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The diffusion of mobile telephony has been very fast. In the European Union, in 2005 426 million people, almost 93 percent of the population, had mobile telephones, whereas in 1998 only 18 percent of the population did.¹ Although the market is maturing and the number of subscribers is stabilizing, new service providers, defined broadly, continue to enter the market. Between 2004 and 2005, the number of service providers increased from 166 to 214 in the European Union.² Value-added 3G services and personalized services are becoming increasingly important. About five years ago, a particular type of mobile telephony firm was launched in the United Kingdom, Sweden, and Finland: mobile virtual network operators (MVNOs).

In this paper, we discuss briefly, and in non-technical terms, some aspects related to the entry of MVNOs. These aspects range from issues related to the entry process itself, such as barriers to entry and exclusionary practices, to the effects of entry on prices and product differentiation.

The paper is organized as follows. Section I presents some useful definitions. Section II discusses entry barriers and describes the role of MVNOs. Section III discusses exclusionary practices. Section IV analyzes the impact on prices of the

1 EUROPEAN COMMISSION, 11TH REPORT ON THE IMPLEMENTATION OF THE TELECOMMUNICATIONS REGULATORY PACKAGE (2005).

2 *Id.* There is some of heterogeneity across Europe, ranging from the United Kingdom, with more than 50 service providers, to Cyprus, Malta, and Slovakia with only two GSM (global system for mobile communications) network operators.

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entry of MVNOs. Section V discusses the choice of product characteristics by MVNOs.³ Finally, Section VI concludes.

I. Basic Concepts

We begin with a few definitions. A mobile network operator (MNO) is a firm that owns a public mobile telephony network; A service provider (SP) is a firm that resells minutes purchased from an MNO. An MVNO is a firm that offers mobile telephony services without holding a license to use the radio-electric spectrum, and therefore without a mobile radio access network, but that issues its own branded SIM cards, has its own unique mobile network code, and operates a physical network infrastructure comprising as a minimum:

- (1) a mobile switching center,
- (2) a home location register, and
- (3) an authentication center.⁴

An MVNO may also have:

- (1) an equipment identity register and associated signaling capabilities, and
- (2) an intelligent network platform to provide its customers with its own value-added services.

This definition is sometimes referred to as that of a full MVNO. However, there is no universally accepted definition, and the term MVNO is used to designate firms that range from an SP to a full MVNO.

There are significant differences in fixed costs and level of autonomy from the host between an SP or thin MVNO.⁵ A full MVNO owns a comprehensive mobile telephony network. This implies that, compared with an SP, it has both higher fixed costs and more autonomy from the host in the design of products in the definition of price plans and in the introduction of new services.

Fixed costs and level of autonomy from the host are complements. Since it has high fixed costs, a full MVNO needs a large customer base to benefit from

3 Sections III and IV are based on D. Brito & P. Pereira, *Access to Bottleneck Inputs under Oligopoly: A Prisoners' Dilemma?*, *Autoridade da Concorrência Working Paper No 16*, (2006). Section V is based on D. Brito & P. Pereira, *Product differentiation when competing with the Supplier of a Bottleneck Input* (2006) (mimeo, Universidade Nova de Lisboa) (on file with authors).

4 A radio access network consists of the masts, the base stations, and the frequencies. Access to the radio access network requires, at least, roaming privileges. Roaming is the ability of a customer of a mobile telephony firm to use its handset to automatically access service from another MNO.

5 A host is an MNO that gives access to its network to an MVNO.

economies of scale. Consequently, it needs to target broad market segments. To do so, a full MVNO needs to have considerable autonomy from the host. On the contrary, because it has small fixed costs, an SP can afford to target only niche market segments, for which no considerable autonomy is required.⁶

Since it needs to target broad market segments, the entry of a full MVNO may have a significant impact in the retail market, which may threaten the host MNO. On the contrary, because an SP can afford to target only niche market segments, entry by an SP may be welcomed by the host MNO. Hosting an SP can be a way of earning revenue from excess capacity, without increasing competition significantly.

From hereinafter, when we refer to an MVNO we mean a full MVNO.

II. Entry Barriers and the Role of MVNOs

To operate a mobile network a firm has to be licensed to use the radio-electric spectrum. Since spectrum is scarce, this means that only a few firms will be licensed. The large investments required to deploy a mobile telephony network limit the number of MNOs that the market can accommodate. In addition, consumer inertia under the form of switching costs, network effects, or brand effects, makes entry difficult. This is particularly true now that mobile telephony markets are reaching their saturation levels, as illustrated in Table 1.

The relative importance of the various entry barriers is unclear. However, there is at least a natural concern that the number of licensed firms may be smaller than the number of firms that would emerge in free entry equilibrium, in particular because mobile telephony markets are typically very concentrated, as illustrated in Table 2.

The entry of SPs, or any other type of firms that offers a limited range of services, can help promote competition, at least in some dimensions like price. However, to the extent that these firms have no autonomy from their hosts in terms of pricing policies, entry of SPs cannot replicate the full range of services offered by MNOs and cannot develop new innovative services, so their ability to compete with MNOs is limited.

In this regard, MVNOs are fundamentally different. MVNOs make possible the entry of firms that offer consumers a portfolio of services indistinguishable from those provided by MNOs, without requiring the allocation of additional radio-electric spectrum. MVNOs allow for a free-entry equilibrium to be attained.

6 Examples of these are the firms targeting the ethnic minorities.

Table 1

	Penetration rate	Growth in percentage points
	Oct-05	(2004/05)
<i>Austria</i>	99%	5
<i>Belgium</i>	83%	5
<i>Cyprus</i>	99%	11
<i>Czech Republic</i>	105%	7
<i>Denmark</i>	96%	6
<i>Estonia</i>	104%	16
<i>Finland</i>	98%	3
<i>France</i>	76%	5
<i>Germany</i>	90%	8
<i>Greece</i>	89%	7
<i>Hungary</i>	90%	8
<i>Ireland</i>	96%	8
<i>Italy</i>	111%	9
<i>Latvia</i>	79%	14
<i>Lithuania</i>	117%	37
<i>Luxembourg</i>	150%	17
<i>Malta</i>	81%	6
<i>Netherlands</i>	94%	10
<i>Poland</i>	71%	16
<i>Portugal</i>	106%	10
<i>Slovakia</i>	80%	5
<i>Slovenia</i>	90%	–
<i>Spain</i>	94%	6
<i>Sweden</i>	101%	7
<i>United Kingdom</i>	103%	10
<i>EU15</i>	92%	–
<i>EU25</i>	91%	–

Source: EUROPEAN COMMISSION, 11TH REPORT ON THE IMPLEMENTATION OF THE TELECOMMUNICATIONS REGULATORY PACKAGE (2005).

III. Exclusionary Practices

A. MARKET FORECLOSURE

In order to operate, an MVNO needs to obtain access to the radio access network of an MNO. The host and the entrant negotiate over several dimensions, such as the prices of origination and termination traffic, the elements of the host's network that the entrant will hire, and the capacity that the entrant

Table 2

	Operators with licenses, Sep-05				Market shares based on customers, Oct-05	
	DCS or GSM	DCS and GSM	UMTS and GSM/DCS	UMTS	Leading operator	Main competitor
<i>Austria</i>	1	3	4	1	40%	25%
<i>Belgium</i>		3	3		47%	32%
<i>Cyprus</i>		2	2		93%	7%
<i>Czech Rep</i>		3	3		NA	NA
<i>Denmark</i>		3	2	1	31%	20%
<i>Estonia</i>	1	3	3		46%	32%
<i>Finland</i>		3	3		NA	NA
<i>France</i>		3	3		47%	36%
<i>Germany</i>	4		4	1	38%	37%
<i>Greece</i>	1	3	3		NA	NA
<i>Hungary</i>		3	3		45%	34%
<i>Ireland</i>		3	2	1	49%	40%
<i>Italy</i>		3	3	2	40%	32%
<i>Latvia</i>		3	4		NA	NA
<i>Lithuania</i>		3	0		37%	32%
<i>Luxembourg</i>	1	2	3		58%	29%
<i>Malta</i>	2		2		52%	48%
<i>Netherlands</i>	2	3	5		36%	24%
<i>Poland</i>		3	3		36%	34%
<i>Portugal</i>		3	3		NA	NA
<i>Slovakia</i>		2	2		56%	44%
<i>Slovenia</i>	1	2	1		74%	20%
<i>Spain</i>		2	3	1	48%	28%
<i>Sweden</i>		4	2	1	NA	NA
<i>United Kingdom</i>	4		4	1	25%	24%
<i>EU15</i>					42%	31%
<i>EU25</i>					43%	32%

Source: EUROPEAN COMMISSION, 11TH REPORT ON THE IMPLEMENTATION OF THE TELECOMMUNICATIONS REGULATORY PACKAGE (2005).

expects to use. Typically, a contract between a host and an entrant involves non-linear price schedules, with payments flowing in both directions. The entrant might be compensated by the host if it brings new customers to the network, if it increases the total network traffic, or if it makes the use of the network more evenly divided throughout the day.

In principle, both parties can negotiate freely a mutually beneficial agreement, whereby the MNO concedes access to its network to the MVNO.⁷ However, some wonder whether MNOs will voluntarily negotiate agreements with MVNOs, since the services the latter provide compete with the MNOs' own retail services. The regulation on MVNOs varies greatly across EU member states. In countries like Denmark, Norway, and the Netherlands, MNOs with significant market power have open access obligations towards MVNOs. In other countries, there are no such regulatory obligations.

The literature on market foreclosure addresses the question of whether a vertically integrated firm can increase its profit by foreclosing the downstream market to rivals.⁸ As it is well-known, the monopolist owner of a bottleneck production factor, which is also present in the downstream retail market, may have the incentive and the ability to restrict access to the bottleneck production factor, in order to restrict competition in the downstream retail market.⁹ An example of this is a monopolist owner of a public switched telephone network, which may want to restrict access to its local loop in order to restrict competition on the markets of fixed telephony or broadband access to the Internet.

In mobile telephony, because MNOs are not monopolist providers of a network, there are at least three reasons to suspect that MNOs have different incentives than fixed telephony incumbents with respect to giving access to their networks. First, even if an MNO denies an entrant access to its network, there is no guarantee that the entrant will not obtain access elsewhere. Second, an MNO that hosts an MVNO shares the revenue loss caused by an entrant with other MNOs. This mitigates the negative impact that entry may have on the revenues of the host MNO. Third, if entry cannot be blocked, then it is probably better for each MNO to be the one that gives access to the entrant. This allows the host MNO to earn additional wholesale revenues that at least partially compensate the loss in retail revenues caused by the entrant. Altogether, this suggests that

7 Typically, each MVNO buys access from only one MNO, although an MNO may sell access to several MVNOs.

8 The case in which the upstream market is monopolized was reviewed by J. TIROLE, *THE THEORY OF INDUSTRIAL ORGANIZATION* 193-4 (MIT Press 1988). The case of oligopolistic vertical integration with an oligopolistic upstream market was analyzed by J. Ordober et al., *Equilibrium Vertical Foreclosure*, 80(1) *AM. ECON. REV.* 127-42 (1990).

9 See, e.g., W. Baumol & J. Sidak, *The Pricing of Inputs Sold to Competitors*, 11(1) *YALE J. ON REG.* 170-202 (1994); G. Biglaiser & P. DeGraba, *Downstream Integration by a Bottleneck Input Supplier whose Regulated Wholesale Prices Are above Costs*, 31(2) *RAND J. ECON.* 137-150 (2001); N. Economides, *The Incentive for non-Price Discrimination by an Input Monopolist*, 16 *INT'L J. OF INDUS. ORG.* 271-84 (1998); T. Krattenmaker & S. Salop, *Anticompetitive Exclusion: Raising Rivals' Costs to Achieve Power of Price*, 96 *YALE L.J.* 209-93 (1986); D. Sibley & D. Weisman, *Raising Rivals' Costs: The Entry of an Upstream Monopolist into Downstream Markets*, 10 *INFO. ECON. & POL'Y* 451-70 (1998); and D. Weisman, *Access Pricing and Exclusionary Behavior*, 72 *ECON. LETTERS* 121-26 (2001). For a dissenting view, see R. Bork, *Vertical Integration and the Sherman Act: The Legal History of an Economic Misconception*, 22 *U. CHI. L. REV.* 157-201 (1954).

MNOs may face a prisoner's dilemma. They would be better off if entry did not occur. However, each has individual incentives to rush to be the one who gives access to the entrant.¹⁰ This does not mean that such voluntary agreements should necessarily occur. Incumbents may still non-cooperatively foreclose the market or collude to foreclose the market.

B. RAISING RIVAL'S COSTS

Once entry occurs, perhaps due to open access regulation, an upstream monopolist that participates in the downstream market may try to raise the costs of the

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downstream rivals, for instance by discriminatory quality degradation. By doing so it might induce the downstream rivals to contract their market share, leaving a larger share of downstream oligopoly profits for its downstream subsidiary.¹¹ In the case of MVNOs, the possibility

of quality degradation may be mitigated by the competition between host MNOs. Following a raising rival's cost strategy, the host should consider that the entrant has other alternatives. To the extent that if entry occurs it is better to be the host, the other MNOs will be eager to take its place. Hence, competition between possible hosts should ensure high-quality access service.

IV. Impact of Entry on Prices

Entry by an MVNO differs from entry by an MNO. An MVNO is simultaneously a rival and a customer of the host MNO. This affects the host's pricing strategy.

We make the helpful simplifying assumption that the host MNO is paid a constant access price for each of the MVNO's customers. Note that if the access price is set above marginal cost, and if the entrant is otherwise equally efficient, which we assume, then the entrant has higher costs than the incumbents.

Suppose that after the entry of an MVNO, all MNOs set the prices that prevailed before entry. If most of the consumers are already served, entry by an

10 In some cases, the host MNO's may even be better off with entry. The MVNO may attract many new customers to the host network, because it has a comprehensive retail network, such as Virgin, 7-Eleven, or Tesco, or because it has a global brand, such as Disney.

11 Salop and Scheffman (1987) addressed the issue of whether an upstream monopolist participating in the downstream market would raise rivals' costs. Economides (1998) showed that an upstream monopolist that is also present in the downstream market has the incentive to raise costs of its downstream rivals through discriminatory quality degradation, until they are driven out of the market. Vickers (1995) showed that an upstream monopolist present in a downstream oligopolistic market, and regulated under asymmetric information, also has incentives to raise rivals' costs. See J. Vickers, *Competition and Regulation in Vertically Related Markets*, 62(1) REV. ECON. STUD. 1-17 (1995); Economides, *supra* note 9; and, S. Salop & D. Scheffman, *Cost-Raising Strategies*, 36(1) J. INDUS. ECON. 19-34 (1987).

MVNO necessarily causes some consumers to switch from the firm they originally patronized to the entrant. If the host MNO loses a significant number of consumers to the entrant, it has an incentive to decrease its price. We call this downward pressure on the prices of the incumbents caused by the entrant stealing customers from them the retail competition effect. There is another effect that is exclusive to the host. If a host decreases its retail price, it gains customers. However, it also decreases the demand of the entrant, and therefore its wholesale revenue. We call this upward pressure on the host's retail price caused by the fact that decreasing its retail price reduces its wholesale revenues the wholesale effect.

The wholesale effect and the retail competition effect have opposing signs. This implies that the impact on prices of the entry of an MVNO is potentially ambiguous. It may cause a price reduction, as one would expect, but it may also lead to higher prices.

The price of the host is more likely to increase when the wholesale effect is large and the retail competition effect is small. This happens when the access price is high, or when the entrant MVNO captures a large fraction of the consumers that switch providers after an increase in the host's price.

If the access price is high, the entrant has higher costs than the incumbents. As a consequence, the entrant may charge a higher price than the prices the incumbents charged prior to entry. Consumers may be, nevertheless, better off due to the increase in variety that the entry brings about. Instead of paying a lower price for a product that they do not have a strong preference for, they pay a bit more for a product that is ideally suited to them and that they get a higher surplus from.

The prices of the non-host incumbents are likely to move in the same direction as the demand for their services. If the wholesale effect is large and the access price is high, the prices of the non-host incumbents are more likely to rise after entry. The reason is that the eventual increase in the host's price and the high price set by the entrant mean that non-host MNOs will have a larger demand, particularly those selling services similar to the host's.

V. Entrants' Product Differentiation Decision

First we discuss the entrant's perspective regarding its product differentiation decision. Suppose that the host MNO and an MVNO have been matched, and that the constant access price per consumer has been set above marginal cost. Before making its product differentiation decision, the entrant should anticipate the implications that this choice will have on price competition.¹² If the entrant chooses to offer a product very similar to the products of any of the incumbent's,

¹² We are assuming that the prices decisions can be changed more rapidly than the product characteristics, brand positioning or consumer perception, which are assumed to be fixed for a longer period.

the consumer's choice will be essentially based on price, and the firm with the lowest price will succeed in capturing a substantial number of consumers. The ensuing price competition between the entrant and the incumbent in question will result in lower retail prices, and both firms will end up with lower profits. Consequently, the entrant should try to offer a product as differentiated as possible from those of the other incumbents.

However, the incumbents do not have symmetric incentives in terms of pricing, because one of them is the host. As mentioned in Section IV, among the incumbents, the host has the lowest incentives to cut its price after entry due to the wholesale effect. This means that it would be less damaging for the profit of the entrant to offer a product that consumers view as a closer substitute to the

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product of the host than to the products of the other MNOs. Thus, anticipating the different price responses of the host and of the other MNOs and holding everything else constant and symmetric among incumbents, the entrant should reduce the level of differentiation of its product compared to the product of the host and increase the level of differentiation of its product compared to the product of the other incumbents. Recall that the higher the access price, the stronger the wholesale effect. Hence, the higher the access price, the closer the entrant should position its product to the host's. However, it is not in the entrant's interest to offer a product identical to the product of the host, because a strong price competition would emerge.

We now turn to the host's perspective regarding the entrant's product differentiation decision. The host benefits from entry because it allows it to capture, through the entrant, subscribers that originally patronized the other incumbents. It might seem that the best situation for the host is one in which the entrant offers a product that competes closely with the products of the rival MNOs, but not with the product of the host. However, this is not necessarily true. Given retail prices, if the entrant offers a service that competes closely with the products of the rival MNOs, the wholesale revenues of the host do not cannibalize its retail subscriber base, and hence do not reduce its retail profits. Additionally, with an access price above marginal cost, the wholesale profits will be large. In other words, given retail prices, it is in the host's interest that the entrant offers a product that competes more closely with the products of the other MNOs than with its own product. However, the relative positioning of the product of the entrant affects prices. If the access price is high, the entrant has a severe cost disadvantage compared with the incumbents. Under these circumstances, offering a product that competes closely with those provided by other MNOs and therefore competing essentially on price while having a cost disadvantage, will lead to low revenues for the entrant and, thus, to low wholesale revenues for the host. This is why both the host and the entrant may prefer for the entrant not to offer a product that competes closely with rival MNOs.

VI. Conclusion

Mobile telephony is an oligopolistic market, where the number of competitors was initially limited to the number of licenses assigned by sectorial regulators. MVNOs allow any eventual entry limitations caused by the scarcity of the radio-electric spectrum to be overcome and free-entry equilibrium to be attained.

Additionally, the mobile telephony industry is one of the few in which more than one firm can provide access to a bottleneck input: a license to use the radio-electric spectrum. Incumbents may still foreclose the market. However, competition between them may lead the incumbents to voluntarily concede access to their networks.

Entry by MVNOs may cause prices to decrease. However, entry may also lead to higher prices for the entrant and the host. This is due to the wholesale effect. A host MNO makes both retail and wholesale profits. This gives the host an incentive to raise its retail price. Due to the same effect, and in order to mitigate post-entry price competition, the entrant should seek to position its product such that the host is its closest competitor. ▼