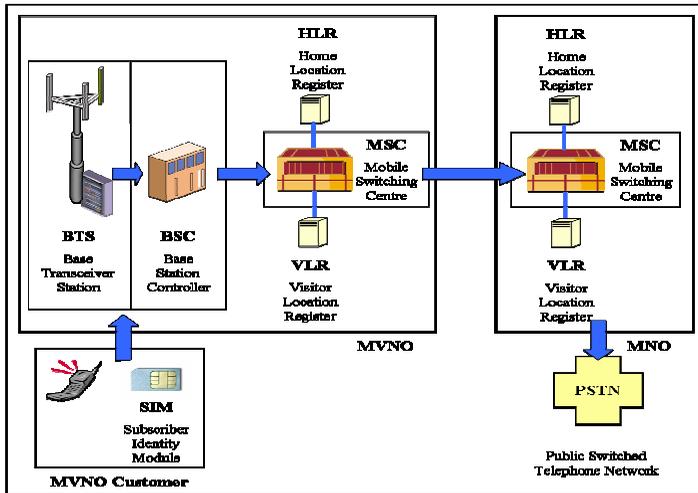


Figure 1. MNO's and MVNO's constituent parts

As shown in the figure, the “full” MVNO has the maximum level of control on its own operations by means of the MSC, which acts as the access point to the MNO and enables the MVNO to control the routing of its outgoing calls (Kanervisto, 2005). But, it is also evident that MVNO subscribers roam networks of other operators, demonstrating the fictitious independence of MVNOs, which are conditioned by MNOs. As a consequence of their infrastructural dependence, MVNOs are aware that they should not to focus their service differentiation on the radio components shared with its hosting MNO (Doyle, 2000), but concentrate their efforts on the elements of the mobile network, which to appeal to customers, such as customer care, billing, marketing, distribution and add-value services (Ulset, 2002).

Strengths, weaknesses, opportunities and threats characterize MVNOs. MVNOs take advantage of one of its most reliable and essential points of strength: a large pre-existent customer base arising from its core field of activity. It effectively uses its customer loyalty and brand recognition as a launching pad to enter the market, making up for its lack of experience in mobile technology and in its know-how related business. Undoubtedly, they would have suffered from a longer time to market for services than in the MNO case (Smura, 2003). The above-mentioned aspects, together with their limited dimension, represent the true weakness for the MVNOs. On the other hand, MVNOs have several opportunities, such as the possibility of covering a niche which MNOs do not serve; the potential advantage of offering high customer orientation and high service quality, through innovative value added content, service and application; the benefit derived from leveraging its own distribution network. Eventually, the biggest threats come from the

difficulty of competing with MNOs and of driving down margins because of the increase in competition; the necessity for MVNOs to be able to either generate more revenue or cut costs in a way that MNOs can not replicate; the uncertainty of the result and the risk of its high investment on equipment, due to the impossibility of controlling the network quality level.

From the MNO's point of view, interconnection agreements with MVNOs are convenient issues, in terms of incomes from concessions, cost reduction and risk sharing; but, at the same time, effects of MVNOs' entry into the market could lower retail prices and cause a sufficient congestion to degrade the quality of the network services; in fact, competition can only occur on the available capacity of the network, which cannot be increased.

Therefore, MNOs should not let a MVNO in unless they are certain that the MVNO in question will not enjoy significant success. So, MNOs should pay attention in providing MVNOs with the most beneficial and profitable amount of network capacity (Torrás, 2002), and at the same time it should be careful with the loss of revenue due to the loss of customers. Consequently, the success of MVNOs can only depend on a customer base or on a competitive brand: primarily, it has to compensate for its own dimensional disadvantage, and to compete with overwhelming network rivals by designing competitive tariffs and services, forming strategic alliances for content, and establishing well negotiated agreement with the hosting MNO.

## **THE COMPETITION BETWEEN DIFFERENT-SIZED MOBILE OPERATORS**

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Once all the issues of the interconnection agreement between operators have been smoothed out, then the factual competition begins, being the opposite actors actively involved in the conflict for the reciprocal erosion of their market shares. Many implications derive from the access of MVNOs into the mobile telecommunications sector, and their productive implications are particularly interesting because of the structural and technical interdependence between operators, their different market share, the interconnection policies, and the business strategies. So far, it is evident that MVNOs are still confined to such dimensions that prevent them from surpassing their "real" competitors, at least as far as the initial phase of the competition is concerned.

Both MVNOs and host MNOs compete to maximize their profits and their interactions can be studied through a model approach. Competition terms are defined by fundamental variables, such as profits, market shares, pricing policies, the degrees of substitutability and asymmetry between the

networks, and the level of infrastructural investments. The model approach analyzes the way in which the consequences of different strategies, implemented by the MVNO and the MNO, are dependent on their different size (Cricelli et al., 2006). The first research phase develops two possible scenarios: one which simulates consequences of variations of the degrees of substitutability and of asymmetry between the networks on operators' market shares and profits; the other which simulates the impact of interconnection charge variations on the above mentioned variables for the two different-sized operators.

In the first scenario, the wide name and reputation acquired by an operator (degree of asymmetry or different relative dimensions) and the possibility for an operator to raise prices without losing any subscribers (degree of substitutability) have been analyzed in the simultaneous maximization of profits. Simulation results show that, a logical consequence of its quality of incumbent, MNO profits are high for high values of asymmetry between the networks. In other words, as the degree of asymmetry between operators corresponds to all these advantages that the MVNO provides to attract MNO subscribers, at a high degree of asymmetry, MVNO meets an extreme difficulty in keeping up with the MNO. In these conditions, the MVNO has to make up for its inferior dimension with brand loyalty gained in its previous field of activity and to transfer it to the mobile telecommunication sector.

Moreover, we have observed that the lower the values of the degree of substitutability, the higher the profit and market share values of the MVNO. At a low degree of substitutability, retail price has less influence on market share and profit. This fact determines that the market is less price-sensitive, and the benefits of MNO are reduced. The MVNO can raise retail prices to such a level as to focus its strategy on product differentiation, rather than on cost-leadership. More broadly, the MVNO puts into action a customer-oriented approach and considers the knowledge of customers' needs as a key to the success for their attraction and satisfaction.

In the second scenario, the analysis considers the variation of interconnection charges in the simultaneous maximization of profits. Simulation results show that by increasing the value of the reciprocal interconnection charge, MNO profit and market share will increase, while MVNO profit and market share will decrease. In other words, the MNO benefits from the advantage of its larger market share and its network externalities. This can be explained by the fact that at the increase of interconnection charges, off-net retail prices increase and, consequently, off-net demand decreases, thus reducing off-net revenues for the MVNO. This fact forces MVNOs to consider the on-net revenues as the main source of its profitability. Thus, the MVNO tries to enlarge its domain by offering highly differentiated and innovative services, which appeal to new subscribers, and

by meeting the specific requirements of potential customers, not yet satisfied by other operators.

## **CONCLUSION**

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For the time being, the mobile telecommunications sector is characterized by asymmetric conditions. Operators acting in this market compete strongly or maintain acquired positions or to conquer a higher market share. The entrants, in general, and the MVNOs, in particular, have to cope with a more serious asymmetric situation which leads them to bridge the gap with the incumbents. However, an incumbent holds a very difficult position to be reached: its consolidated size in terms of market share, profits, technological awareness, and experience in the market, produces further advantages in scale economies and network externalities.

Our model approach shows that despite all efforts to obtain significant results in the competition, MVNOs have to avoid the difficulties by pointing at product differentiation and market niche strategies. Their success strongly depends on the capacity of taking advantage of brand name, of designing competitive tariffs and offering appealing services to its customers. In other words, while MNOs take advantage of their “technological level”, MVNOs should focus on “customer satisfaction services”.

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# Asymmetric regulation of mobile termination rates?

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## ABSTRACT<sup>15</sup>

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*This paper examines mobile termination fees and their regulation when networks are asymmetric in size. It is demonstrated that with consumer ignorance regarding the exact termination rates (a) the higher a mobile network's termination rate, the smaller the network's size (as measured through its subscriber base) and (b) asymmetric regulation of only the larger operators in a market will, ceteris paribus, induce the smaller operators to increase their termination rates. The results are supported by empirical evidence using data on mobile termination rates from 48 European mobile operators from 2001 to 2003.*

*It is also argued, that, if termination rates are to be regulated, a symmetric solution with regulation of both smaller and larger operators should be implemented. This does not imply that all operators' termination rates are the same. In fact, as long as smaller operators that were licensed relatively late face cost disadvantages due to exogenous factors (which they cannot influence) differences in regulation can be justified. While exempting smaller operators from regulation altogether while imposing regulation on larger providers is most likely not efficient, regulated termination rates may well differ between firms as long as these differences reflect disadvantages that newcomers face due to exogenous factors outside their own control.*

## INTRODUCTION

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Across many mobile telecommunications markets competition has long been left without much regulatory intervention, but recently some aspects have come under close scrutiny by regulatory authorities. Apart from mobile number portability and national and international roaming, one of the key areas under investigation have been mobile termination rates. According to the European Commissions 11<sup>th</sup> Implementation Report (the last one available as of 7 February 2007), there has been substantial downward

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15 This paper is based on Dewenter & Haucap (2005).

pressure on mobile termination rates through regulatory intervention in many Member States.

In fact, today most Member States regulate at least the larger mobile operators. Apart from the more general question of whether mobile termination rates should be regulated at all (see, e.g., Crandall and Sidak, 2004; Littlechild, 2006), an issue that has been subject to substantial debate in this context has been the question whether smaller operators (i.e., the latest market entrants) should also be subjected to *ex ante* regulation of their termination rates or whether they should rather be left unregulated. Indeed, quite a number of countries (such as the Netherlands, Spain, or most recently Switzerland) initially only regulated the large mobile operators' termination rates, while other countries (such as Germany or Greece) did not initially regulate any firms. Other countries (such as Austria and the UK) immediately regulated all of the firms' termination rates, following the "one network, one market" paradigm. Hence, there were three different regulatory environments. Even today the question of whether new entrants' termination rates should be subject to regulation immediately is controversial.

This paper, therefore, aims at answering two questions: First, what termination rates emerge if prices are left unregulated? And secondly, how are these rates affected by regulation?

## **RELEVANT FINDINGS IN THE LITERATURE**

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Gans and King (2000) were among the first to address these questions. Their finding is that mobile termination rates will be excessive not only because of the termination monopoly (see, e.g., Laffont, Rey & Tirole, 1998; Vogelsang, 2003) but also due to a negative pricing externality, which results from consumer ignorance regarding prices. Consumer ignorance is a particular problem of mobile telephony as customers are often not able to identify which specific network they are calling. This is because consumers may not know which operator is associated with each particular number. As a consequence, consumers are often ignorant about the price that they actually have to pay for a mobile call if prices differ between different networks (see Gans and King, 2000; Wright, 2002). In addition, mobile number portability is likely to exacerbate this problem as mobile prefixes will no longer identify networks (see Bühler and Haucap, 2004).

Hence, as Gans and King (2000) have pointed out consumers are likely to base their calling decisions on average prices. This will be the case if either carriers are unable to set different prices for different mobile networks

anyway or if consumers cannot determine ex ante which mobile network they are actually calling, i.e., if callers suffer from consumer ignorance.

If consumers are not aware of the correct prices and base their demand on the average price, a negative pricing externality arises as the price of one firm will not only affect its own demand, but also that of its rivals. This induces firms to increase their termination rates to inefficiently high levels as they do not account for the effect that their own price has on the average price perception and, thereby, their rivals' demand. This externality problem comes on top of any monopoly and associated double marginalization problems.

If market shares are endogenous and termination rates are set prior to other prices, termination rates may even be set so high that they "choke" off demand for mobile termination altogether, at least in theory (see Gans and King, 2000, p. 323). Consequently, demand for termination services will increase with any downward regulation of termination rates.

Our work extends this research into three directions: Firstly, we have introduced network asymmetry into the model and have considered mobile networks of different sizes (in terms of their subscriber bases). While Gans and King (2000) have analyzed a symmetric duopoly, we provide a model with four asymmetric mobile network operators, two large one and two small ones (which is not untypical for many European markets). Secondly, we have analyzed the effects of asymmetric regulation in this framework. And thirdly, we have provided empirical evidence for our model.

## **THEORETICAL RESULTS**

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Based on a simple oligopoly model the main theoretical results of our paper are, firstly, that smaller mobile operators tend to charge higher termination rates than larger operators, even if there were no differences in costs. The reason is that a small operator's impact on the weighted average price is relatively small so that smaller operators can increase their prices significantly without a major reduction in demand. In fact, the smaller a mobile network's subscriber base the higher the network's termination fee. In contrast, a large operator also has a larger impact on the weighted average price so that the firm is more constrained in its pricing policy. Of course, if smaller operators have higher costs than larger operators the differences in termination rates will be even larger.

And secondly, asymmetric regulation of the larger operators only will, *ceteris paribus*, induce the small operators to increase their termination rates even further. Before we discuss the public policy implications resulting from these findings, let us first have a look at the empirical evidence.

## DATA AND METHODOLOGY

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To test our theoretical hypotheses empirically, we have assembled data on mobile termination rates and the subscriber base of 48 different mobile operators from the EU15 countries plus Norway and Switzerland. Data on the networks' subscriber base has been gathered from *Mobile Communications*, while the termination rates have been obtained from various issues of the *Cullen Report*, published by *Cullen International*. Information on regulatory regimes has also been obtained from this source and also from various regulatory authorities. Our earliest observations are from February 2001 and our latest one from February 2003. Hence, our data set includes regulated and unregulated termination rates. While we use monthly data in principle, there are missing observations for several months due to limited data availability.

Since we could not observe all operators' prices for every observation point (especially in 2001), we have less than 13 observations for some of the 48 operators. The total number of observations is 458. Therefore, we confine our analysis to pooled estimations.

The endogenous variable of our analysis, which we try to explain, is the operators' termination rate. Since termination rates differ in their structure across countries and at times even across firms, we have calculated termination rates for a two-minute call. We have also restricted the analysis to peak-time tariffs. As exogenous variables (that are thought to affect the operators' termination rates) we have used (apart from a constant) market shares (based on subscriber numbers), the Herfindahl-Hirschman Index (HHI) for market concentration, market size (based on total subscriber numbers), a dummy variable (GSM1800) for the mobile network technology employed by an operator and two dummy variables (RC and RF) describing the regulatory framework in place.

The dummy variable describing an operator's technology (GSM1800) is set to one if an operator exclusively uses GSM1800 MHz technologies, while it is set to zero if an operator either exclusively uses GSM900 MHz technologies or hybrid networks. This dummy variable is introduced in order to account for potential cost differences between networks, as pure GSM1800 MHz

networks are sometimes considered to be somewhat more costly. In fact, as virtually all European countries have sequentially licensed mobile operators, it is usually the smaller operators (which have entered the markets at a later stage), who have exclusively adopted GSM1800 MHz technology. Therefore, we have included an explanatory dummy variable (GSM1800) to account for any possible cost differences.

Concerning the regulatory framework the variable RC is set to one if any mobile termination rate in a specific country is regulated, while RC is zero if none of the mobile operators' termination rates is regulated. Furthermore, the variable RF is set to one if a specific firm's termination rate is regulated, while RF is zero if the firm's termination rate is not regulated. Using two dummy variables is necessary because in some countries all mobile termination rates are regulated, in others only some termination rates (usually those of large operators) are regulated, and in others again none are regulated. Hence, RC and RF are set to one if all firms are regulated in a country, RC and RF are both set to zero if none is regulated, and RC is set to one and RF to either zero or one if some firms, but not all are regulated in a country. We have also used dummy variables indicating the respective year and country to control for eventual time trends and country-specific effects.

Before we present our empirical results let us briefly provide some descriptive statistics of our variables to shed some light on price trends and regulatory practice in Europe. The (unweighted) average termination rate per minute across all 48 operators decreases from 27.1 Eurocents in 2001 to 19.3 Eurocents in 2002 and 18.9 Eurocents in February 2003. While the maximum rate in 2001 has been 40 Eurocents and the minimum 19.5 Eurocents (among the 48 operators in our sample), in 2003 the maximum rate has been 27 Eurocents and the minimum 9.8 Eurocents. Over this period the regulated firms' average termination rate has been 21.2 Eurocents, while it has been 22.2 Eurocents for unregulated firms. Looking at the different countries, the average termination rate in regulated countries has been 22.2 Eurocents, while it has only been 21.4 Eurocents in unregulated countries. This indicates that termination rates have been higher on average in regulated countries. In this context, it may be interesting to note that only 14 operators were regulated in February 2001 while there were 26 regulated firms in February 2003 (among the 48 operators observed).

## **EMPIRICAL RESULTS**

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Our empirical analysis has revealed that technology has a positive and statistically significant impact on termination rates, at least at the 10% level of significance. Firms exclusively using the GSM1800 technology tend, therefore, to have higher termination rates of about 2.6 Eurocents on average for a two minute peak-time call.

Operators' market shares tend to have a statistically significant impact on their termination rates with the sign as predicted by our model, i.e. smaller operators tend to have significantly higher mobile termination rates. In light of our hypothesis, this may indeed indicate that the smaller operators set relatively high termination rates as they only have small effects on average prices.

In contrast, the Herfindahl-Hirschman Index (HHI) does not appear to be statistically significant to explain termination rates. Hence, market concentration is apparently less of an issue to determine termination rates than an operator's relative size.

While market size is not statistically significant, we find statistically significant effects for the regulatory framework. On the one hand, and not surprisingly, firm-specific regulation tends to lower the regulated firm's termination rate. Regulated firms termination charges are lower by about 2.9 Eurocents for a two minute peak-time call. On the other hand, termination rates in regulated countries tend to be higher overall by about 8.7 Eurocents for a two minute peak-time call. Remember that while RF is a dummy variable set equal to one (and otherwise zero) for regulated firms, independent of the regulation of their competitors, RC always equals one if at least one firm in the same country is regulated. The estimated coefficient of RF therefore measures the average difference between regulated firms' termination rates and average termination rates overall. The coefficient of RC, in contrast, estimates the difference between average termination rates in regulated and unregulated countries. The combination of both variables (RC-RF) thus calculates the mark-up in average termination rates for unregulated firms whose competitors are regulated. Hence unregulated firms' termination rates in regulated countries are higher by about  $8.7 - (-2.9) = 11.6$  Eurocents for a two minute peak-time call.

## **POLICY IMPLICATIONS**

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In summary, our empirical analysis tends to support the hypotheses derived from our theoretical model. Firstly, smaller mobile operators tend to have higher termination rates than their larger competitors. Secondly, downward regulation of the large operators' rates tends to have a positive effect on the termination rates of unregulated operators.

At this point, some general remarks about the desirability of regulating mobile termination rates may be adequate. First of all, it is important to emphasize that customer ignorance by itself is not a justification for economic regulation. In fact for the consumer ignorance problem remedies other than price regulation (such as automated price information) may already solve the problem. This would not require Government intervention, as market mechanisms may solve these information problems. However, as long as consumer ignorance plays a role, our paper offers one potential explanation for the apparently counter-intuitive observation that smaller operators charge higher prices.

With respect to the more general question whether mobile termination rates should be regulated at all, one should note that there are a number of strong arguments against their regulation: First of all, it is not only necessary, but even efficient that some prices exceed marginal costs in an industry characterized by significant sunk and common costs. If mobile termination rates exceed marginal costs because of Ramsey-type pricing patterns, there is little reason for regulatory intervention (see, e.g., Kruse, 2003, or Koboldt, 2003). And secondly, profits from high termination fees may be used to subsidize mobile handsets, thereby allowing a faster diffusion of mobile telephony in general and new mobile services (such as UMTS) in particular (see Wright, 2002; Thompson, Renard & Wright, 2006). While these arguments have to be weighed against arguments in favour of regulation (such as some potentially inefficient substitution between fixed-line and mobile telephony), we concur with Crandall and Sidak (2004) that overall there are convincing arguments against the regulation of mobile termination fees.

If, however, termination rates are to be regulated we propose a symmetric solution with regulation of both smaller and larger operators. It should be noted though that this does not need to imply that their termination rates need to be at the same level. In fact, as long as smaller operators that were licensed relatively late face cost disadvantages due to exogenous factors

(which they cannot influence) differences in regulation can be justified. While exempting smaller operators from regulation altogether while imposing regulation on larger providers is most likely not efficient, regulated termination rates may well differ between firms as long as these differences reflect disadvantages that newcomers face due to exogenous factors outside their own control such as some cost differences (see Dewenter, 2007). Hence, this paper argues for regulatory symmetry in principle, even though the relevant costs may be different though. What is important in this case is that the same cost *standard* and *methodology* are applied in principle to all operators.

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# Asymmetric regulation applied to interconnection charges

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## ABSTRACT

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*This paper focuses on how to regulate interconnection charges (IC) in the presence of persistent market asymmetries (e.g. asymmetric operators' performances or asymmetric market shares). The aim is to determine whether asymmetric regulation, like asymmetric termination charges, can or cannot compensate market asymmetries. Based on Peitz's (2005) general theoretical model, we developed a specific application based on the French mobile market case. We concluded that the later entrant has the opportunity to catch up its entry delay thanks to asymmetric termination prices. Our conclusion is consistent with Peitz's findings.*

## CONTEXT

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This paper focuses on how to regulate interconnection charges in the presence of market asymmetries. The aim of this paper is to determine whether asymmetric regulation (e.g. the set of asymmetric termination charges) can or cannot counterbalance market asymmetries.

Asymmetric access price regulation could be oriented towards cost-based price for first entrants and to access mark-up for the later entrant.

Based on Peitz's (2005) general theoretical model, we developed a specific application to the French mobile market case. One of the features of the French market is the persistence of asymmetries between the first two market entrants on the one hand – Orange and SFR – and, on other hand, the later-market entrant – Bouygues Telecom – which has never caught up with the two leaders.

This phenomenon of non-catching up is not due to a later entrant's obvious inefficiency<sup>16</sup>, but can be mainly, in the French case, explained by the two following elements:

- Market entry delays: Orange and SFR entered the market in 1991 while Bouygues Telecom entered in 1996.
- Differences in frequencies granted initially: 900 MHz frequencies for Orange and SFR and 1800 MHz frequencies for Bouygues Telecom<sup>17</sup>.

Differences in initially granted frequencies have consequences in terms of network costs: the use of 1800 MHz frequencies implies that the later entrant bears higher costs than Orange and SFR. These higher costs prevent the later entrant from competing on equal terms against first entrants. Thus, by the time competitors can enter the market (entry delays), the first mover will, ideally, have already established brand recognition and brand-loyalty advantages as well as cost advantages in distribution and/or infrastructure systems (see the papers of Benzoni and Dewenter in the present volume).

The French mobile market is composed of 3 operators. Until 2000, reciprocal termination charges stood at zero: each operator agreed to terminate calls from the other operator's network at no charge (in France the system is called "bill and keep"). Since 2000, regulation of termination charges has been cost-oriented and symmetric in France. In symmetric regulation, differences in size (market shares) negatively impact the weaker operator: in comparison with stronger operators, weaker operators have more outgoing calls and less incoming calls, which means that they pay more interconnection charges per user.

This paper analyses different cases from symmetric and asymmetric termination charges and justifies implementing asymmetric regulation to neutralize market asymmetries.

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16 See for further elements Benzoni, L, Basque, D, Dacquay, G and Lagier, J, (2006). *The Curse of later entrants: theoretical dynamics of non-catching up in a sequential entry market: The case of European mobile markets*. Submitted for publication to "Telecommunications Policy".

17 "PCN ("Personal Communication network") and GSM ("Global System for Mobile communication") operate on different frequencies (900 MHz for GSM and 1710-1880 MHz for PCN). A PCN network requires a denser system of transmitters and rather aims at local or regional users." European Commission, case Nr IV/M.618 Cable & Wireless / VEBA, 1995:

## **AN OVERVIEW OF ECONOMIC LITERATURE ON ASYMMETRIC REGULATION**

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A limited number of papers have focused on network asymmetries backing asymmetric regulation under specific conditions. In the literature on competing interconnected networks, initiated by Laffont, Rey and Tirole (1998 a,b) and Armstrong (1998, 2004), De Bijl and Peitz (2002) and Peitz (2005) show that asymmetric access price regulation can be preferred to symmetric regulation, in the presence of network asymmetries. More specifically, Peitz develops a model with a strong operator and a weak operator, competing on the telecommunications market. He highlights that both the weak operator's profit and consumer welfare increase if the regulator sets a higher price to access the weak operator's network. Another Peitz's paper concludes that asymmetric access price regulation can stimulate entry and increase consumer surplus at the same time.

Our model is based on Peitz's theoretical model, which considers the particularities of the French mobile market and analyses the benefits of asymmetric regulation in terms of social welfare.

The hypotheses of our model differ from Peitz on 3 points:

- The number of operators: 2 for Peitz and 3 for our model.
- The tariff structure: non-linear (binomial) for the Peitz model versus linear (cost per minute) for our model.
- The cost levels: equal costs for both operators for the Peitz's model versus different costs for our model (causes of these different costs are entry delays, no catching-up phenomenon and thereby the weakest market share of the later entrant).

## **THE MODEL**

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The following part summarises the hypotheses and the results of the model developed, which applies asymmetric termination charges between first and later entrants in the French mobile market.

The particularities of the French market are based on the following hypotheses and data:

- 3 operators.
- A linear retail price of 19.8 €c per outgoing minute<sup>18</sup>.
- Higher unit costs for the weakest operator (6.76 €c per outgoing or ingoing minute<sup>19</sup>) than for the strongest ones (3.95 €c<sup>20</sup>).
- Call distribution follows market share distribution. Market share distribution in France, stands at 47.3% for Orange, 35.8% for SFR and 16.9% for Bouygues Telecom which means that a typical user will respect this ranking when making calls.
- Bouygues Telecom's AMPU is 20% higher than the SFR + Orange's AMPU<sup>21</sup>.

## RESULTS

The synthesis of our analysis is given in the table here below (in €c):

	IC ARCEP	Threshold IC	IC>Threshold
<b>Orange</b>			
Market share	47%	47%	47%
Retail prices	19,8	19,8	19,8
IC	7,5	7,5	7,5
Half-call costs	4,0	4,0	4,0
Margin per user	<b>1632</b>	<b>1559</b>	<b>1546</b>
<b>SFR</b>			
Market share	36%	36%	36%
Retail prices	19,8	19,8	19,8
IC	7,5	7,5	7,5
Half-call costs	4,0	4,0	4,0
Margin per user	<b>1632</b>	<b>1558</b>	<b>1544</b>
<b>Bouygues Telecom</b>			
Market share	17%	17%	17%
Retail prices	19,8	19,8	19,8
IC	7,5	7,5	7,5
Half-call costs	4,0	4,0	4,0
Margin per user	<b>1238</b>	<b>1558</b>	<b>1616</b>

Figure 1. Synthesis of the results

18 Source : ARCEP « *Projet de décision soumis à consultation publique et notifié à la Commission européenne et aux autres régulateurs européens sur l'analyse du marché de gros de l'accès et du départ d'appel sur les réseaux mobiles ouverts au public* », 2004. Average revenue of outgoing call (given by ARCEP) is pondered by operator's market share.

19 Source : modèle CMILT Tera.

20 Source : modèle CMILT Tera.

21 Source : OMSYC 2004 (Bouygues's AMPU: 168 min ; Orange's AMPU: 121 min and SFR's AMPU 164 min, Global AMPU : 139,5 min).

The first column (« ARCEP IC») is consistent with the current French mobile market trends whereby Interconnection Charges (IC) are set by the French regulator ARCEP and cost oriented, i.e. 7.5 €c for Orange and SFR versus 9.24 €c for Bouygues Telecom. The monthly margin per user is roughly 16 €c for Orange and SFR versus 12 €c for Bouygues Telecom<sup>22</sup>. It is consequently impossible for Bouygues Telecom to lower its prices in order to gain market share. If Bouygues Telecom were to lower its prices, competitors could react by lowering prices in the same proportion or enter a price war, strategy which Bouygues Telecom could not adopt (because of higher costs).

The second column (« Threshold IC») models a hypothetical market in which IC enables all operators to benefit from the same level of margin per user. (IC = 12 €c for Bouygues Telecom versus 7,5 €c for Orange and SFR).

The third column (« IC > Threshold») models a market with an IC level higher than the threshold IC, allowing Bouygues Telecom to benefit from higher margins than competitors (IC=12,5€c for Bouygues Telecom, unchanged for Orange & SFR). For this IC level, Bouygues Telecom's margin per user is equal to 16€c versus 15€c for Orange or SFR. This is the sole context in which Bouygues Telecom, the later entrant and weaker operator, can adopt an aggressive policy (e.g. by lowering prices), to gain market share.

This simple model shows that thanks to asymmetric termination charges the later entrant can catch-up its initial entry delay. This result depends on the difference in termination charges between later and first entrants. This difference should be sufficient to enable later entrants to lower its prices without a risk of eviction due to a higher price reduction of first entrants. Finally, interconnection charges must be closer to the level equalising all operators' margin per user. With these interconnection charges levels, the later-entrant can lower prices to benefit its consumers, and then gain market share.

## **CONCLUSION**

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Our simple model based on the French mobile market, highlights that asymmetric termination charges between first and later entrants can counterbalance market asymmetries which stem from entry delays and be an answer to the “non catching-up” problem. The results of these asymmetries in termination prices must allow later entrants to lower prices benefiting

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*22 Margin takes into account networks costs and interconnection costs.*

consumers who sign up with the company, and help it gain market share. This conclusion is consistent with Peitz's analyses and its key conclusion: "The weak operator's profit and consumer welfare increase if the regulator sets a higher price to access the weaker operator's network" (Peitz 2005).

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# Paradoxical impact of asymmetric regulation in Taiwan's mobile communications

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## ABSTRACT<sup>23</sup>

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*The mobile penetration rate in Taiwan has climbed from 6.86 to 112.15 mobile phone accounts per 100 capita in the first six years of market competition, during which the state-owned incumbent Chunghua Telecom was dethroned by a new entrant, Taiwan Cellular Corp. This paper addresses the cause of Taiwan's unprecedented mobile growth, and provides policy solutions for countries that strive to improve their telecommunications sectors in a short time. The authors highlight the fundamental role of asymmetric regulation, rather than pure liberalization, in the creation of the deregulated telecommunications industry in Taiwan. The asymmetric regulation in Taiwan is manifested in a twofold framework: the dominant carrier versus competitors, and the fixed-line carrier versus mobile companies. An econometric analysis concludes that dualistic asymmetric regulation leads to higher growth for mobile competitors and raises the total mobile penetration rate. However, the authors warn against the paradoxical consequences of dualistic asymmetric regulation. The regulatory benefits which mobile entrants received evolved into rents when they successfully lobbied to end the follow-me call service, the pricing scheme of which contradicts the asymmetric revenue-sharing constraint. The paper calls for a sunset clause for dualistic asymmetric regulation in order to take full advantage of its strengths, while at the same time preventing rent-seeking by the firms which benefit.*

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23 This paper is rewritten from Chou & Liu (2006)

## INTRODUCTION: ON THE WAVE OF THE WIRELESS SOCIETY

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Driven by the policy goal of building Taiwan as the Asia-Pacific Telecommunications Hub and obtaining WTO membership, the Taiwan government passed three telecommunications reform acts since the early 1990s in order to restructure the market. Together these acts established a liberalization framework by introducing private competition, the separation of the public telecommunications operator from the regulatory regime, and the categorization of telecommunications services. In early 1997, eight mobile licenses were awarded to six out of twenty-two enterprises via a beauty contest. In each region, four new entrants competed with the state-owned incumbent—Chunghua Telecom—for a share of its market<sup>24</sup>.

Within only six years of opening the market, mobile subscription in Taiwan has escalated from 6.86 percent to 112.15 percent<sup>25</sup> (as of September 2003). An additional 20 million users signed up for the service, and the number of mobile subscribers has grown 16.02 times. The unmet demand for mobile telephony before 1998—a waiting list of over one million—has vanished entirely. Meanwhile, Chunghua Telecom's market share plummeted to about 30 percent. The leader status of Chunghua Telecom has been snatched away by a private entrant, Taiwan Cellular Corp, which now holds a stable 30 percent market share, equivalent to 9 million subscribers. Table 1 summarizes the development of mobile communications in Taiwan.

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*24 Among the eight, two nationwide licenses went to Taiwan Cellular Corp and FarEastTone, and six regional licenses went to KG Telecom, Tuntex, TransAsia, MobiTai, Taiwan Cellular Corp, and FarEastTone. The licenses are ratified with the standard of the Global System for Mobile communications (GSM). Nationwide operators use the 1900 GSM standard, while regional operators deploy the 900 GSM standard.*

*25 A percentage over 100 means that some users have more than one mobile account*

	<b>Mobile Subscribers</b>	<b>Penetration Rate (subscribers/p er hundred persons)</b>	<b>Market Share of Entrants</b>	<b>Market Share of the Incumbent</b>
<b>Dec. 2005</b>	19,876,128	86.93	60.45%	39.55%
<b>Dec. 2004</b>	21,527,933	94.88	61.95%	38.05%
<b>Dec. 2003</b>	25,089,644	110.99	67.60%	32.40%
<b>Dec. 2002</b>	23,905,409	106.15	71.87%	28.13%
<b>Dec. 2001</b>	21,632,980	96.55	73.80%	26.20%
<b>Dec. 2000</b>	17,874,000	80.24	73.90%	26.10%
<b>Dec. 1999</b>	11,541,139	52.24	69.85%	30.15%
<b>Dec. 1998</b>	4,727,045	21.56	53.89%	46.11%
<b>Dec. 1997</b>	1,492,000	6.86	0.00%	100.00%

Source: DGT <<http://www.dgt.gov.tw/Chinese/Data-statistics/11.3/graph3.shtml>>

Table 1. Mobile Communications in Taiwan

It has been said that the liberalization policy implemented by the Ministry of Transportation and Communication (MOTC) and Directorate General of Telecommunications (DGT) constitutes a breathtaking development (Chou, 2000:35)<sup>26</sup>. An examination of liberalization precedents worldwide finds that Taiwan's experience is exceptional. Among the countries that have undergone telecommunications reforms, none of them has ever achieved so high a mobile penetration rate or reversed the dominant status of the incumbent in such a short time.

This paper addresses the "real" cause behind the unprecedented mobile development in Taiwan, and discusses feasible solutions for other countries planning to improve their telecommunications in a short time. The asymmetric features inherent in Taiwan's communications regulations are highlighted for the first time, and based upon a perspective of

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<sup>26</sup> National Communications Commission was inaugurated in January 2006 to incorporate two separate regulatory administrations on telecommunications, DGT, and on broadcasting/TV, Government Information Office (GIO), into one independent agency that regulates information and communications businesses. All the commissioners must be nominated by the Prime Minister of the Executive Yuan, and confirmed by the Congress.

contractarianism and institutional economics, it is contended that this dualistic asymmetric regulation is in fact the key institutional component which fostered the growth in Taiwan's mobile telephony. The telecommunications regulator places restraints, including price caps and interconnection mandates, on the dominant carrier alone, and yet gives mobile providers the authority to set their own tariffs and interconnection charges. This asymmetry in regulations allows fixed-line end users to be easily lured to switch to mobile services, as mobile companies set high tariffs for fixed-line-to-mobile communications. Subsequently, the traffic of mobile communications has surged, with revenues surpassing those of fixed-line telephony (DGT, 2003).

The dualistic asymmetric regulation in Taiwan is thus a potential model for policymakers in other countries wishing to expand telecommunications. The question which remains is, should countries embrace this approach without reservation? In response, this paper investigates the paradoxical consequences which the dualistic asymmetric regulation brings about, and finds that the asymmetric regulation could entail rents for mobile competitors, even though it successfully grows mobile services. The rival competitors thus have incentive to secure these rents through uneconomic activities such as political lobbies or entangling lawsuits.

## **DUALISTIC ASYMMETRIC REGULATION AND ITS POLICY IMPACT**

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Diagram 1 portrays the twofold framework of the asymmetric regulation: dominant/non-dominant carrier<sup>27</sup> and fixed-line/mobile service provider. The letters A, B, C, and D individually represent different types of telecommunications service providers (TSPs). Diagram 1 also shows six types of communications transmission and termination between A, B, C, and D. In 1997, the DGT declared Chunghua Telecom, the only fixed-line carrier thus far, to be the dominant carrier, and other mobile service providers to be non-dominant carriers. Accordingly, the dualistic framework of asymmetric regulation is manifested in Line 2 as Chunghua Telecom versus non-dominant mobile firms. Compared with its counterparts, Chunghua Telecom

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*27 The term "dominant carrier" is defined by Article 5 of the "Administrative Regulation Governing Tariffs of Type I Telecommunications Enterprises" as a TSP that meets any of the following criteria:*

*having control over essential facilities, or*

*having dominant market power over prices, or*

*having subscribers or turnover that account for at least 25 percent in the relevant market.*

bears excessive regulatory oversight from the DGT. The asymmetric constraints on the dominant carrier and on the fixed-line service provider are respectively analyzed as follows.

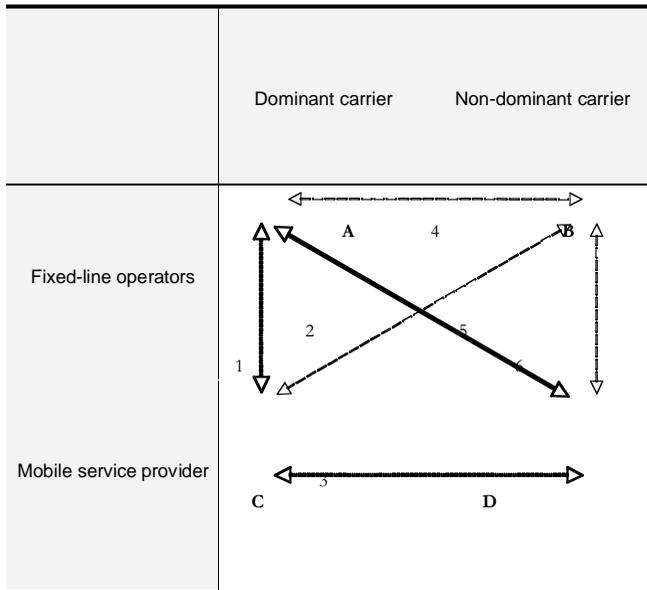


Diagram 1. Dualistic Asymmetric Regulation in Taiwan

- A: the fixed-line operator with the dominant status;
  - B: the non-dominant fixed-line operator;
  - C: the mobile company with the dominant status; and
  - D: the non-dominant mobile firm.
- Line 1: communication originated, transmitted, or terminated between A and C;
  - Line 2: communication originated, transmitted, or terminated between A and D;
  - Line 3: communication originated, transmitted, or terminated between C and D;
  - Line 4: communication originated, transmitted, or terminated between A and B;
  - Line 5: communication originated, transmitted, or terminated between B and C; and
  - Line 6: communication originated, transmitted, or terminated between B and D;
- **Notice:** Three new fixed-line licenses were awarded on March 19, 2000 and these non-dominant firms started local service in April 2001.

### **Asymmetric Constraints on the Dominant Carrier**

Article 26.1 of the Telecommunications Act (1999) forbids the dominant carrier from refusing interconnection and abusing its market power. The dominant carrier is obligated to disclose certain cost information, sell bottleneck services, and provide unbundled access to its network (Liu, 2001).<sup>28 29</sup> Article 9 of the “Administrative Regulation Governing Tariffs of Type I Telecommunications Enterprises” promulgates that the dominant carrier must set its tariffs based on the price caps approved by the DGT.

As is well known, unbundled access may deprive the incumbent of economies of scope and scale while providing cost savings to its rivals. Total element long-run incremental cost (TELRIC) pricing, which charges unbundled elements at long-run marginal costs, does not compensate for the incumbent’s opportunity costs of providing such access (Brock & Katz, 1997:114-5). Sidak and Spulber also argue that unbundled access infringes upon the incumbent’s property rights as protected by the Constitution (1998:34). In addition, asymmetric disclosure of cost information empowers rivals in competing against the dominant carrier, as they can behave strategically by setting prices slightly below the incumbent’s (Besen & Farrell, 1994:127). Our previous study demonstrates that the mandate of *symmetric* information disclosure otherwise deflates the market values of competitive rivals as they are unable to engage in strategic behaviours (Chou, 1999:304-5). As far as price caps are concerned, they function closer to the requirement of information disclosure in a competitive market. Such regulation enables rival competitors to obtain information regarding the incumbent’s tariff schemes at reduced costs and to strategically price their services. Admittedly, market entrants prefer asymmetric constraints on the dominant carrier so that they can realize a competitive advantage in capturing market share.

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*28 Article 26.1 states that a designated dominant carrier is prohibited from: refusing, directly or indirectly, interconnection requested by other facility-based TSPs by reason of proprietary technology; refusing to disclose information to other facility-based TSPs regarding the measurements of interconnection charges and relevant costs thereof; improperly determining, maintaining, or altering the prices charged for telecommunications services; refusing, without due cause, access to network elements requested by other facility-based TSPs; rejecting, without due cause, the lease requests of transmission circuits made by TSPs or subscribers; rejecting, without due cause, testing requests made by TSPs or subscribers; and, abusing market power or engaging in unfair competition.*

*29 This provision corresponds to Article 10 of the Fair Trade Law that prohibits anti-competitive conduct by the dominant carrier.*

### ***Asymmetric Restrictions on the Fixed-line Service Provider***

The determining feature of the dualistic asymmetric regulation lies in the restriction on the fixed-line operator. This regulation distinguishes Taiwan from all other regulatory governances worldwide. In the DGT's view, the fixed-line network is the basic infrastructure over which long-distance, international, and mobile services are originated, transmitted, or terminated. Like long-distance and international services, mobile communications are treated as the downstream service of local telephony. As the "access charge" model is used for revenue allocation between upstream and downstream services, the DGT applied the same rule to mobile communications generated from Chunghua Telecom's fixed-line network.

Article 19 of "The Administrative Rules for Network Interconnection Between Type I Telecommunications Carriers" stipulates that: Except for international communications, ownership of tariffs for communications between mobile communications networks and fixed-line communications networks shall be governed by the following principles:

- Tariffs shall be collected by the call-originating telecommunications carrier from its subscribers pursuant to the tariff schedules set by mobile communications network carriers, and the revenue from tariffs shall go to the mobile communications network carriers; and
- Bad debts shall be assumed by the call-originating telecommunications carrier and such carrier shall not be relieved of its responsibility to pay relevant charges to the call-terminating telecommunications carriers.

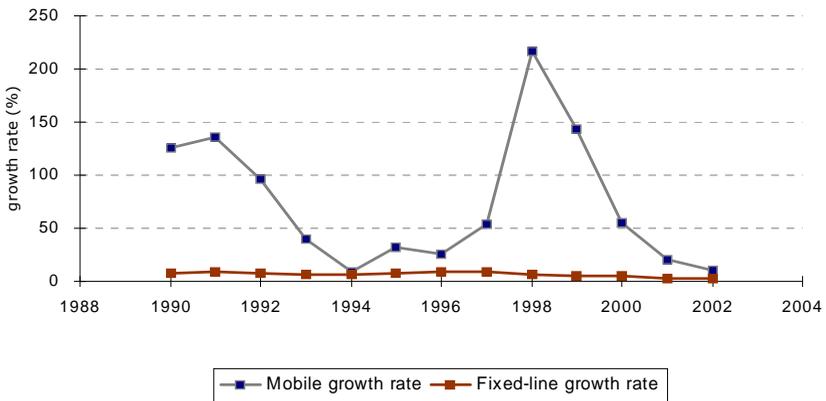
While the calling party pays all the communications charges, Article 19 delegates to mobile firms the pricing authority over all outgoing and incoming mobile services, and allocates such revenues to them. Under this pricing scheme, Chunghua Telecom cannot retain the revenues of the outgoing mobile communications originated from its fixed-line network but is mandated to collect the charges on behalf of the mobile firms.

Chunghua Telecom is then paid access charges by the mobile firms for transmitting calls to their mobile networks. Since the establishment of the asymmetric revenue-sharing scheme between mobile and fixed-line communications, the mobile market has grown very quickly, while local telephony has experienced stagnant growth (see Diagram 2). Indeed, the growth of both types of communications is interdependent, as they entail substantial effects of substitution for each other (Kelly, 1996:11).<sup>30</sup> Table 2

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<sup>30</sup> *Mobile substitution takes place at the level of (1) marginal choice over a second fixed-line telephone and (2) replacement of fixed-line telephony (Kelly, 1996:11).*

delineates four calling patterns between fixed-line and mobile communications. Chunghua Telecom can only set the tariff of the calling pattern A (fixed-line-to-fixed-line communications), while the pricing authority of the other three goes to mobile firms. Chunghua Telecom under this asymmetric revenue-sharing scheme retains only the revenues of Pattern A. Unlike in most countries, where Pattern B's (mobile-to-fixed-line communications) tariff is set higher than C's (fixed-line-to-mobile communications) due to a concern with universal service, those tariffs in Taiwan are identical. Because mobile firms collect the revenues of both Patterns B and C, they have no incentive to differentiate the tariffs.



Source: DGT statistics (<http://www.dgt.gov.tw>)

Diagram 2. Mobile and Fixed-line Communications in Taiwan

Supposing a consumer's choice of mobile telephony is a function of the price and the quantity of outgoing and incoming calls (Shih, 2000:8-10), a higher tariff of Pattern C inevitably reduces the calling volume from the fixed-line network to mobile systems while multiplying the calls made from mobile networks. By setting a lower tariff for Pattern D (mobile-to-mobile communications) than C, mobile carriers further encourage the fixed-line users to migrate to mobile-to-mobile communications. Currently, the number of mobile subscribers has exceeded that of fixed-line telephony by ten million (DGT, 2003). When telephone users migrate from the calling pattern C to D, Chunghua Telecom hardly obtains any access charges from mobile service providers, and its expected revenues are seriously truncated. Accordingly, this asymmetric tariff scheme enables mobile firms to sign up customers more quickly and allows mobile-to-mobile service to prevail. While mobile

service providers have enjoyed extraordinarily high profits over the last five years, Chunghua Telecom is experiencing a decline in calls and traffic volume of local voice telephony.

To	From	Fixed-line Network	Mobile Network
	<b>Fixed-line Network</b>	<b>A</b> (NT\$0.34/min)	<b>B</b> (NT\$5.00/min)
	<b>Mobile Network</b>	<b>C</b> (NT\$5.60/min)	<b>D</b> (NT\$4.8/min)

Source: <http://www.dgt.gov.tw>

Table 2. Calling Patterns from Fixed-line to Mobile Communications

When making a call terminated by the local exchange carrier, the caller will adopt either the calling pattern A or B, depending on availability of access to the local exchange network. When making a call terminated by mobile service providers, the caller will definitely choose Pattern D as long as he/she has mobile access. It is imperative to notice that Pattern A will not be replaced by B, because the former's tariff is much cheaper than the latter's. However, the calling pattern D is more likely to replace C if the latter's tariff is more expensive than the former's.

## THE EMPIRICAL STUDY OF THE DUALISTIC ASYMMETRIC REGULATION

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The authors run regression tests which are used to measure the impacts of the dualistic asymmetric regulation on mobile communications development, indicated by the mobile penetration rate and its growth rate. The fixed effects model runs an ordinary least square (OLS) estimation on two dummy policy variables—the asymmetric constraints on the dominant carrier and on the fixed-line carrier—and their interaction term. The regression analyses were performed on panel data designated by country and by year (1981 to 2002). Eight OECD countries with different mobile pricing schemes—Japan, Hong Kong, Singapore, France, Germany, Portugal, Britain and the U.S.—are selected as the benchmark of regulatory governance. Among those countries, Portugal has a tariff regime similar to Taiwan's, in which the fixed-line operators retain only interconnection charges for their outbound traffic terminated at the mobile network. In contrast, France, Germany, and the UK set up the "caller pays" tariff scheme, in which outgoing traffic is charged by its originator and mobile firms retain only the revenues of their own outgoing

calls. Japan, Hong Kong, Singapore, and the U.S. on the other hand have adopted the “both-ends-pay” (or “mobile party pays”) principle, in which mobile phone users pay for both outgoing and incoming calls but mobile firms are not authorized to set the tariff for fixed-line-to-mobile communications and do not own such revenues.

As far as the asymmetric restraints on the incumbent are concerned, in 1993, the OFTEL of Hong Kong issued a price cap regulation on the dominant carrier, Hong Kong Telecom, until 2002. Japan did not impose restrictions on the incumbent, NTT, until 1998, although mobile services were provided early in 1981. Singapore has not yet considered asymmetric regulation since it opened its telecommunications market in 1996. France initiated asymmetric restrictions on the dominant carrier in 1995 but ended them in 1998, and Germany began asymmetric regulation in 1993. Portugal followed the WTO basic telecommunications service agreement to adopt the dominant carrier restriction in 1998. The United Kingdom took the asymmetric regulation approach on BT since its privatization in 1984. And the US promulgated the price cap regulation against the Baby Bells and AT&T in 1989 and repealed it by the enactment of the Telecommunications Act in 1996.

VARIABLES	MOBILE SUBSCRIPTION PER CAPITA [A]	PENETRATION RATE OF THE INCUMBENT [B]	PENETRATION RATE OF THE COMPETITORS [C]
MARKET OPENNESS (NO. OF FIRMS)	x	x	x
DOMINANT-CARRIER RESTRAINT			
REVENUE-SHARING CONSTRAINT			
INTERACTION EFFECT	x		x
OBSERVATIONS	136	116	116

X: the variable has a statistically significant and positive impact on the mobile penetration rate.  
Data source: ITU Telecommunication Indicators (2003); DGT statistics (<http://www.dgt.gov.tw>)

Table 3. Regulatory Impact on the Mobile Penetration Rate

Table 3 presents the regression results for the mobile penetration rate, and Table 4 reports the results for the growth rate.<sup>31</sup> Column A in Table 3 validates the effectiveness of the dualistic asymmetric regulation on a country's mobile penetration level. Neither the restraint on the incumbent nor that on the fixed-line operator can by itself generate significant impact; whereas, their interaction term (i.e., the dualistic asymmetric regulation) raises the penetration rate per capita. Likewise, Column C of Table 3 shows that this regulatory asymmetry increases the competitors' subscription level per capita. However, neither of the dual regulatory asymmetries significantly causes the incumbent's subscription level per head to plummet (see Column B in Table 3). That is, simultaneous introduction of both asymmetric restraints is confirmed to develop a country's mobile communications, and seemingly, it does not accomplish this at the expense of its incumbent's advances.

The results in Table 4 then reveal the other part of the story. Although the dominant-carrier restraint and the implementation of the twofold asymmetric regulation do not affect the incumbent's mobile penetration level, they do have significant and negative impacts on its growth pattern (see Column A of Table 4). In contrast, Column B in Table 4 demonstrates a much stronger impact on the development of the competitors' mobile voice services. Simultaneous introduction of both asymmetric regulations increases the competitors' growth rate.

The regression results combined lead us to conclude that the implementation of the dualistic asymmetric regulation will foster rapid development in mobile communications in a short period of time. It allows us to recommend a policy solution for countries with underdeveloped telecommunications. They are advised to simultaneously implement the twofold asymmetric regulation in hopes of rapidly expanding mobile voice services in a short time. The question which remains is whether or not implementation of such dualistic asymmetric regulation is justified based on the outcome of rapid penetration in mobile communications. The findings in Table 4 affirm that, while the competitors gain from the twofold asymmetric regulation in the form of a boost in their subscription level, the incumbent's ability to grow its customer base is devastated by the same regulatory framework. That is, the swift expansion of mobile communications is made possible at the expense of the incumbent's growth. The next section explores the drawbacks which the asymmetric regulation entails.

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<sup>31</sup> *The two proxy variables for the asymmetric regulation on the incumbent, caps and xcaps, produced similar and consistent findings, although the dummy one gave a slightly larger impact. This paper thus presented the regression results generated by the dummy variable caps.*

Variables	Growth rate of the incumbent's mobile subscription [A]	Growth rate of the competitors' mobile subscription [B]
Market Openness		x
Dominant-carrier restraint	-x	
Revenue-sharing constraint		
Interaction effect 1	-x	x
Mobile-party-pays principal		
Interaction effect 2	-x	
Observations	112	47

X: the variable has a statistically significant and positive impact on the mobile growth rate.

-X: the variable has a statistically significant and negative impact on the mobile growth rate.

Data source: ITU Telecommunication Indicators (2003); DGT statistics (<http://www.dgt.gov.tw>).

Table 4. Regulatory Impact on the Growth Rate of Mobile Communications

## SEEKING REGULATORY RENTS

In the last decade, the contractarian approach has made itself a presence in policy analysis in response to the call for regulatory devolution and renovation. It views industrial regulation as a contract between the regulator and the regulated firm. Both parties *ex ante* specify the substantive terms and conditions of regulation and *ex post* implement and enforce the regulation (Moe, 1984:750). Indeed, each telecommunications operator has a unique incentive intensity concerning service provision. If the incentive scheme with which a policy alternative is associated corresponds to its incentive intensity, its opportunity costs are greatly reduced and its expected payoffs increase. Otherwise, the policy alternative will distort the firm's incentive to undertake telecommunications. As evidenced by the above

analysis, the twofold asymmetric regulation in Taiwan increases the expected payoffs of mobile entrants by granting them the right to charge and collect tariffs of fixed-line-to-mobile communications, and as a result, they are more likely to make telecommunications investment. Since the promulgation of the regulation, mobile competitors have signed up 2.32 times more subscribers than Chunghua Telecom (DGT, 2003). Chunghua Telecom so far has lost nearly 70 percent of the mobile market to the entrants.

From the contractarian point of view, the regulatory asymmetry enables the mobile entrants in Taiwan to reduce business risks and take advantage of the unequal terms of competition to behave opportunistically, since the incumbent is obligated to disclose all cost information and to provide full network access. The asymmetric revenue-sharing constraint even acts like a wealth transfer from Chunghua Telecom to the competitors. The mobile competitors are thus greatly better off in the asymmetric regulatory governance and they have strong incentives to preserve this governance.

Policy scholars have long observed that interest group politics play an influential role in policy formation and implementation. Since policies inevitably allocate costs and benefits among regulated firms, the firms as interest groups will make efforts to direct the policy agenda toward their own benefits. The winners in the current regulatory regime desire to sustain influence over policymaking and deter policy changes that do not reward them. On the contrary, losers tend to expand the scope of conflict. By mobilizing countervailing forces, these firms struggle to redefine policy images and change policy agendas (Baumgartner & Jones, 1993:83-9). Accordingly, the telecommunications firm has incentive to invest in non-economic activities, such as lobbies or public affairs, in exchange for regulations in their favour.

However, such non-economic activities do not necessarily lead to socially desirable outcomes even if they benefit individual firms (Mbaku, 1998:195). Especially when the benefited firms successfully lobby against the deployment of new services or technologies, the regulatory benefits they receive evolve into rents, that is, abnormal profits. The economic output will decrease when the firms allocate resources towards rent seeking rather than production and innovation (Shleifer & Vishny, 1998:81-9). Sidak and Spulber argue against regulations that encourage entry by subsidizing entrants or applying rules asymmetrically on incumbents because they may create the potential for uneconomic bypass. The entry would be uneconomic without subsidies or asymmetric regulation (1998:30).

This dualistic asymmetric regulation places Taiwanese mobile entrants in an advantageous position to compete with Chunghua Telecom and, as is evidenced by the analysis, entails regulatory benefits for them. They

undoubtedly will engage in lobbies to preserve the benefits. The case of the follow-me call service (the 099 service) is then examined to illustrate how mobile entrants “lobbied against” a new service whose pricing scheme contradicts the dualistic asymmetric regulation.

The 099 call service offered by Chunghua Telecom since 1999 allows consumers to be fully connected with only one number.<sup>32</sup> Consumers' utilities are indeed increased through its full access. When the 099 number is set on the consumer's mobile phone, the traffic is terminated at the mobile system and the mobile service provider must grant Chunghua Telecom interconnection with its system. Chunghua Telecom's original rate for the 099 call service was \$NT3.60 per minute and the company contributed an NT\$2.00 access charge to the mobile firm for traffic termination.

From the viewpoint of the mobile rival competitors, the allocation of the revenues of the 099 call service and access charges nonetheless infringes on their right to retain the revenues from all mobile communications. The mobile firm earns a net profit of about NT\$5.00 per minute for the mobile service terminated over its network, while obtaining only an NT\$2.00 access charge for the 099 call service. In addition, the 099 call service shares certain characteristic of a mobile service and yet costs less than mobile telephony, so that mobile subscribers are easily lured to the service. The mobile competitors were set to lose profits if the 099 call service became more popular. Therefore, mobile rivals lobbied the DGT to raise the tariff and the access charge on the 099 call service. The mandated high tariffs of the 099 call service then led to a huge decline in subscription right after its debut. This case demonstrates that the regulated firms will invest in non-economic activities to deter service renovation that conflicts with their interests and to maintain their privileges induced by the *status quo* policy regime.

## **CONCLUSION: PARADOXICAL IMPACT ON TELECOMMUNICATIONS DEVELOPMENT**

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This paper examined the paradoxical impact which dualistic asymmetric regulation in Taiwan has had on telecommunications development. The empirical analysis allows us to recommend a policy solution for countries with underdeveloped telecommunications. Simultaneously implementing the

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<sup>32</sup> *The 099 call service operates via setting up the 099 number either on the consumer's home phone, office phone, or mobile phone. In such a case, the consumer can be reached anywhere.*

twofold asymmetric regulation will bring about rapid penetration in mobile communications. It is notable, however, that this prompt development of mobile communications is achieved at the expense of the incumbent's growth. Designated as a competition safeguard, the asymmetric regulation entails policy benefits for mobile entrants, enabling them to earn a higher penetration rate and abnormal profits. These beneficiaries, through the lobbying venue, may then forestall value-added services whose pricing scheme infringes on the asymmetric revenue-sharing constraint. The regulatory gains may thus evolve into rents when the benefited firms lobby against a newly invented value-added service.

The dualistic asymmetric regulation even creates disincentive for telecommunications firms to deploy fixed-line technologies and services, since the local exchange carrier is prohibited from setting and collecting tariffs for its outgoing traffic. As the fixed-line network involves specific assets, the firm is more likely to forego providing service if it is deprived of the opportunity to earn a fair return on this irreversible investment. The regulation therefore impedes competition in local telephony. In the long run, it may hinder telecommunications development since it distorts companies' incentive to invest in local exchange service and directs their efforts to rent-seeking activities.

Policymakers must be alert about the rent-seeking behaviors by the rival competitors when promulgating the twofold asymmetric regulation in hopes of rapid growth in communications services. The present empirical analysis does imply that there should be an deactivating point for the regulation, such that it no longer applies once a certain point in market development (defined, for example, in terms of penetration rate) has been reached. It is suggested that policymakers insert such "sunset clauses" along these lines in dualistic asymmetric regulation in order to fully utilize its merits while avoiding rent-seeking activities by the beneficiaries. However, the asymmetric revenue-sharing constraint should not be repealed until after the mobile market has consolidated. Telecommunications officials must also refrain from arbitrary discretion when promulgating regulations on the dominant carrier in the competitive market. By following these recommendations, regulators could create policy credibility and mitigate business risks for the companies, thus creating an even playing field in which companies are equally affected by regulations and can thus focus on providing service and developing telecommunications in a way which maximizes public benefit.

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# Effects of network asymmetries on access pricing in mobile telecommunications

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## ABSTRACT<sup>33</sup>

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*Network shares and retail prices are not symmetric in the cellular telecommunications market and this gives rise to new questions of access fee regulation. In this paper, I consider a market with two types of asymmetry arising from different entry timing: a better reputation for the incumbent and lower cost of servicing for the entrant as a result of more advanced technology. In the presence of asymmetries, firms are no longer indifferent to the access fee, preferring unilateral deviation in their own favour. Moreover, in contrast with the European regulatory framework, the access fee on the basis of termination cost is not necessarily a socially preferable solution.*

## INTRODUCTION

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Over the last decade, the deregulation of telecommunications - formerly seen as a natural monopoly - plays an important role within policy and in economic literature. At the beginning of the millennium a new framework for communications networks was introduced which was designed to harmonize European regulation in order to reduce entry barriers and facilitate effective competition for the benefit of consumers. Under the new regulatory regime, each country is required to establish a national regulatory authority to monitor competition in communications markets and to define the relevant

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<sup>33</sup> The original analytical paper "Network Asymmetries and Access Pricing in Telecommunications" was written during my PhD studies at the Corvinus University of Budapest, Hungary and as a visiting researcher at the Tinbergen Institute, the Netherlands. I thank Mark Armstrong, Paul de Bijl, Gergely Csorba, Ferenc Forgó, András Gömöri, Maarten Janssen and Patrick Rey for their comments and recommendations.

market segments<sup>34</sup>. Furthermore they are to decide whether an operator has significant market power (SMP) in a particular segment and to assess the appropriate regulatory obligations. On the basis of the EU communications directive on access and interconnection, the wholesale voice call termination has already been defined as a relevant market in most of the European countries. An operator which is at the same time a network owner is monopolistic provider for its respective bottleneck. Having SMP over its own network it can charge an access fee for using its network in its own favour. Under the new regulatory framework this termination charge set by the SMP operators is controlled, namely on the basis of termination cost, more precisely by using the long-run incremental cost (LRIC) method.

Nevertheless, several asymmetries can be observed on the mobile telecommunications market and these asymmetries require an individual consideration of each firm with regard to regulation. The questions which arise are whether all the firms should be regulated in the same way, more precisely on the basis of termination cost, or the regulation can favour one of the firms, and if a firm has a more favourable position, which firm that is and why.

In this paper I focus on market asymmetries and seek to find an argument for or against the current access price regulation. I distinguish two types of asymmetry. Liberalizing the telephony market has provided opportunity for new entry and as a consequence resulted in asymmetries among firms entering the market early (incumbent) and late (entrant). The reasons for this may be as follows: first, the entrant had the opportunity to introduce a more recent technology which implies a lower cost of servicing (i.e. supply side advantage). On the other hand the incumbent who entered the market earlier may gain an extra advantage because of the existence of an installed base or reliability or reputation for quality, realized in the form of extra utility for those consumers who wished to subscribe for the incumbent's services (i.e. demand side advantage or brand loyalty).

I mainly focus on asymmetry originating from different costs, however I compare my results with the case of brand loyalty as well. I seek to find the answer to the following questions: is the cost-based access fee tenable, or do other ways of asymmetric or symmetric access price regulation seem reasonable? What is the effect of access price regulation on firms' profit or on competition and on consumer surplus?

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*34 The most pertinent and normative European (tele)communications authority is Ofcom in the UK. For more details in accordance with the EU harmonization across cellular markets see Ofcom (2004).*

I formalize a market with two firms which have already built up their own network, provide full coverage and compete for consumers. Besides, the firms are interconnected: they have to pay a two-way access fee for call termination. I formulate a model for the case of competition in two-part tariffs, where each firm sets a uniform per-minute charge and a fixed fee (e.g. monthly subscription fee). I find that firms set their per-minute prices equal to their perceived marginal costs and compete for the consumers with fixed fees, while trying to extract as much of the consumer surplus as possible. I find that independently of asymmetry, the firms' preferences over the access fee are divergent, and the industry profit increases with the profit of the firm with larger market share. Depending on which firm has an advantage, the successful regulatory policy allows a positive access mark-up for the less advantageous firm since that tool favours that particular firm and the consumers.

The structure of the present paper is as follows. In Section 2, I briefly introduce the previous and strongly related findings in this topic. In Section 3, I draft the basic concepts and modelling used in the analytical paper from which I conclude my results. Section 4 derives the results for cost asymmetry and Section 5 for a situation in which both cost asymmetry and brand royalty are present. In Section 6, I conclude.

## **LITERATURE**

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This paper is an extension of the common symmetric models of network interconnection and competition. The first articles published on this topic are Armstrong (1998) and Laffont et al. (1998a), in which the authors analyze the problem of two-way access pricing in the set up of a symmetric cost structure, uniform pricing and reciprocal (equal) access fee. One of the main and principally cited results of their articles is that under two-part tariffs, profit is independent of the access fee and therefore any kind of regulatory policy has no effect on firms' profit. Let's assume that a firm can distinguish in prices between calls terminating on its own network and on its rival's network, that is termination-based price discrimination. In this case if each firm charges a two-part tariff, as Laffont et al. (1998b) shows, they will agree on a cost-based access fee causing equal retail prices, thus bringing price discrimination to an end.

The profit-neutrality property is confirmed in a more general set up by Dessein (2004) and Hahn (2004), who consider consumer heterogeneity in terms of demand for calls (e.g. heavy and light telephone users) and calling patterns.

In Carter and Wright (2003) and Peitz (2005) the authors consider an asymmetric market in the presence of brand loyalty and leave the other characteristics, for instance symmetrical costs. In the case of reciprocal (equal) access fees, Carter and Wright state that the firm with brand loyalty, called the incumbent prefers a cost-based access fee and if brand loyalty is sufficiently strong, the other firm, called the entrant has the same preference. Therefore the successful regulator only has to require the access fee to be reciprocal and let the incumbent set it. Peitz emphasizes the use of a non-reciprocal access fee. He argues that an asymmetric access price regulation, which allows higher access fees for the entrant than its termination cost, can be socially more desirable: it favours the entrant and increases consumer surplus at the same time.

In de Bijl and Peitz (2002) and de Bijl and Peitz (2004), the authors focus on the same type of asymmetry although they analyze the market in a dynamic set up. They find that independently of the type of access price regulation, asymmetry among firms lessens over time; the entrant's profit and the consumer surplus increase and finally a symmetric equilibrium emerges. In their 2004 article, they extend their model with asymmetric marginal costs and derive similar results to those they found previously.

Armstrong (2002) also assumes a market with brand loyalty and cost asymmetry, particularly when the demand side advantage outweighs the cost advantage, and in case of unit consumption as a policy implication he derives that the firms have divergent preferences over the access fee. Total industry profit changes in the same direction as the incumbent's larger profit, so that a side payment to the entrant might compensate for an access fee which is against the entrant's interest. This step decreases the consumer surplus; however the increment in industry profit is equal to the decrease in the consumer surplus, thus resulting in welfare-neutrality of the outcome.

## **MODELLING**

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The analysis is made by means of industrial organization. This method is based on profit maximization during which each company takes into consideration the rival company's decision and vice versa. Such behavior of the firms is called strategic interaction, and therefore the analysis is based on game theory.

Firms are considered to make a simultaneous decision meaning there is no leader or follower in the decision making process, or to put it differently, they are not able to observe the other's decision in advance. A firm decides on

price by maximizing its own profit. The outcome of profit maximization is a Nash-equilibrium from which none of the companies wants to unilaterally deviate.

I built a model for a market with two networks and call them an incumbent and an entrant to make a distinction according to their reputation and costs. Each firm incurs three types of costs:

- (i) connection independent cost. For instance this could be the fee for a license or the cost of building-up and improving facilities. In the model these costs are considered as sunk costs.
- (ii) connection dependent but traffic independent cost. This is the fixed cost of serving a consumer, and without loss of generality I assume that the fixed cost is the same for both firms.
- (iii) traffic dependent cost. This is the unit cost of originating and of terminating a call which costs are assumed to be the same. I define the cost asymmetry assuming that the entrant is more efficient, so it has a smaller termination cost.

The networks are interconnected which means that if a consumer subscribed to a firm originates a call, that call may be terminated on the rival firm's network. In this case, the firm has to purchase access to ensure that its subscribers are able to call all consumers independently of service providers and therefore the firm has to pay an access fee for each unit call terminated on the rival's network. I assume that the access fee is not a decision variable of the firm and is determined by the regulator. To measure the deviation of access fee from termination cost, I use the term access mark-up which is the difference between the access fee and the termination cost. In case of a positive access mark-up the access fee is larger than the termination cost.

A consumer faces a two-step problem: in the first step the consumer decides on whether to connect to a network and in the second step the consumer chooses the amount of telephony consumption. Consumers are homogeneous in the sense that each consumer gains the same fixed surplus of being connected. On the other hand, the consumers are heterogeneous since they have different a priori preferences over the services: a consumer values a service more when it is 'closer' to its preference (i.e. horizontal product differentiation). As the preference of a consumer is different from the characteristics of service supplied by the networks, each consumer has to pay 'transportation cost' which is in our case the same for every consumer and measures the disutility of not being a consumer of the ideal service. The higher the transportation cost, the more differentiated the networks are, so the less the substitutability between networks.

A consumer receives extra utility when subscribed to a network, called brand loyalty (it can also be translated as switching cost), and it is assumed that the

incumbent has a stronger reputation on the market, causing higher utility for its consumers. Besides, a consumer gains utility from the telephony consumption.

Let's assume that joining the network costs nothing and a consumer has to pay for telephony consumption according to a two-part tariff, which consists of a fixed fee (i.e. monthly fee) and a per-minute price. These terms determine the consumer's budget constraint.

The consumer first maximizes her utility given her budget constraint in order to decide on the amount of telephone calls, and she does it for each price to determine her demand function. Then according to her net utility, taking the transportation cost and the brand loyalty into consideration chooses a network. In this way the companies' market share can be defined depending on the prices.

In the model, I use the assumption of balanced calling pattern which means that each consumer, independently of the network she is subscribed to, is equally likely to be called by any other consumer. This implies that in case of homogenous consumers, the fraction of calls originating in a network which terminates on the other network is proportional to the latter network's market share.

## **COST ASYMMETRY**

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I start the analysis by showing and comparing the equilibrium outcome in case of cost-based access fee, and then I extend the analysis to a particular situation when the less advantageous company, that is the incumbent is allowed to set an access fee different from its termination cost. The questions are how this deviation affects the prices and, through those, the firms' profit and the consumer surplus.

In the equilibrium each firm charges its perceived marginal cost as a retail per-minute price which is equal to the cost of originating and terminating a call, plus the cost of a call likely to terminate in the rival's firm network. That depends on the rival's market share and on the access fee the company has to pay. The per-minute price is higher if the termination cost or the paid access fee is higher, and also increases in the other company's market share. This latest relationship can be explained in the following way. Each company has to pay access fee after each call terminated in the rival's network, and I assumed homogenous consumers with balanced calling pattern. Under these circumstances if a company has a higher market share,

it will receive more calls from the rival's network thus increasing the cost of providing access to the other company.

The difference between the equilibrium per-minute prices is equal to the cost difference, i.e. the incumbent with the larger cost charges a larger per-minute price. As a consequence, the consumers of the incumbent initiate less calls thus obtaining lower net surplus and the entrant has a higher market share.

Since each firm charges its perceived marginal cost as a retail price, it gets zero profit from calls originating in its network; therefore the profit arises from the connection dependent profit (fixed fee) and from the incoming calls (access revenue).

Now the question is how much the fixed fee will be and who will set it higher. The answer depends on the cost difference. If the cost difference is large, the entrant will charge smaller fixed fee, otherwise it will set a higher one. The intuition is the following. Because of larger amount of outgoing calls and smaller access fee, the entrant faces a negative access profit. To overcome it and increase its total profit, the entrant is interested in either lowering the total access deficit or raising the total retail profit. The retail profit can be increased by a higher fixed fee or a higher market share, however these two tools contradict to each other: the higher the fixed fee, the less consumer will buy from the entrant thus decreasing its market share. On the other hand, the higher the market share, the further is the market from the symmetric outcome which means a smaller access deficit for the entrant<sup>35</sup>. Merging these two effects, in case of a large cost difference, the entrant sets a very small per-minute price resulting in a low retail profit, so the total profit can be increased by decreasing the access deficit. A smaller access deficit can be reached by moving further from the symmetric case through a higher market share caused by a smaller fixed fee. In case of a smaller cost difference, retail profit can be increased at the cost of a higher access deficit by charging a higher fixed fee and receiving a smaller market share.

Since the profit mainly depends on the fixed fee and the access revenue, the same argument can be applied to the difference between firms' profits.

Let's now consider what the consequences are of a deviation from the cost-based access fee. When the less advantageous firm, that is the incumbent can set unilaterally a slightly higher access fee, the entrant's perceived marginal cost increases, therefore it sets a higher per-minute price. Nevertheless the entrant's price will remain lower until the cost difference is reasonable or the incumbent's access fee remains close to its termination

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<sup>3</sup> This property can be seen more clearly from the form of the firm's profit function.

cost. The market shares will not change in respect to the increase in the incumbent's access fee.

As a consequence of this deviation on the welfare, namely on profits and consumer surplus I found the following results. The profit-neutrality of the symmetric equilibrium no longer holds: the firms are not indifferent to the access fee and want to unilaterally deviate from cost-based access fee. In response to an increase in the incumbent's access fee, its profit increases, that is the less advantageous firm gets better off, but the entrant's profit decreases. Nevertheless in case of a reasonable cost difference the overall effect on profit is negative, meaning decreasing industry profit: the incumbent's increasing access fee decreases the entrant's profit more than it increases the incumbent's profit. On the other hand the consumer surplus changes positively as a result of a higher access fee for the incumbent.

These results are summarized in the following table:

<b>Access fee</b>	<b>Cost-based access fee</b>	<b>Incumbent unilaterally and marginally increases its access fee (access markup)</b>
<b>Per-minute price</b>	Equal to perceived marginal cost of a minute call	
<b>Difference in per-minute prices</b>	Equal to cost-difference, so entrant sets lower price	Larger than cost-difference; For very small cost difference entrant may charge higher price
<b>Difference in fixed fees</b>	Entrant generally sets higher fixed fee and sets it lower only in case of large cost difference	No significant change
<b>Market shares</b>	Entrant has higher market share	No change
<b>Profit and difference</b>	Arises from fixed fee and access revenue; Entrant has generally a higher profit	Incumbent's profit increases, entrant's profit decreases; Industry profit generally decreases and increases only if cost difference is small
<b>Consumer surplus compared to cost-based case</b>	-	Increases

Table 1. Results in case of cost asymmetry and comparison

## BRAND LOYALTY AND COST ASYMMETRY

I analyze the simultaneous presence of two asymmetries, cost difference and brand loyalty in a slightly different way. Two cases may appear: the effect of cost advantage outweighs the effect of brand loyalty, meaning the entrant has a more advantageous position or the opposite when the incumbent has a favourable position. The extreme cases are analyzed in the previous section when brand loyalty was zero and in Peitz (2005) when costs are symmetrical. If the market deviates from the extreme cases, one of the effects remains stronger and the results will be similar to the corresponding extreme case (see Table 2).

	<b><i>Cost difference has stronger effect</i></b>	<b><i>Brand loyalty has stronger effect</i></b>
<b><i>Firms' position</i></b>	Entrant is in advantageous situation	Incumbent is in advantageous situation
<b><i>Deviation from cost-based access fee</i></b>	Incumbent increases its access-fee	Entrant increases its access-fee
<b><i>Per-minute price</i></b>	Equal to perceived marginal cost of a minute call	
<b><i>Difference in per-minute prices</i></b>	Larger than cost-difference: entrant charges lower price	Larger than cost difference: incumbent charges lower price
<b><i>Difference in fixed fees</i></b>	Entrant generally sets higher fixed fee and sets it lower only in case of large cost difference	Incumbent sets higher fixed fee
<b><i>Market shares</i></b>	Entrant has higher market share	Incumbent has higher market share
<b><i>Profit difference</i></b>	Generally entrant has higher profit	Incumbent has higher profit
<b><i>Profit change compared to cost-based case</i></b>	Incumbent's profit increases, entrant's profit decreases; Industry profit decreases	Entrant's profit increases, incumbent's profit decreases; Industry profit decreases
<b><i>Consumer surplus compared to cost-based case</i></b>	Increases	Increases

Table 2. Most important results in case of deviation from cost-based access fee in the joint presence of cost asymmetry and brand loyalty

Depending on which firm has an advantage in the market or which advantage outweighs the other, the regulator might allow the less advantageous firm to set a higher access fee than its termination cost. Independently of which situation emerges, an increase in the access fee of the less advantageous firm is followed by a larger consumer surplus, though the consumer surplus remains lower than that of the full symmetric case. At the same time, the company experiencing positive discrimination gains higher profit while the other loses, and the industry profit also decreases.

An interesting question which arises is whether we can determine the limit between these two cases. Unfortunately the analytical separation cannot be defined, therefore what a regulator might do before deciding about the access fee regulation is to observe the market outcome, meaning the prices and the market shares and deduce the firms' positions from it.

I would like to make another comment. Because of the learning process of consumers about the quality of the operators, and as a consequence of competition, the additional incentives to innovate and to reduce costs, the brand loyalty and the cost advantage might diminish over time which may result in more symmetric competition. In fact this phenomenon can be observed in most of the mobile markets. In this case the results of Laffont et al. (1998a,b), that is the profit neutrality of access fee under two-part tariffs will be valid.

## CONCLUSION

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In the present paper, I analyzed network interconnection and competition under two different types of asymmetry:

- *demand side advantage* emerging from the incumbent's stronger reputation or the lack of information about the entrant's servicing quality, and
- *a supply side advantage*, that is the entrant's lower termination cost from a more efficient technology.

In contrast to the symmetric situation, firms have divergent preferences over the unilateral deviation from the cost-based access fees. As preceding papers show, in case of a demand side asymmetry, a firm which entered the market later is allowed to set an access fee larger than its termination cost thus resulting a higher profit and consumer surplus. Emphasizing a stronger supply side asymmetry, I find the opposite: the incumbent may be allowed to set higher access fee in order to increase its profit and consumer surplus at the same time.

As the results show, the access fee regulated on the basis of termination cost might not necessarily provide the socially preferable solution. In case of an infant market, when the incumbent derives advantage from earlier presence in the market, an access mark-up for the entrant may increase consumer surplus and welfare. However in a more symmetric market when the importance of the incumbent's reputation is eliminated or outweighed by the entrants cost advantage, a positive mark-up for the incumbent might provide a socially better outcome.

In the preceding analytical paper the model is formalized by using assumptions in order to make the analysis feasible, so it is not completely corresponding to the real market situation. Therefore the results and conclusions are rather recommendations and the restricting assumptions should be taken into consideration before deriving far-reaching conclusions out of them.

However, as for the implementation of these results, it would be required to report precisely the costs and have a reliable estimate for the incumbent's advantage. Moreover, this paper presented a model for mobile telephony where operators have full coverage. In general operators do not always establish their own network therefore they provide services through the rivals' bottlenecks. In these cases an analysis extended to other types of entry, namely local-loop unbundling or carrier select, would refine the results and their policy implications.

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# An analysis of asymmetric access charge regulation in asymmetric mobile telecommunication market

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## ABSTRACT

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*Asymmetric regulation has been a controversial issue in the regulatory debate. This paper presents an econometric model to analyze the efficiency of asymmetric access charge regulation of mobile to mobile calls. We found that asymmetric access charge regulation would actually play an important role in shaping competition by forcing the dominant carrier to increase its retail price, and by providing non-dominant carriers an additional markup. It may lead to a decrease in quantity level than symmetric regulation in short term. In long term, however, when the market becomes more competitive by asymmetric regulation, its side effect is reduced.*

## INTRODUCTION

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The desirability of an asymmetric regulation has been one of the important subjects in the regulatory debate and it is generally agreed that an asymmetric regulation is somewhat necessary and justified during the transition phase from a monopolistic to a competitive market. Asymmetric regulation can be defined as the introduction of specific rules or obligations, which the incumbent or dominant operator has to observe yet competitors do not. An asymmetric market environment generally asks for asymmetric regulation in order to foster effective competition. The introduction of competition into the Korean mobile telephone industry has continuously created regulatory problems in access pricing. The access charge of call termination for incoming calls is one of the major sources of profit for network operators. In the view of economic welfare, the best solution is that an

access charge must be set equal to marginal cost in terminating calls that are originated by other network operators. Generally, symmetric regulation is providing all firms with the same environment in which they can compete. Asymmetry of market power or market share does not itself require asymmetric regulation. All forms of asymmetric regulation including asymmetric access charge regulation contain an intrinsic bias toward some firms and run the risk of imposing large productive efficiency costs. Nevertheless, it is generally believed that asymmetric regulation is required to counterbalance the competitive advantages enjoyed by a dominant firm by virtue of the favourable position assured them by the monopolistic conditions reigning in the market. Furthermore, by imposing certain conditions that constrain the dominant firm, a non-dominant firm or new entrants can increase their capacity or ability to compete with the dominant firm.

In this paper, we focus on regulation of access charge not on the regulation of the retail-price. Asymmetric access charge means that the charge for access for the dominant firm and non-dominant firm is different. We show that an asymmetric access charge is somewhat desirable to introduce or promote competition, but it will also result in the decrease of social welfare. This paper aims to i) outline the asymmetric regulation of the access charge in the Korean mobile telephone industry ii) examine the efficiency of an asymmetric regulation of the access charge with regard to the price and quantity level of mobile telephony service, and finally iii) propose a possible suggestion for maximizing the efficiency of asymmetric regulation.

For these objectives, a simple stylized setting from economic theory is introduced. Based on this setting, we prove that the asymmetric regulation of the access charge is desirable to promote competition but will, in turn, decrease social welfare. The paper ends with a possible suggestion for maximizing the efficiency of an asymmetric regulation.

The exponential growth during 1990s in the Korean mobile telephony service market has changed the relationship between fixed and mobile services: from the complementary to the competitive service. It is forecasted that fixed telephony service will gradually fade out in 2014 as the volume of fixed calls is decreasing to an annual ratio of 10.8%. Fixed to mobile call will also begin to be on the decrease after the year 2003.

As of December 2004, call volume originated from a fixed network including fixed to mobile call was 81.0 billion minutes, but as of December 2005, volume is almost the same as before, 81.2 billion minutes. On the contrary, call volume originated on a mobile network, including mobile to a fixed network was increased from 72.8 billion minutes to 81.4 billion minutes within the same time period.

	<b>Fixed to Mobile call</b>	<b>Mobile to Mobile call</b>	<b>Mobile to Fixed call</b>
<b>Definition of service</b>	Local call	Mobile call	Mobile call
<b>Market structure</b>	Monopolistic market structure	Oligopolistic market structure	Oligopolistic market structure
<b>Market size (US\$)</b>	2.57 billion	7.27 billion	1.73 billion

Table 1. The Korean mobile call traffic distribution as of 2005

This paper is organized as follows: Section II reviews previous research on the regulation of access charge. Then Section III describes the Korean mobile telecommunication market structure. Section IV establishes an analysis model. And its results and implication is also discussed in this section. Finally, Section V concludes this paper.

## PREVIOUS RESEARCH ON ACCESS CHARGE REGULATION

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It is well known that there are two efficiency losses which may emerge in an asymmetric market situation. The first one is allocative efficiency losses which is associated with the exercise of market power through increasing prices to consumers. The second one is productive inefficiency which a dominant firm has an incentive to produce but which is also below the social optimum production amount (Waverman *et. al.*,1997).

The rationale for asymmetric regulation is the infant industry policy and competition argument. In other words, it is necessary that a new market entrant should be protected temporarily from the full forces of competition in order to be able to reach a critical mass in market penetration. However, it is generally agreed that asymmetric regulation may result in serious distortions of the competitive processes and a symmetric framework would be desirable in most cases.

Most prior studies on the access charge regulation have concentrated on the level of the access price under a symmetric market situation. Armstrong and Vickers (1998) showed that optimal regulation of the margin between the retail price and the access price entails the ECPR (*Efficient Component-Pricing Rule*) as well as the fact that the welfare and entrant profits are higher when the level of the access price, rather than the margin, is

regulated. Laffont *et. al.* (1998) outlined two-way interconnection issues and studied the problem in great depth focusing on the telecommunication industry. They showed that symmetric mobile networks will set the common access charge above the cost of providing access in order to lessen retail price competition.

Meanwhile Carter and Wright (1999) make allowances for an unequal sized firm by providing for brand loyalty, showing that the ability to use the interconnection charge to facilitate collusion is retained with asymmetry. Dessein (2000) showed that in a symmetric model, equilibrium profits remain independent of the reciprocal access charge. Lapuerta and Tye (1999) insisted that interconnection charges are best set by the legal or regulatory authority based on the costs of providing network access. Peitz (2002) argued that asymmetric access price regulation that gives a positive access markup to the entrant and is cost-based for the incumbent is an effective instrument which can be used to increase consumer surplus and the entrant's profit. Nevertheless, he suggested that after the transition phase when entrants have gained competitive strength an asymmetric regulation should be replaced by symmetric regulation.

Chou *et. al.* (2001) examined the impact of asymmetric regulation on the performance of the incumbent and entrants, respectively. They asserted that dualistic asymmetric regulation grants mobile competitors a higher penetration rate and a greater market share. Hahn (2000) suggested that in a symmetric equilibrium, each network's profit-maximizing pricing policy involves a distortion in call allocation for all types, except when the reciprocal access charge is set equal to the call-termination cost. Gans and King (2000) examined the influence of mobile network competition on the prices of fixed to mobile calls. They found that a low cost method of lowering fixed to mobile charges would be to facilitate the identification of carriers by consumers and to restructure billing so that mobile networks are able to directly charge fixed line consumers for termination services.

Although much research has been conducted on the access charge regulation, most tend to analyze or examine how to regulate the access charge under a symmetric market situation. Further, unlike this present undertaking, few studies have specifically focused on the efficiency level of asymmetric access charge regulation in an asymmetric market situation.

## **THE KOREAN MOBILE TELECOMMUNICATIONS MARKET AND ACCESS CHARGE STRUCTURE**

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### ***Overview the Korean mobile telecommunications market***

When cellular phone service was introduced in Korea in May 1984, it was used mainly by high ranking business officials. Today, mobile communications services are now regarded as a substantial consumer good. As of November 2006, the Korean mobile market has grown to 40 million users, which is an 82% penetration rate. That is higher than most of the other developing countries, as well as mature markets such as Europe and the United States. Because of this high penetration rate, growth is expected to stagnate. This tremendous growth rate of the Korean mobile market was due to the introduction of competition in the mobile telecommunication market in 1996. Also, due to spectrum scarcity, the Korean mobile market is now considered to be a closed oligopoly (Park et al. 2002). Obviously, where there are more firms in a market, more effective competition is likely to happen. Thus, although the introduction of competition helped to reduce the price of services, the price is still considered to be somewhat high. This spectrum scarcity in the mobile telecommunication industry gave rise to another regulatory problem: the license fee. Johannes (2003) pointed out that under certain conditions, the license fee may influence the price.

There are three network operators in the Korean mobile telephony service market. One firm holds cellular licenses: SK telecom. Two hold PCS licenses: KTF and LG Telecom. Even though there are three network operators in the Korean mobile market, the mobile telecommunication market seems to provide vigorous competition; SK Telecom still holds the first place in mobile markets as the dominant player. As of December 2006, the Market share of SK telecomm has grown to 50.4%.

<b><i>Network Operator</i></b>	<b><i>Subscribers</i></b>	<b><i>Market Share</i></b>
<b><i>SK Telecom</i></b>	20,270,000	50.4%
<b><i>KTF</i></b>	12,910,000	32.1%
<b><i>LG Telecom</i></b>	7,010,000	17.5%

*Table 2. Market shares of mobile telecom services in Korea as of Dec. 2006*

### ***Access charge structure for mobile calls in the Korean market***

As described previously, it has been argued that as a result of the introduction of the PCS in 1997, the mobile telecommunication market may have become more vigorously competitive, but the profitability of the mobile telephony service providers is unclear due to this competition. Further, in spite of this argument, price competition in the Korean mobile telecommunication market has been unsatisfactory. Presently, in the case of mobile to mobile, the access charge levied on cellular operators by the PCS operators are no less than 12¢ and 13.225¢ per 3 minutes, respectively. Whereas in the case of fixed to mobile calls, the access charges levied on PCS operators and on cellular operators by the fixed carrier are no less than 16.425¢ and 15.9¢ per 3 minutes, respectively. Recently, the Korean Ministry of Information and Communication (MIC) decided to change the access charge model from a representative cost model to a long-term incremental cost (LRIC) model. The MIC expects that the unfairness caused by the representative cost model will be wiped out by changing the LRIC model so that fairer competition in the telecommunication industry will be promoted. In April 2002, a new calculation method for wireless access fees was introduced to reflect differences in spectrum bands and traffic patterns of the respective carriers. Termination charges of new entrants were set up higher than that of SKT (KTF's was higher by 17% and LGT by 29%). It is expected that a late comers' financial status would be improved by reflecting the different cost structure among incumbents and new entrants when calculating interconnection charges in the wholesale market.

For several years, there has been a great many heated discussions between the government and mobile service providers and among service providers on the necessity of an asymmetric regulation. Nevertheless they have not reached a conclusion. The dominant player has voiced arguments against MIC's tendency toward asymmetric regulation. The actual access charge model between fixed and mobile networks is shown in figure 1.

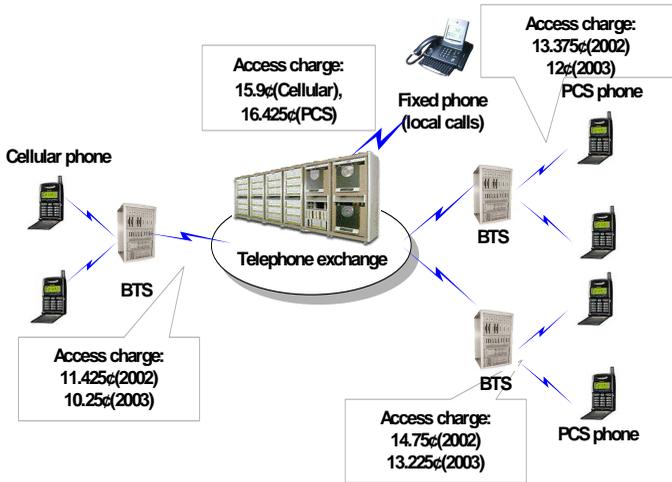


Figure 1. Access charge of mobile calls in Korean telecommunication market

## ANALYSIS OF EFFICIENCY OF ASYMMETRIC REGULATION OF ACCESS CHARGE

### The Model

In this section, we characterize the Korean mobile telephony industry, as it currently exists in a simple stylized setting described in the previous section. As described in section two, there are three mobile carriers in Korea. Mobile users in Korea consider that cellular and PCS operators provide homogeneous services. For simplicity, suppose that the mobile telephony industry is a form of a closed duopoly market structure where there are two types of mobile telephony services: PCS and cellular mobile telephony services. Also suppose that there is one dominant mobile carrier  $i$  and the other is non-dominant firm  $j$ .

Let the demand function for mobile to mobile calls originated at firm  $i$  and  $j$  be given by  $Q(P) = a - b(p_i + p_j)$ , where  $P$  is the price of a mobile to mobile call and that the dominant and non-dominant firm face same demand function. (Doyle & Smith, 1998) It is convenient to assume that this demand function is linear, since this linear demand assumption allows us to analytically calculate prices and termination charges, and to compare these charges over different regimes. Also assume that the mobile carriers set these prices  $p_i$  and  $p_j$ . The marginal costs of originating and terminating a call on a mobile network

provider  $i$  and  $j$  is given by  $\alpha_i$  and  $\alpha_j$ . We assume for simplicity that the fixed costs of all firms are absent and two mobile service providers have the same cost structure. It means that access charges have to be the same between two service providers ( $\alpha_i = \alpha_j$ ). Let the termination charges levied by each mobile carrier  $i$  and  $j$  on the each mobile carrier for delivering a call be denoted  $t_i$  and  $t_j$  respectively. And let  $S_i$  and  $S_j$  be the market share of mobile carrier  $i$  and  $j$ . Also, we assume that there is no price discrimination between an on-net and off-net call. The cost structure of the model is shown in Figure 2.

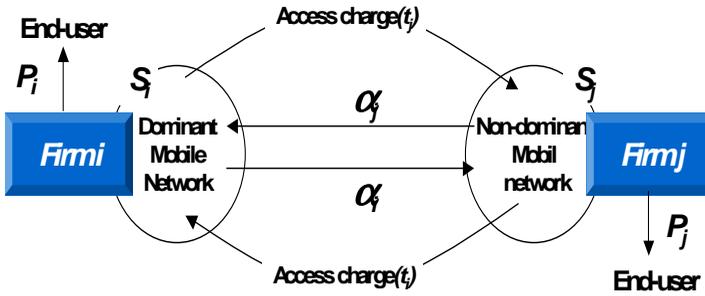


Figure 2. Cost and access charge structure

Let  $\Pi_i$  and  $\Pi_j$  denote the profits of the dominant and non-dominant firm, respectively. Assume that the two firms maximize profits. Each mobile carrier  $i$  and  $j$  seeks to maximize the profits given by the equation (1) and (2):

$$\begin{aligned} \text{Max}\Pi_i &= s_i^2 (p_i - 2\alpha_i)Q(p) \\ &+ s_i s_j [(p_i - t_j - \alpha_i)Q(p) \\ &+ (t_i - \alpha_i)Q(p)] \end{aligned} \quad (1) \quad \text{And,}$$

$$\begin{aligned} \text{Max}\Pi_j &= s_j^2 (p_j - 2\alpha_j)Q(p) \\ &+ s_j s_i [(p_j - t_i - \alpha_j)Q(p) \\ &+ (t_j - \alpha_j)Q(p)] \end{aligned} \quad (2)$$

Note that the each carrier can obtain profits from two sources: mobile to mobile call and access.

$\Pi_i$  and  $\Pi_j$  shows the profits derived from the mobile to mobile call for mobile carrier  $i$  and  $j$ . The first term in the equation (1) and (2) is the profits from on-net calls, the second term is the profits from off-net calls and the last term is profits from incoming calls. Let us assume that operator  $i$ 's and  $j$ 's marginal cost of an off-net call, which are denoted by  $\alpha_i$  and  $\alpha_j$ , are the same as the marginal cost of on-net call. The regulator determines the access price  $t_i$  and  $t_j$  and forces the operators to fully provide their networks to rivals at this termination charge.

We model competition in the mobile telecommunication market as a Bertrand game where firms choose their price level simultaneously. Each firm set its price level and sells output at its price level. And the solution concept that we use for this game is the Nash equilibrium. Hence, each firm sets its price which is an optimal response to its rival's price choice. Thus, the equilibrium price is a pair  $(p_i, p_j)$  which corresponds to the price level of each firm in the mobile telecommunication market.

### ***Analysis and Discussion***

In this section we considered two following arguments which are often argued in the mobile telecommunications market using the model described before.

*Argument 1: If the dominant carrier, which has significant market power, is required to charge a cost-based access charge, the non-dominant carrier without significant market power can charge an access markup to its cost, and each mobile carrier is well behaved, an asymmetric market structure will be mitigated. That is to say, asymmetric access charge regulation that grants an access markup to the non-dominant carrier will play an important role in shaping competition in the telecommunications market.*

To support this argument, we analyzed two different cases: symmetric access charge regulation vs. asymmetric access charge regulation. In order to evaluate the alternative regimes, we begin with the case for symmetric access charge regulation. We define symmetric access charge regulation as rule which does not grants an access mark-up to the non-dominant carrier. The first order condition for maximizing the mobile carrier's profits in the case of an asymmetric access charge regulation can be written as equation (2). Firm  $i$ 's and  $j$ 's best response functions are as follows;

$$\begin{aligned} \frac{\partial \Pi_i}{\partial p_i} &= a - 2bp_i - bp_j + 2b\alpha_i = 0 \\ \Rightarrow p_i &= R(p_j) \\ \frac{\partial \Pi_j}{\partial p_j} &= a - 2bp_j - bp_i + 2b\alpha_j = 0 \\ \Rightarrow p_j &= R(p_i) \end{aligned} \quad (3)$$

so long as  $\alpha_i = \alpha_j$  and  $t_j - t_i = 0$

For the case of a linear demand  $Q(P) = a - bP$ , we can easily derive the best  $i$  and  $j$ 's price response function from equation (3)

$$P_i^*_{symmetric} = \frac{1}{2} \left( \frac{a}{b} - p_j + 2\alpha_i \right) \quad P_j^*_{symmetric} = \frac{1}{2} \left( \frac{a}{b} - p_i + 2\alpha_j \right)$$

On the other hand, in the case of an asymmetric access charge regulation with an access markup for the non-dominant carrier, the first order condition for the maximizing mobile operator's profit is given by equation (4). Firm  $i$  and  $j$ 's best response function are as follows:

$$\begin{aligned} \frac{\partial \Pi_i}{\partial p_i} &= a - 2bp_i - bp_j + s_j b(t_j - t_i) + 2b\alpha_i = 0 \\ \Rightarrow p_i &= R(p_j) \\ \frac{\partial \Pi_j}{\partial p_j} &= a - 2bp_j - bp_i + s_i b(t_i - t_j) + 2b\alpha_j = 0 \\ \Rightarrow p_j &= R(p_i) \end{aligned} \quad (4)$$

so long as  $\alpha_i = \alpha_j$  and  $t_j - t_i \geq 0$

From the above equation (4), we can also easily derive the best  $i$  and  $j$ 's price response function

$$P_i^* \text{ asymmetric} = \frac{1}{2} \left[ \frac{a}{b} - p_j + s_j(t_j - t_i) + 2\alpha_i \right]$$

$$P_j^* \text{ asymmetric} = \frac{1}{2} \left[ \frac{a}{b} - p_i + s_i(t_i - t_j) + 2\alpha_j \right]$$

From equation (3) and (4), we can easily verify that  $P_i^* \text{ asymmetric}$  is not less than  $P_i^* \text{ symmetric}$  and  $P_j^* \text{ asymmetric}$  is less than  $P_j^* \text{ symmetric}$  as shown in equation (5)

$$\begin{aligned} P_i^* \text{ symmetric} &= \frac{1}{2} \left( \frac{a}{b} - p_j + 2\alpha_i \right) \\ &\leq P_i^* \text{ asymmetric} = \frac{1}{2} \left[ \frac{a}{b} - p_j + s_j(t_j - t_i) + 2\alpha_i \right] \end{aligned}$$

and (5)

$$\begin{aligned} P_j^* \text{ symmetric} &= \frac{1}{2} \left( \frac{a}{b} - p_i + 2\alpha_j \right) \\ &\geq P_j^* \text{ asymmetric} = \frac{1}{2} \left[ \frac{a}{b} - p_i + s_i(t_i - t_j) + 2\alpha_j \right] \end{aligned}$$

so long as  $\alpha_i = \alpha_j$  and  $t_j - t_i \geq 0$

The dotted lines represent the reaction functions of the carriers when access charge is regulated asymmetrically.

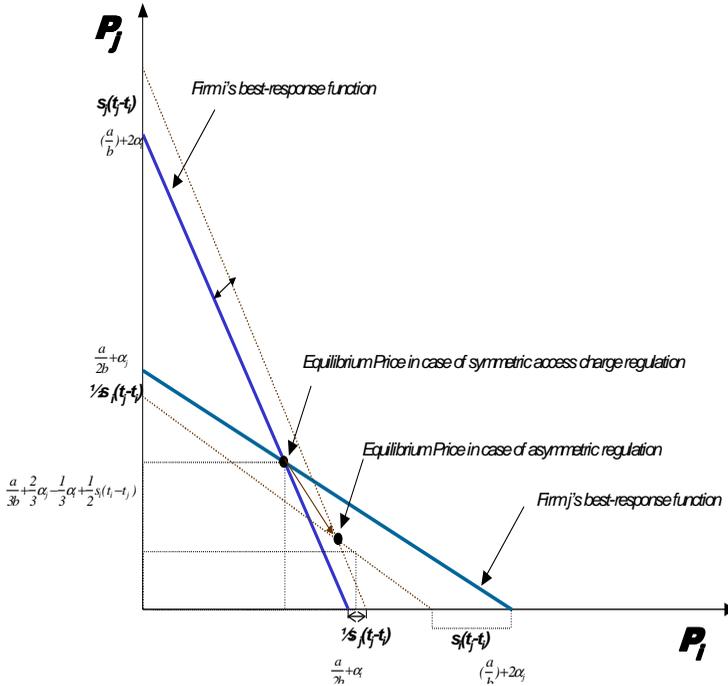


Figure 3. Equilibrium price in case of symmetric & asymmetric market situation

Some implications of this model are obvious from equation (5). For example, asymmetric access charge regulation gives the dominant carrier incentives to increase its mobile to mobile call price and an incentive to decrease the price level to the non-dominant for profit maximization. In other words, access markup to the non-dominant carrier allows the non-dominant carrier to increase its market share in the mobile call market. An increase (decrease, respectively) in the retail price implies a decrease (an increase, respectively) in the market share of the mobile telecommunication market.

It is pretty straightforward to see that the market shares are dependent on retail price and on  $(t_j - t_i)$ , because of

$$\frac{\partial s_i}{\partial p_i} < 0, \quad \frac{\partial s_i}{\partial (t_j - t_i)} < 0 \quad \text{and} \quad \frac{\partial s_j}{\partial (t_j - t_i)} > 0$$

It follows directly that an asymmetric access charge regulation that grants an access mark-up to the non-dominant carrier without significant market power could play an important role in mitigating the asymmetric market situation. Also we can see that the larger the difference in the access charge is, the less the difference in market share between two operators. As a result, we can say that asymmetric access charge regulation will play an important role in mitigating the asymmetric market situation in the Korean telecommunication market.

*Argument 2: Asymmetric access charge regulation may lead to a decrease in the total quantity in the short term perspective. In the long term, however, the mitigation of asymmetric market situation made by asymmetric access charge regulation will bring an increase total market quantity level. In other words, asymmetric access charge regulation will eventually bring a substantial welfare increases to the telecommunication industry.*

The market outcome and the efficiency of asymmetric regulation can be evaluated by assessing the positive change of total quantity level. From the equation (3), we can also easily derive the optimal  $i$  and  $j$ 's price and quantity in case of symmetric regulation respectively;

$$p_{i \text{ symmetric}}^* = \frac{a}{3b} + \frac{2}{3}\alpha_i - \frac{1}{3}\alpha_j$$

$$q_{i \text{ symmetric}}^* = \frac{2a}{3} - \frac{2b}{3}\alpha_i + \frac{b}{3}\alpha_j$$

$$p_{j \text{ symmetric}}^* = \frac{a}{3b} - \frac{1}{3}\alpha_i + \frac{2}{3}\alpha_j$$

$$q_{j \text{ symmetric}}^* = \frac{2a}{3} + \frac{b}{3}\alpha_i - \frac{2b}{3}\alpha_j$$

Also, we can derive the optimal  $i$  and  $j$ 's price and quantity in case of asymmetric regulation from the equation (4)

$$P_{i \text{ asymmetric}}^* = \frac{a}{3b} + \frac{2}{3}\alpha_i - \frac{1}{3}\alpha_j + \frac{1}{3}s_i(t_j - t_i) + \frac{2}{3}(t_j - t_i)$$

$$q_{i \text{ asymmetric}}^* = \frac{2a}{3} - \frac{2b}{3}\alpha_i + \frac{b}{3}\alpha_j - \frac{b}{3}s_i(t_j - t_i) - \frac{2b}{3}(t_j - t_i)$$

$$P_{j \text{ asymmetric}}^* = \frac{a}{3b} + \frac{2}{3}\alpha_j - \frac{1}{3}\alpha_i - \frac{1}{3}s_j(t_j - t_i) - \frac{2}{3}(t_j - t_i)$$

$$q_{j \text{ asymmetric}}^* = \frac{2a}{3} - \frac{2b}{3}\alpha_j + \frac{b}{3}\alpha_i + \frac{b}{3}s_j(t_j - t_i) + \frac{2b}{3}(t_j - t_i)$$

For the case of a linear demand

$$Q(P) = a - bP \text{ and } Q(P) = q_1 + q_2$$

We can easily verify that  $Q_{\text{asymmetric}}^*(p)$  is less than  $Q_{\text{symmetric}}^*(p)$  as shown in equation (6).

$$\begin{aligned} Q_{\text{asymmetric}}^*(p) - Q_{\text{symmetric}}^*(p) &= \Delta Q(p) \\ &= -\frac{1}{3}b(t_j - t_i)(s_i - s_j) \leq 0 \end{aligned} \quad (6)$$

so long as  $b \geq 0$ ,  $t_j - t_i \geq 0$  and  $s_i - s_j \geq 0$

As shown in the equation (6), we know that the total quantity of asymmetric regulation becomes less than that of symmetric regulation in most cases. In long term perspective, however, the mitigation of the asymmetric market situation made by asymmetric access charge regulation will be a policy instrument that increases the total quantity level. As the market becomes more competitive and symmetric, the total output will be increased. In that case, we can get the same quantity levels of asymmetric and symmetric regulation situation theoretically. In other words, an asymmetric access charge regulation may bring the same quantity level of the symmetric regulation case by making  $s_i = s_j$  in the equation (6). It follows that asymmetric access charge regulation can be a powerful policy instrument that increases market competitiveness in the long term perspective.

## **CONCLUSION**

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The desirability of asymmetric regulation access charge has been a controversial issue in the Korean mobile telecommunications industry. Up to now, there has been a lot of discussion about the effectiveness of overall asymmetric regulation in Korean telecommunications market. However, there have been very few theoretical researches about the effectiveness of asymmetric access charge regulation of mobile calls. With the aid of a simple model, we showed that the asymmetric regulation of access charge in asymmetric market structure may help to mitigate asymmetric market share and promote competition in the mobile telecommunication industry.

We introduced a theoretical framework to analyze the effects of an asymmetric access charge regulation through the Korean mobile telephony industry as an example. We showed that an asymmetric access charge regulation based on the long-run incremental costs that grants an access markup to the non-dominant carrier can be an effective instrument to shape the market more competitive in an asymmetric mobile market situation. However, in spite of the advantage of fostering competition in the market, an asymmetric access charge regulation could lead to a decrease in total quantity level in short term. In long term perspective, however, the mitigation of the asymmetric market situation made by asymmetric access charge regulation will help to cure this side effect. As the market becomes more competitive and symmetric, the total output will be increased.

Recently the Korean Ministry of Information and Communication (MIC) started the mobile number portability in 2004. As a spirit of asymmetric regulation, MIC has taken an asymmetric approach among service providers in determining the implementation date for portability requirements. For the first six months, the service provider with the least market share can bring new customers from the other service providers with higher market shares, while churning of the other direction is not allowed. Then, for the next six months, the service provider with the second least market share can enjoy a similar opportunity. After one year, the number portability is started to fully implement among three mobile service providers. An interesting question for further study is how much this asymmetric regulation for number portability promotes competition in mobile telecommunication market and increases the total social welfare.

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# Termination-discriminatory pricing and subscriber bandwagons

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## ABSTRACT

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*This article studies network effects induced by termination-based price discrimination in the evolving Taiwan mobile phone market. An econometric model that estimates the effects attests the formation of bandwagon behaviour among network subscribers. It is shown that networks with a large subscriber base will recruit a disproportionately greater share of new users ceteris paribus compared with low-penetrating operators. The strength of the subscriber bandwagon varies closely with the price differential of intra- and inter-network calls.*

## INTRODUCTION

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Widespread telecommunications pricing schemes that discriminate against inter-network calls have already prolonged the size effect and, arguably, erected a barrier to an otherwise unrestricted, efficient use of interconnected networks. Under such pricing, callers pay substantially more for inter- than intra-network calls, so continue to refer to network size when choosing between competing operators. This phenomenon has been labelled as “pecuniary externality” (Economides, Lopotomo, & Woroch, 1996) or “tariff-mediated network externalities” (Laffont, Rey, & Tirole, 1998). This article empirically examines the network effects caused by termination-based pricing in the Taiwan mobile phone market, which has been fastest-growing in penetration in the world, but also increasingly dominated by large networks.

Taiwanese mobile phone operators have always deployed termination-based tariffs: Almost without exception, inter-network call-time is priced at a large mark-up above that of intra-operator call-time. A caller is fully aware of where a call is to be terminated since network affiliation of any phone number is transparent: mobile operators are distinguished by exclusive prefix codes in

their phone numbers (especially as number portability is not yet available). The frenzied marketing campaigns of service operators, battling for subscriber share, have mobilized a sharp perception of the rate gap among the wireless-savvy public and thus galvanized reaction by users.

Industry anecdotes suggest that subscribers, concerned about the higher cost of inter-operator connection, tend to congregate their network memberships. For a subscriber-to-be, joining the most widely connected network can minimize the need for costly interconnected calls. When network users mimic the prevailing choice sequentially, a subscriber bandwagon arises—a hypothesis this paper seeks to examine. Within the exploding mobile telephony diffusion, the subscriber market in Taiwan has evolved into one which is very unequally divided between the operator oligopolies: Networks with more subscribers are seen expanding markedly faster than small ones and so becoming increasingly dominant.

This econometric investigation explores such tariff-induced impacts on Taiwanese mobile companies' positions. The results demonstrate a strong bandwagon tendency in this market. The share of subscriptions obtained by an operator depends on the relative size of its customer base to date, and the strength of the bandwagon is mediated by discriminatory pricing. Moreover, termination-discriminatory tariffs also impact network traffic. Airtime traffic is analyzed comparing the patterns of calls made inside and between individual networks. It is found that an average mobile phone subscriber called within his own network far more than he called outside, suggesting that higher charges suppress inter-operator calls and thus cause imbalanced airtime traffic within networks versus across networks. Mobile phone use, therefore, largely clusters within individual networks rather than traversing into others. Also found is that subscribers to a big network, individually, consume measurably more intra-network airtime than do subscribers to a small network, as they have more co-subscribers who can be called at a minimal expense.

These findings impart straightforward but significant policy implications in regard to competition between interconnected networks. Here we identify a *raison d'être* for the mounting network domination or concentration which is often seen in lately open-to-competition telecommunications markets and has thus far confounded policymakers. Price discrimination against interconnected calls and network effects caused appear to be accountable to a certain extent.

## **THE TAIWANESE MOBILE TELEPHONE MARKET**

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In Taiwan, the public cellular telephone service was inaugurated (using AMPS) in 1990 by the Directorate General of Telecommunications (DGT), a government agency that administered all telecommunications services under the auspices of the Ministry of Transportation and Communications (MTC). In preparation for telecom liberalization, the 1996 Telecommunications Act restructured the DGT to become a purely regulatory body and privatized the state-owned telecommunications enterprise. Business/service operation was segregated from the DGT and then incorporated as a publicly traded company, Chunghua Telecom. In 1998, the DGT, as an independent regulator, reinvented the mobile phone sector by infusing competition. Eight GSM licenses were issued through a competitive application: two nationwide (1800 MHz) and six regional (900 and 1800 MHz each for the north, central, and south regions, respectively). These permits went to six start-up carriers: Taiwan Cellular won a nationwide, Far Eastone a nationwide and a north, KG Telecom a north, Tuntex a central and south, TransAsia a south, and MobiTai a central permit. All these mobile newcomers launched their services in early 1999, rivalling both the incumbent Chunghua Telecom and each other.

This new entry unleashed a fierce war for subscribers and brought an explosive boost to this previously stagnant market. Before the entry, a mere 6.86% of Taiwanese people were mobile subscribers. By 2001, penetration had skyrocketed to an unprecedented 96.6% (see Figure 1), a figure second only to Luxembourg, according to the ITU (2003). The operators revitalized the subscriber market with non-stop barrages of marketing campaigns in the bid for market share. Common promotions were handset subsidies, subscription referral rewards, and reduced activation fees. All the operators bundled subscriptions with subsidized handsets in order to attract account sign-ups. The handset would be sold at a substantial discount (from 10% to 100%) as part of a subscription contract of a lengthy term (normally two or three years). With-the-contract prices offered by the operators for the latest handset models from various brands were heavily advertised and buyers could make a sign-up in any owned, franchised, or independent retail phone store. These handset subsidies significantly stimulated the public's appetite for mobile phone services insomuch as rendering ever more sophisticated handsets affordable to the trend-conscious Taiwanese. Furthermore, the ferocious subscriber competition presses down call charges and kept the players on close watch of each other's price offers.

All mobile operators tariffed call terminations discriminatorily and marked inter-network rates high up relative to intra-network rates, while such pricing is not outlawed by the regulation. Market experiences indicate that in the fight for share, there was more competition around the intra-network rate than its counterpart: rate discounts were frequently applied to intra- but not inter-network usage. Chunghua, with its pre-established subscriber base, was the initial price leader, but gradually lost its lead when the other companies came to similar levels of market presence.<sup>36</sup>

A key factor in this fledgling mobile competition was interconnection between (and among) the new operators and other telecom carriers, including the incumbent wireless and fixed-line networks. To pave the ground for interconnection, the DGT drew up the “Administrative Regulation Governing Interconnection” pursuant to the Telecom Act. This order prohibited a carrier from rebuffing any interconnection request. It provided guidelines to govern bilateral negotiations between carriers over the rates and terms of their interconnection. In the order, pro-entrant pricing principles – unbundling of network components and the total element long-run incremental cost (TELRIC) calculation – were adopted with a view to foster competitive interconnection.

Despite the TELRIC provision, the level of the market interconnection fees has never been in line with what the cost-based approach intended. It is documented that the average interconnection charge in Taiwan since 1999 is six times that of neighbouring Hong Kong and Singapore (Chou, 2000). Although the fee has dropped steadily, the reduction is too small to push the interconnection market close to the competitive ideal. Several reasons are responsible for the high interconnection charge. First, the interconnection of competing networks was a groundbreaking event for Taiwanese telecommunications at the time. Neither the regulators nor the market players had the capability of implementing the somewhat complicated TELRIC procedure. Instead, interconnection terms were settled through “rule of thumb” bargaining. Another explanation was the market leverage of the dominant carriers.

The new entrants often complained about Chunghua’s inflated cost for interconnection and its inertia to decrease it. They contended that the high termination fee was intended strategically by Chunghua in order to raise its competitors’ costs in the subscription market. Interestingly enough, however, some of those who opposed the high interconnection cost later became comfortable with it, once they had secured some critical shares.

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*36 The Act imposed asymmetric obligations on Chunghua Telecom to prevent it from exploiting its incumbency. The DGT requires the dominant carrier alone to file and announce any new tariff plan 14 days before it comes into effect.*

The excessive termination charge undoubtedly elevated retail inter-network call rates, especially when the caller-pays pricing scheme was employed (as mandated by the Interconnection Regulation). It is so normal for the operators to price inter-network calls at more than twice that of intra-network calls (e.g. NT\$6–7.2/min as opposed to NT\$3/min).

Also pivotal to competition between mobile networks is service coverage area (Valletti, 1999). In Taiwan, only Chunghua, Taiwan Cellular, and Far Eastone have ever operated nationwide under one permit. Others were regional firms and handicapped, vis-à-vis the national players, in attracting sign-ups. First, regional coverage constrained the market base and hence reduced the potential for economies of scale in marketing, billing, and distribution. Second, a circumscribed service footprint dictates calls (including all that aim for a different region) made in such a network to be more likely inter-operator traffic, which is expensive. Even though regional operators have forged roaming alliances to enable subscribers' mobility across regions, such traffic remains incurring the full interconnection fee and is charged at the inter-network rate. As a result of the disadvantages, the regional operators struggled painfully in the subscriber competition. Despite the fact that they still had access to one-third of the national market, their subscriber shares were so scant as well out of proportion compared to those of the national players. Three of the four regional firms were eventually consolidated into, or merged with, countrywide networks: KG amalgamated with Tuntex in January 1999 and TransAsia was acquired by Taiwan Cellular in May 2001. These consolidations ran abruptly contrary to the original licensing blueprint of the DGT, which had aimed for diversified market control and a balance between nationwide and regional service coverage.

Notwithstanding their concurrent inceptions, the new services had headed for disparate paths in their evolution. Taiwan Cellular, alongside the incumbent Chunghua, had commanded the lion's share of subscribers and thrived from the network rivalry. The share of Far Eastone and KG Telecom hovered below the two majors. The regional firms, MobiTai and TransAsia (before merger) obtained subscribers so slowly ever since the outset and continued to shrink. Table 1 summarizes the trend of subscriber shares of the competing firms.

<i>Company</i>	<i>1998 May</i>	<i>1998 Dec</i>	<i>2000 Sept</i>	<i>2003 Jan</i>
<b>Chunghua Telecom</b>	20.18	21.28	26.09	31.03
<b>Taiwan Cellular</b>	25.53	35.87	29.75	34.18
<b>Far Eastone</b>	16.90	21.83	18.41	17.99
<b>KG Telecom</b>	13.65	9.88	19.04	13.80
<b>TransAsia</b>	7.57	5.86	3.69	---
<b>MobiTai</b>	7.45	5.25	2.98	2.97
<b>Tuntex</b>	8.72	---	---	---
<b>HHI</b>	1720	2376	2290	2654

Note: 1. Share numbers of 1998 May and December are calculated excluding Chunghua's subscribers acquired prior to the competitive entry. 2. Tuntex and TransAsia were merged with other firms respectively.

*Table 1. Mobile networks' subscriber shares*

## **COMPETITION AND INTERCONNECTION BETWEEN MOBILE NETWORKS**

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Telecommunications carriers, even competing ones, interconnect with one another, either voluntarily or by mandate, so as to provide end-to-end connectivity across networks. An interconnected operator levies fees for terminating calls originated from another network. In the absence of price regulation, this charge raises the retail prices of outbound (or inter-network) calls relative to those of internal (or intra-network) calls. The use of the caller-pays billing regime further deepens the rate differential, because the extra cost is borne entirely by the caller. In the face of the asymmetric rates for call terminations, subscribers to different networks will have to pay dissimilar costs to communicate with the very same person or group. Kim and Kwon's consumer survey (2003) in the Korean market has demonstrated mobile subscribers' preference for network size and shown that the reported size valuation was related to the intra-network call rate discount and size as a signal of quality. The termination-based pricing can drive overarching market consequences in the context of network competition, in particular when interconnection is not charged on a cost basis.

Economides, Lopomo, and Woroch (1996) recognize the potential of such tariff schemes to tilt competition into domination within a network market. They visualize a pecuniary externality as a result: a network with more users is of higher subscription value because it allows one to call more people inexpensively. This externality essentially compels nonusers to enter the

dominant circle, *ceteris paribus*. Laffont, Rey, and Tirole (1998) and Armstrong (1998) prove this view theoretically. Their models show that when network terminations are price-discriminated firms face a stronger incentive to combat for market share. In capturing subscriber shares, a dominant network player wants to keep high interconnection charges out of the motivation to exploit its size advantage and squeeze the survival of networks with a small share or coverage.

As new users continue to pile on to a network with a large subscriber base for the size benefit (i.e. reduce the making of inter-network calls), a subscriber bandwagon develops. Consumption bandwagon (or network externality) is typically associated with communications services: The user of such a product often emulates others' consumption decisions, since the value of adoption is determined by the user base (see Rohlfs 2001 for the latest survey on network externality). To tap such "demand-side scale economies" (Economides, 1996), network shoppers will optimize their selection decision by choosing the same network as most "early birds." As such, users are more likely to be attracted to the network which has already achieved wide acceptance. Katz and Shapiro (1986) remark: "the relative attractiveness today of rival technologies is influenced by their sales histories." This bandwagon effect often results in the market being dominated by a small number of firms (Farrell & Saloner, 1986; Rohlfs, 2001). Katz and Shapiro (1994) also acknowledge that "because of the strong positive feedback elements, systems markets are especially prone to 'tipping,' which is the tendency of one system to pull away from its rivals in popularity once it has gained an initial edge."

### **EMPIRICAL EXAMINATION OF SUBSCRIBER BANDWAGON EFFECT AND TAIWAN MOBILE PHONE DATA**

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In the context of mobile networks, the following hypothesis is examined: a network's capture of new subscriptions will be related to its installed base share as well as to termination-sensitive pricing. Searching for the link between sequential market shares is consistent with the attraction model of network effects (Redmond, 1991; Clark & Chatterjee, 1999).

A panel dataset of the Taiwanese mobile phone market from May 2000 to January 2003 (22 months) was gathered for the model. All operators during this period were observed: Chunghua ( $i = 1, t = 1$  to 22), Taiwan Cellular unmerged ( $i = 2, t = 1$  to 13), Far Eastone ( $i = 3, t = 1$  to 22), KG Telecom ( $i = 4, t = 1$  to 22), TransAsia unmerged ( $i = 5, t = 1$  to 13), MobiTai ( $i = 6, t = 1$  to 22), and Taiwan Cellular merging TransAsia ( $i = 7, t = 14$  to 22). Data were

obtained primarily from the MTC Department of Statistics, which has compiled mobile operators' monthly subscriberships since May 2000 (Ministry of Transportation and Communications, 2003). The subscriber share variables were drawn or calculated from these subscriber numbers. Additionally, the MTC data report firms' phone-bill revenues and total call-minute volumes each month. Information was also collected from the operators' company websites (Chunghua Telecom Co., Ltd., 2000-2003; Far Eastone Telecommunications Co., Ltd., 2000-2003; TransAsia Telecommunications Co., Ltd., 2000-2003; Taiwan Cellular Corp., 2000-2003; KG Telecom Co., Ltd., 2000-2003; MobiTai Communication Co., 2000-2003), which posted detailed call tariffs and subscription promotions.

It is seen that all operators offered an array of two-part tariff subscription plans from which customers could select. One subscription featured a flat monthly connection fee and intra-/inter-network call rates. Almost as a rule, within a given operator, the higher the flat fee, the lower the unit rates. Nonetheless, as a departure from the standard two-part tariff, the subscription schemes do not stipulate a call-minute allowance, but deduct the fixed monthly fee from the phone bill (for both intra- and inter-network charges combined). In other words, the user pays nothing rather than the subscription fee if his bill in a month does not exceed this fee amount; otherwise, he pays actual call expenses.

To enable a consistent comparison between operators offering multiple unit rates, the measurement of the rate variables looked at only the low-end subscription option from each firm, i.e. the one with the cheapest monthly connection (subscription) fee.  $Price_{i,t}$  is the intra-net rate in this observed tariff and  $P\Delta_t$  can be computed once comparing all firms' intra- and inter-network rates at a time.<sup>37</sup> The data showed that the firms' rates were fairly well matched. The standard deviation of  $Price_{i,t}$  among all  $i$  at a given time was consistently far below the mean, with the ratio ranging from 1:12.45 to 17.09 throughout the observation interval. It can also be seen that generally both call rate averages declined over time, although the intra-net rate plunged faster the inter-net rate. One may speculate if small operators charge lower prices to counterbalance their disadvantage in the subscription market (Armstrong, 1997, p. 67). However, no systematic pattern between rates and subscriber size across the networks was found. The small operators had not been more aggressive in pricing and it is perhaps because of their limiting cash flow.

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*37 To forestall the possibility that the regression results obtained only were peculiar to this choice of observations, the most expensive, or "luxurious," package was also measured and entered in the model. The corresponding empirical outputs by the alternative measurement showed no qualitative discrepancy.*

Each mobile operator's new subscriber share gain, measured in terms of number of accounts, in a given month is related to its cumulative subscriber base and the intra/inter price differential  $P\Delta_t$ , through an econometric model. Other variables are also operationalized as control for other variations in operators' new subscriber shares:

The monthly consumer magazine "Call" tracks the top 40 popular phone models in Taiwan every month (Top Mobile Handset Specifications and Marketing Information, 2000-2003). For each model named, the subsidized (or not) prices offered by all operators were tabulated in detail. To obtain a measure of a company's overall spending on handset subsidy, its aggregate subsidy rate (out of the regular prices) for a month's top 20 models was calculated and assigned to  $\text{HandSubs}_{i,t}$ . Certain trends can be identified from this: carriers do not subsidize all handset brands and models in the same way, though there is much more similarity where the most popular Nokia and Motorola models are concerned. Additionally, large carriers tend to score higher than small ones on  $\text{HandSubs}_{i,t}$ .

The DGT regularly appraises mobile operators' services. Various aspects of service provision were evaluated, including network congestion rate, signal coverage rate, reception quality, call completion rate, and customer service (Directorate General of Telecommunications, 2003). Each firm was given a grade for each aspect. These evaluations were incorporated into a percentage to enter as  $\text{Quality}_{i,t}$ .

## **RESULTS**

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The results of the econometric estimation substantiate a bandwagon trend existing in the Taiwanese wireless phone market. It is shown that the subscription market was persistently "tilted"—large networks were more sought after by new mobile users than others. Noteworthy is that the total bandwagon effect of a current base snowballed throughout as it self-perpetuated its growth through continual accumulation. Any extra share gain boosted this subscription bandwagon which then induced an even larger customer recruitment. This positive feedback in subscriber share building accrued to the larger, that is, more popular, network. In contrast to the positive cycle was a vicious downward spiral, into which small networks had fallen. Narrow penetration and meager subscription sign-ups, in repetition, particularly afflicted the small operators. As a result, the share disparity between operators widened over time, as seen.

The result of the price differential ( $P_{\Delta t}$ ) variable amplifies the bandwagon effect. The higher  $P_{\Delta t}$ , the stronger the subscription bandwagon. Here, we see that termination-sensitive tariffs greatly contribute to the escalation of the imbalance amid different-sized networks. The parametric evidence presented attests that the tariff-mediated externality among mobile networks enhances networks which already enjoy deep user reach and marginalizes those without.

From the above estimation, it is demonstrated that mobile networks which have captured at least 18.5% of the existing market-wide mobile subscribers tend to expand their user bases further and those which do not tend to lose the market subscriber share. In other words, operators who have installed some critical mass of subscribers will subsequently attract more new subscribers at the expense of others who have not.

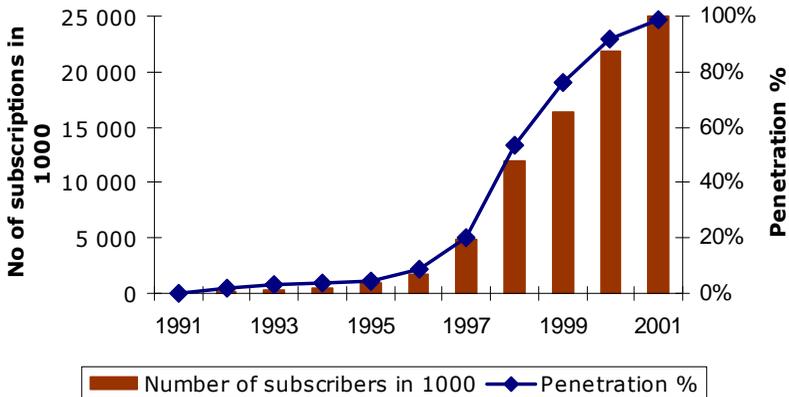


Figure 1. The Growth of Mobile Phone Subscriptions in Taiwan

$Price_{i,t}$  consistently retains a negative association with an operator’s ongoing subscriber capture. However, the relationship is not statistically significant. This should not be surprising as, very likely, the across-firm variation in the intra-net rates is too limited to yield any discernable result. The close agreement of prices gave little room for subscribers to respond distinctively.  $HandSubsi_{i,t}$  significantly increases the operator’s share capture. This shows that new subscribers respond more to those who can give higher handset subsidies. This result coincides with industry wisdom.

Phone service quality also proved an important consideration for Taiwanese wireless customers.  $Quality_{i,t}$  was highly significant in explaining the subscriber recruitment after adjustment for other factors. It is shown that a better-evaluated service improves a firm’s position to draw subscribers.

## **CONCLUSION**

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Prior to the new millennium, the movement to open competition had revolutionized the previous telecommunications landscape in many countries. Market competition was hailed as a superior approach to spurring telecommunications growth and has by and large fulfilled this expectation. Even so, the extant knowledge of telecom network competition has lagged behind the pace by which competition is shaping network markets. In the context of a facility-based network market, competition is symbiotic with network interconnection. Different networks have to reciprocally link with each other in order to weave an interoperable platform. In view of the rising salience and importance of two-way competitive interconnection in the present telecommunications environment, our empirical understanding of its dynamics and evolution to date still remains fairly incomplete.

This study corroborates effects due to network externalities in the Taiwanese mobile phone market and shows that the effects have resulted in the increasing dominance of large operators. The econometric results unequivocally reveal bandwagon behaviour among sequential phone subscribers. Networks with different sizes at any time will disproportionately divide new subscribers. The large networks devour a much larger share of new sign-ups, increasingly trivializing their smaller rivals. Crucially, the subscriber bandwagon is closely coupled with the asymmetric costs of network terminations. The high costs of interconnection give an inexorable double bind for small operators— not only lackluster subscription recruitment but also sparse airtime demand. The other analysis in this study shows also that cellular airtime traffic tends to be concentrated within, rather than travelling through, individual networks. A mobile subscriber calls out of its network far less than within the network, and calls more if he is with a larger network. Therefore, operators split the industry airtime disproportionately with respect to size. This “traffic clustering” pattern implies that the size of a competing network affects its baseline ability to draw airtime revenue from its customers. Reasonably, one wonders about a connection between large operators’ strong cash flow and their ability to resource more expensive handset subsidy programs. This is an important issue since it is concerned that subscription contracts solicited by bundled subsidized handsets may wield a lock-in effect on customers (i.e. Valletti & Cave, 1998; Doyle & Smith, 1998).

The market consequences of costs for interconnection are serious. As we know that high interconnection costs magnify subscribers’ preference for network size, these findings are compatible with the possibility that dominant carriers are setting high termination fees with the intent to dwarf smaller

competitors. The evidence presented here warrants tighter regulatory scrutiny of interconnection fee negotiations between operators, to protect against dominant carriers using excessive access charges as a means of leverage. Furthermore, in order to reduce the prices of outbound calls and invigorate cross-network traffic, policymakers may consider pricing regimes where call recipients share the connection cost (i.e. Doyle & Smith, 1998). Finally, since the evolution of the network market is path-dependent and susceptible to tipping, the regulator should not downplay the influence of any market gain, even a small one, that develops from anticompetitive practices. Circumspection should be taken to prevent any unjust market advantage from being parlayed into a large and lasting one.

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# Asymmetric theory of access pricing in mobile telephony

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## ABSTRACT

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*This paper summarizes recent economic studies on access pricing and competition in mobile telecommunication markets in different-sized networks. For this purpose, the studies can be composed into three categories concerning the issue of collusion between firms, the strategic choices of network operators on access charges and retail prices, and finally, the impacts of the asymmetric regulation in mobile communications. Both the theoretical models and empirical works are included in this survey.*

## INTRODUCTION

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Since the early 1990's, mobile telephony has been among the most growth dominant industries worldwide. In this context, Armstrong and Laffont, Rey and Tirole (LRT) both published in 1998, were the first two to study the choice of reciprocal two-way access charge and competition between two symmetric network operators under competitive environment.

Researchers can easily recognize that this setting of "face-to-face" competition between two similar networks is rather unrealistic. Indeed, telecommunication markets had just been liberalized after a long monopoly regime. Since the incumbent exploited the markets earlier than new entrants, it built its reputation and kept customers with, sometimes, very sophisticated contracts. Furthermore, telecommunication services exhibited network effects; that is, consumers relatively prefer to join a bigger network because of brand awareness and lower expected price, especially when firms can price discriminate for on-net and off-net calls which is often the case in practice. A consequence is that new entrants are very hard to compete with the incumbent, and hence competition in mobile markets becomes more complex and required further advanced economic analysis.

The following part aims at summarizing the recent economic studies of competition and access pricing between asymmetric networks in three categories: collusion, advantages of big networks, and asymmetric

regulations. For more general economic issues in mobile telephony and access pricing, reader should consult Armstrong (2002), Laffont and Tirole (2000), De Bijl and Peitz (2003) with numerical examples and simulation model and an excellent survey by Vogelsang (2003).

## **COLLUSION AND ACCESS CHARGES**

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Collusion is a dominant concern in the symmetric setting started from the works of LRT(a,b) and Armstrong (1998). The general result obtained is that, under symmetric setting, firms have incentives to increase access charges so that they can enjoy higher profits due to the phenomenon of “raising each other costs”. The argument is fundamentally based on the standard model of double marginalization studied in industrial economics. Furthermore, in a symmetric setting, firms may also collude easily even without using access charges.

Kim and Lim (2004) study revenue sharing rule for the case of two symmetric firms. Their finding is that the firms also can enjoy shared monopoly profits if each mobile operator agrees to give away to the other a half of revenues from its calls that terminated in the competitor network. A simple explanation is that if it can retain nothing from calls, it would then have no incentives to provide services. Yet, if it can retain all the revenue, it would lower prices in order to maximize its profits and not the joint profits taking into account of its rival's cost. Therefore, in symmetric setting, one can expect for a symmetric outcome, that is, firms share revenue equally and obtain half of the joined monopoly profits.

One may wonder whether the reasoning will change when changing into asymmetric setting. This is because when firms are symmetric, their objectives often coincide; however, when firms are asymmetric, they may have different targets and sometime very conflicting ones. For example, a small firm would want to build its market share and reputation while the big firm aims at weakening the competitor so that it will enjoy more profits in the future. Consequently, at first glance, the possibility of a collusion does not seem not very easy to be the case since firms are different in size.

However, complex economic analysis gives us much more insight into this concern and we will start to look at this from the paper by Berger (2004). Let us realistically assume that two asymmetric network operators can apply termination based price discrimination. The additive ingredient in Berger's model to the literature is that receivers can derive utility from calls. Therefore, when network operators take this into account, they would charge very high

off-net prices. In order to keep their market shares, they need to compensate subscribers for high off-net calls; hence, they can lower on-net prices.

Regarding the level of access charges, the collusive level can only arise when access charges are below costs. The reason is that, when off-net prices are above monopoly level under cost based access charge, firms are better off negotiating so that they can bring prices down to the monopoly level and enjoy higher shared profits. Therefore, below cost access charges is a collusive instrument. The author can find a wide range of parameters that lead to prices above monopoly level of off-net calls under cost based access charges.

In the similar reasoning that firms can strategically share the industry monopoly profits, Kocsic (2005) also shows that this can be the case if side-payments are allowed. More precisely, her model studies the competitions between networks which are both different in costs and in sizes where firms can only offer linear retail tariffs without termination based discrimination.

The model is as follows: consider the case of an incumbent which has a bigger market share due to brand loyalty; however, the entrant can use a more advanced technology so that it can provide telecommunication services with lower costs. The author shows that competition between networks leads to an equilibrium where the incumbent's price is higher than the entrant's due to brand loyalty and higher cost.

Regarding how the level of access charges affects competition and welfare, the author shows that in the case of asymmetric networks where an incumbent's share is large (or large brand loyalty), the whole industry's profit is higher with smaller difference in termination charges. Intuitively, if the incumbent's access charge is regulated at cost, the termination charge of the entrant at cost is maximal for the industry's profits. However, if difference in costs is large, the entrant can gain more market share since it can offer lower prices. In this case, the higher entrant's access fee makes the whole industry more profitable. In either case, the industry can increase its profits if there are some side-transfers between network operators.

## **BIG NETWORK ADVANTAGES**

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It is obvious that in the presence of asymmetry, a big network has several advantages relative to the smaller one. Therefore, the question arises is whether the big network operator with its advantages has incentives to foreclose the competitor, hence dampen competition. The two instruments

can be employed by the big operator are high access charges and high on-net and off-net price differentials.

High access charges puts the small network at a disadvantage since it brings higher entrant perceived costs which can be transposed into higher entrant retail prices (*price squeezing*). The latter favours the big network in the sense that it helps customers realize network effects. So when on-net price is less expensive than off-net price, subscribers would prefer to be in the same network. All things equal, joining the big network is better since subscribers can expect to call more with cheaper prices. Therefore, this part is to study incentives of the big network operator to choose the level of access charge and price differentials of on-net and off-net calls.

### **Theory**

The very first paper studying the choice of access charges by the big network operator in the setting of asymmetric network sizes was carried out by Carter and Wright (2003) and follows their earlier work in 1999. Then many subsequent works have followed their idea to model the asymmetry between networks. They assume that because firms provide different service quality transforming into different net utility for customers, so the higher quality can capture more subscribers and hence higher market share. This parameter also can be called as “brand loyalty”. In such an asymmetric setting, the authors look at the choice of reciprocal access charges given that firms can practice two-part tariffs without price discrimination for on-net and off-net calls.

The main result derived is that big network operators always prefers cost based access charges. This is because once the networks market shares have been determined, firms can capture all surpluses from their subscribers via fixed fees. Thus the main concern for the big firm now is to obtain net profits from off-net calls. In the same analysis with LRT 1998b, under balanced calling pattern assumption, the per minute price should be set at perceived marginal cost which increases with the rival’s share when access charges above cost and decreasing otherwise.

$$p_i = 2c + s_j (a - c)$$

Where:

$s_j$  is the market share of the competitor;  $c$  is unit cost for call origination or termination.

Therefore, when firms agree at above cost access charges, the big network will set lower per minute prices, and hence will suffer from access deficit due

to the fact that its customers will make more off-net calls as its per minute price is lower. The same applies when access charge are lower than cost. That is, small network will charge lower per minute prices; hence its subscribers will make more calls including off-net calls. This takes away profit from the big network operator also.

In sum, under reciprocal access obligation, the big network operator would never want to deviate from cost based access charges. Further analysis specifies that when the asymmetry between two networks is sufficiently high, the small firm also prefers this level. However, unlike in the above case, when the two firms are free to set access charges, they charge at very high levels and the big network operator can use high access charge as means of entry barriers.

Behringer (2006) addresses the same issue when asymmetric firms set access charges non-cooperatively. He also finds that, as can be seen in practice, both firms would like to set high charge. His model can be seen as a two stage game: first is the choice of access charge; then firms set their retail tariffs. The model allows for termination based price discriminations and firms can practice two-part tariff.

In the second stage of the game, firms can not be better than setting per minute prices equal to their perceived marginal cost, while fixed fees are used to gain profits. In other words, the price for each unit on-net call is exactly the cost of providing services and for each unit of off-net calls, prices should equal the cost of origination plus access charges. At the first stage, firms would set very high access charges above costs. Higher access charges increase off-net perceived costs and hence off-net prices of rivals; thus reducing the rival's market share and increasing its own share, leading to higher demand.

A very interesting result emerging from this model is the analysis of the effect of asymmetry on the setting of access prices. When the asymmetry is high, the small firm finds it optimal to set lower access charge as well as the fixed fees. This is because when the small network sets lower access prices, the big network operator can gain more from interconnection, hence less willing to compete hard and becomes a softer competitor. Thus the small network can use lower fixed fees to obtain more market share.

In contrast to this finding, Dewenter and Haucap (2005) believe that the small network can charge higher access charges than the big one. The reason for this is that, given demand for off-net calls, an increase in access charges by the big firm affects off-net prices. This however, is not the case for the small network with a small increase in access charges, hence the big network always has to set lower access prices than the smaller networks.

To get more exposure of the choices facing big networks regarding access charges and price differentials, Elliot (2004) illustrates his theory with a nice simulation model. Firstly, his model confirms the result derived by Carter and Wright that the big network operator is better off with reciprocal cost based access charges. Secondly, incorporating termination based price discrimination in the model further extends the analysis of the operators' choices of access charge. Indeed, he demonstrates that both large and small firms prefer low level of access charges; and the most favourite is "bill and keep" regime. Moreover, small firms are more sensitive to the level of access charges because of "tariff mediated network externalities".

The explanation can be seen from the argument by Gans and King (2000): whereby high access charges induce more expensive off-net calls, hence firms want to gain market shares to keep off-net perceived marginal costs low; and maintain competition. Nevertheless, when access charges are lower than cost, firms do not need to compete very fiercely, since networks will make loss whenever their customers make off-net calls; hence no need to offer low fix tariff to gain more subscribers. Applying this idea to the above result is that, because market share is very important for small network, it will suffer from intense competition, i.e., high level of access charges. Meanwhile, a low level of access charges lowers the intensity of competition, and so the small network can gain more market share. Therefore, although big networks do not enjoy intense competition, the impact is softer than for the small one. This explains the above finding.

Regarding the issue of on-net and off-net price differentials separately, Hoernig (2005) questions how these prices are determined. Following Berger's idea, it is assumed that the utility of receivers is proportional to the utility of callers; while, again, network size is decided by the brand loyalty parameter. Furthermore, it is assumed for the balanced calling pattern that each subscriber makes calls proportional to network market shares. The length of calls, however, is different, accordingly actual traffic is not necessary balanced between networks.

The optimal pricing structure is characterized by Lerner indices for on-net and off-net pricing. It is found that the Lerner index for off-net pricing is always higher and linear with the index of on-net pricing, and passes through the monopoly point. This is mainly because firms wish to capture the surplus from receiving calls of the rival's subscribers. Furthermore, depending on the level of receiving utility, the off-net index can decrease or increase in on-net index.

More interestingly, at equal on-net Lerner index, the level of off-net index is higher with bigger networks unless the small network offers very high prices for on-net calls which is unlikely to occur. (Indeed the author shows that this

is never the case in the equilibrium.) Moreover, the higher the level of asymmetry between networks, the higher the off-net Lerner indices are. Therefore, to internalize the effect of externality due to the fact that call receivers derive utility, firms with a high market share would like to charge very high prices for off-net calls even without an anti-competitive intent. As such, at the same level of on-net prices for both networks, small firms suffered from access deficits due to the lower levels of off-net prices compared to the big networks. The above analysis is true for the case of linear pricing.

Regarding two-part pricing, the author shows that it is optimal for firms to price each minute of on-net calls below cost; but above cost for each minute of off-net calls. The more important result is that, while the on-net pricing strategy is the same for both firms, the optimal off-net prices do depend on firm market shares. To be precise, the off-net price for each minute of calls is higher with larger share firm; hence the more asymmetry between networks, the bigger difference between off-net prices between networks. And again, this is due to the fact that firms need to take into account the fact that receivers benefit from receiving calls. If the parameter of utility that receivers derive from calls is reduced to zero, the optimal pricing structures would be the same for both firms and perceived marginal costs would be equal. Although the paper gives some very realistic assumptions, it is not able to fully characterize the equilibrium due to the complexity of price structures. Hence, a numeric example is shown instead.

While the above papers consider the case between a small and a large network, it cannot express the full advantage of big networks in mobile markets. The fact that small networks are often the entrants who enter the market later than the big networks which was the previous incumbent, hence entrants are often under more competitive pressure than the incumbent. This is exactly the motivation for the work by Armstrong (2004) who models the case that there is one incumbent competing with a competitive fringe of entrants. The demand is inelastic but is heterogeneous in the sense that an H-type customer makes more calls than an L-type customer. There is no problem of information asymmetry in observing customer types. In practice the H-type customers may receive more calls than the L-type customers.

Let us consider two possibilities of non-reciprocal access charges. Allowing an increase of the incumbent's access charges while keeping the entrant's constant leads to higher entrant perceived marginal costs, hence its retail prices because the entrants are price takers. In contrast, fixing incumbent's access charge and allowing entrants to raise theirs access charges would cause stronger competition. This is because apart from profits from retail market, entrants now can gain more from interconnections from L-type customers; hence they would offer lower retail tariff to attract subscribers.

The interesting case is the analysis of reciprocal access charges. Under reciprocal obligation, raising access charges means that H-type customer is relatively less important as they are sources of access deficits while L-type customers brings more profits to firm from interconnections. This would result in less or more intense competition accordingly to different types of customers.

### **Empirical evidence**

Empirical studies often concentrate on whether network size matters for the choice of mobile subscribers and how calling behaviours are affected under termination based price discrimination. It is also worth noting that there are two types of network effects. The first case is whether large networks can proportionally attract more customers and the second case is whether customers make more on-net calls than off-net calls with or without termination based price discrimination.

Kim and Won (2003) is the first study on the effects of network sizes on the choice of mobile subscribers with a survey of 1335 respondents. Using a multiple discrete choice model, the authors find supported empirical evidence to the hypothesis that network sizes highly impact the choice of Korean mobile subscribers.

In explanation, the two main reasons are found empirically. Firstly, in the presence of termination based price discrimination, customers could expect to call more people at less expensive prices (*tariff mediated network externalities*). For example, for the case of SK telecom, the largest operator in Korea, the ratio of on-net call minutes over total call minutes is much higher than its market share. Secondly, networks with large subscribers can be considered as giving a positive signal for good service quality. Therefore, larger networks tend to recruit larger new subscribers, all else equal.

In the same light, Fu (2004) obtained data from May 2000 to January 2003 in the Taiwan mobile market. He uses a more comprehensive econometric method that is able to infer individuals' preferences from observing aggregate behaviour rather than just surveying customers' preferences. This method is known as "*marco empiricism*". The aim is to validate the two factors affecting the choice of new subscribers: the sizes of networks and prices for on-net and off-net calls.

Regarding network size, he shows that bigger networks can capture more new subscribers than smaller networks. Furthermore, the snowball effect exists in this case. Precisely, the large network can recruit more subscribers, hence obtains a larger market share. Again, any larger market share leads to more subscriber recruitment. This positive feedback results in the higher

difference in market shares between small and big operators overtime. (Apart from this, prices, hand subsidization and phone quality are also the sources influencing consumer choices).

Moreover, in the presence of termination based price discrimination, within traffic and cross traffic this phenomenon points to lopsided effects. In particular, big network subscribers make more calls than small network subscribers because average price is lower, and hence traffic from a big network to a small network is higher than the vice versa. Moreover, on-net traffic is much higher than off-net traffic under termination based price discrimination in all networks and is increasing with networks sizes.

To understand the choice of mobile subscribers and network effects, Birke and Swan (2005) look at the evidence in the UK market using an econometric method of mixed conditional logit. Firstly, the authors reveal that the actual number of on-net calls is higher than off-net calls. In the presence of termination based price discrimination, it is more relevant to look at the relationship between the ratio of off-net calls on on-net calls and the ratio off-net prices on on-net prices. Running a regression of this relationship, the authors find that an increase in off-net call prices leads to a decrease in the ratio of off-net to on-net calls. A more interesting point is that, even under no termination based price discrimination, the on-net traffic is still higher than off-net traffic. This can be translated as the “*pure network effect*”: customers tend to call subscribers of the same network more than to subscribers of different networks.

Regarding operator choices, it is indicated empirically that a consumer's family have the most significant impact on the subscriber choices. Meanwhile, network sizes affect consumer choice at only 1 percent of the significant level. This result contrasts with the work by Fu (2004), who asserts that network sizes have a major impact, and even have a snowball effect. To conclude, it suggests that high on-net and off-net price differentials can be used as a pre-empting instrument; or in other words, high off-net price is a source of market power rather than the result of market power.

## **ASYMMETRIC REGULATIONS**

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The above two parts give us very good insight to understanding firm incentives to setting access charges. In telecommunications markets, small networks are often the ones which enter into the market later than bigger networks. Furthermore, regulation authorities are keen on promoting competition in mobile markets which can be referred to as “light hand”

regulation. To achieve this goal, the entrants' *ex ante* profits should be attractive, and hence asymmetric regulation, which treats new mobile entrants more favourably as it is often used. Regulation forms may vary and regulators can regulate the fixed network price setting and allow mobile operators to decide on their access charges without restraint. Another form is that mobile incumbents are often regulated, both in the whole sale market and in the retail market as well, which is not the case for new mobile entrants.

Although we are only interested in competition between mobile operators, the existence of fixed networks may influence mobile operator behaviors. We will look at this issue in the article by Baake and Mitusch (2005) who consider the case that there is one full coverage fixed network and two mobile operators without full coverage. The problem is motivated by the German telecommunication markets where the fixed network operator is regulated for both wholesale markets and retail markets, while mobile operators are free to set their retail prices and reciprocal access charges. This type of asymmetric regulation favours mobile operators over the fixed network. Nevertheless the paper seeks an answer in the choice of mobile-to-mobile, and not fixed-to-mobile access prices.

The authors demonstrate that mobile-to-mobile access charges negatively impact mobile subscription fees; but is the instrument to increase the market share of mobile operators. A very rich intuition emerged from this paper. First, it is well known that higher access charge lead to stronger competition because of "*tariff mediated network effects*" under termination based price discrimination. Second, because customers have high worth to mobile operators, especially in the case of less than full coverage, instead of providing incentives to lower competition as noted by Gans and King, firms are more eager to compete for new customers. Therefore, high access charge is a good new and no need to be seen as a collusive device.

We will now concentrate on the case of mobile communications where the incumbent is regulated, which is not the case for the entrant. In particular, the incumbent has to provide cost based access charges, while the entrant is more flexible to set prices for the provided services. We will look at this issue in more detail in a series papers by professor Peitz and his joint work with De Bijl.

In fact, as Dewenter and Haucap point out in their above model, when the big network operator is forced to provide services at cost, the small network operators would set access charge above cost in order to maximize their profits. To understand this access price setting and how asymmetric regulation affects the level of competition; we will first consult Peitz (2005a) which studies the benefits of asymmetric access price regulation in mobile

telephony where firms can not discriminate on the basis of call termination. He assumes that firms are different in size due to the fact that the entrant brings lower utility to customers due to its later entry; for example: less services, unknown quality, low brand awareness. The usual consequence of two-part tariff leads to per minute price equal to the perceived marginal cost.

Considering the case that both firms provide termination services at cost, Peitz shows mathematically that at this charge level, a small increase of the entrant access charge leads to higher consumer surplus and the entrant's profit. The intuition is that, under asymmetric regulation, the entrant can obtain revenue from two sources: fixed fees from subscribers and termination charges for off-net calls originating from the rival network. For this reason, customers become worthier to the entrant. To attract customers, the operator needs to offer higher net utility, thereby increasing consumer surplus. In response, the incumbent also has to offer high net utility or it will lose subscribers and termination taxes, hence competition is more intense and consumer surplus increases. As the entrant builds its market share, it can also gain higher profit.

One may wonder whether the deviation from cost based access charges, which can be regarded as socially optimal, will cause distortion due to the incumbent's higher perceived marginal cost. This, however, can be seen from Peitz's argument that in the early period, the entrant's share is not big and does not affect the incumbent's perceived marginal cost, but competition is strongly affected. Social welfare is, therefore, not significantly influenced while entry is encouraged.

In the companion paper, Peitz (2005b) considers a similar case for the usage of price discrimination. The same logic applies and similar results appear in this paper, that, asymmetric regulation brings higher net utility for consumers and higher entrant profit. Unlike for the first model, social welfare is lower because the incumbent's perceived marginal cost for off-net calls is too high as entrants can gain more market share under price discrimination.

For more illustrations of asymmetric regulation, we can look at a detailed simulation analysis with the impact of each parameter in De Bijl and Peitz (2002, 2004), and more specifically their joint book in 2003. Using a simulation model, they can compare the three modes of regulation: cost based regulation, reciprocal access charges with a mark-up and asymmetric regulation. The result is that although cost based access charges are socially optimal, asymmetric regulation brings higher consumer surplus due to lower price, and is the source of higher entrant market share and profit. Social welfare is lower but not very notably, hence asymmetric regulation can be seen as the best device to promote competition. Furthermore, when both

firms provide termination services with a positive mark-up, social welfare definitely is worse off.

To conclude, the firm's prediction from these works is that in the early period of liberalization, asymmetric regulation is necessary to help entrants be competitive with the incumbent. Nonetheless, in the long run when entrants are well established in the market, asymmetric regulation should be replaced by symmetric regulation of access charges at cost.

To understand how theory and practice of asymmetric regulation can coincide, Peitz (2003) discusses that European mobile markets have many similar characteristics with his model, such as the entry of new mobile operators and asymmetric regulation, which is designed to help new competitors. Using a very simple model based on the above argument, he strongly supports the European Union's legalization of mobile markets.

This is also confirmed by Benzoni who shows that because of entry delay, new entrants have a hard time competing with the incumbent mobile operator. Furthermore, the longer the delay, the harder a time the entrants will have competing. This is because later entrants have to "catch up with" the incumbent with a sufficient investment level while the incumbent has accumulated large profit and investment. Applying the theory of "first mover advantage" in the European mobile markets, he empirically shows that the entrants' profits are much lower when they enter the market very late. For that reason, asymmetric regulation is necessary to help entrants establish themselves in the marketplace as of market entry.

Despite advanced economics theory and wide usage of asymmetric regulations in practice, relatively little empirical evidence has been revealed. The only formal up-to-date work on this topic is by Chou and Liu (2006) which evaluates the impacts of asymmetric regulation in Taiwan's mobile telephony: the fixed telephone operator and the dominant mobile operator are regulated, while the others have more flexibility. The dominant mobile firm has to set its tariff under approved price-cap that may lead to the ability to infer information by entrants and price their services strategically. In addition, regulating fixed line operator is carried out on the basis of revenue sharing rule. More precisely, the fixed line operator can only retain revenue from fix-to-fix calls, but receives no calls between mobile networks and fixed networks.

To assess this asymmetric regulation, the authors use a fixed effect model with two dummy policy variables which are:

- The constraints on the dominant firm and on the fixed line operator
- The interaction of the two above terms

The result is that, although each policy variable does not highly affect, their interaction it substantially raises Taiwan penetration. In particular, mobile penetration level in Taiwan increases at about twenty two percent with very high entrants mobile penetration growth rates., The incumbent's mobile penetration is almost the same, but the growth rate significantly decreases to eighty percent. Despite the fact that asymmetric regulation promotes mobile subscription and entrants market shares, the incumbent suffers much from this as it is not able to increase its customer base. The authors then call for a sunset clause in asymmetric regulation in Taiwan.

## **CONCLUSION**

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The departure in economic studies of mobile telephony from a symmetric to asymmetric setting is a great step in understanding the incentives of network operators to set access prices and how mobile operators should be regulated. In addition, as we have seen, unlike in symmetric setting, collusion ability between asymmetric firms seems difficult to sustain but other concerns should be carefully considered.

To conclude, some general observations can be drawn here:

- Because of an early entry, big network operator and small network operators should be treated asymmetrically in liberalization period.
- Understanding incentives to access pricing setting is very important in analyzing competition and regulation in mobile communications.
- The criteria to replace asymmetric regulation by symmetric regulation is unclear.

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# COMPETITION AND REGULATION WITH ASYMMETRIES IN MOBILE MARKETS

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Europe's mobile markets count close to 500 million subscribers, making mobile telephony a dynamic economic area. But, despite these dynamics, the resulting industrial structure presents asymmetries of size partly due to the "first mover advantages" of the early entrants, leading to a phenomenon of "non-catching-up" for the last operators to enter national markets. The present project intends to contribute to understanding the specific "first mover advantages" and asymmetries of size in the field of mobile telecommunications and to the related key regulatory issues. No document currently compiles papers analysing the mechanisms related to asymmetries in mobile networks and which is accessible to a wide readership. The present collection of essays is, therefore, dedicated to presenting ideas regarding the various dimensions of asymmetry in mobile markets and to propose international highlights. European and non-European scholars have been invited to present their works for wide circulation amongst regulatory authorities, as well as industrial players and in the telecommunications research community.