

A critical review of the "ladder of investment" approach*

Marc BOURREAU[†], Pinar DOĞAN[‡] and Matthieu MANANT[§]

October 23, 2009

Abstract

The "ladder of investment" is a regulatory approach proposed by Martin Cave (2006), which has been widely embraced by national regulatory authorities in the European telecommunications sector. The approach entails providing entrants, successively, with different levels of access - the "rungs" of the investment ladder, while inducing them to climb the ladder by setting an access charge that increases over time or by withdrawing access obligations after some pre-determined date (i.e., by setting sunset clauses). Proponents of the ladder of investment approach claim that such regulatory measures would make service-based entry and facility-based entry complements—albeit they have been traditionally viewed as substitutes—in promoting competition. The regulators, thus, have shown a strong interest in this approach. In this paper, we provide a critical review of the ladder of investment approach by setting out its two underlying assumptions and discussing their validity with references to the related industrial organization literature.

Keywords: Ladder of investment; Facility-based competition; Telecommunications.

JEL codes: L51; L96.

*This research received financial support from France Telecom. The views expressed in this paper are those of the authors and do not necessarily reflect those of France Telecom. We thank Marc Lebourges, Jérôme Pouyet, Nicolas Schutz and Thomas Tregouët for their comments and suggestions. We also thank the audiences at the European Telecommunications Network Operators workshop of 25 March 2009 and at the Centre for European Policy Studies Task Force meeting of 5 May 2009. Finally, we thank Katie Naeve for her editorial assistance.

[†]Telecom ParisTech, Department of Economics and Social Sciences, and CREST-LEI, Paris. Email: marc.bourreau@telecom-paristech.fr.

[‡]Harvard Kennedy School, Harvard University, Cambridge, MA. Email: Pinar_Dogan@hks.harvard.edu.

[§]Université Paris Sud XI. Email: matthieu.manant@u-psud.fr.

1 Introduction

According to the traditional view, service-based entry and facility-based entry are two alternative ways to promote competition in the telecommunications sector. The rationale is that, once entrants rely on the incumbent's infrastructure to provide their services, the resulting profits would destroy any incentive to build an alternative infrastructure. Regulators therefore face a trade-off: while service-based entry promotes competition in the short-run, the full benefits of competition would be achieved in the longer-run only with facility-based entry to the market.

In 2001, with a report to the European Commission, Martin Cave proposed an original regulatory approach to solve this dilemma: the ladder of investment (LOI).¹ The basic principle of the LOI approach consists of gradually offering potential entrants different levels of access to the incumbent's network. The entrants begin with acquiring access at a level which requires little investment to provide their services (e.g., resale level). Then, as the entrants' customer bases grow, they are encouraged to invest in the network elements necessary to bypass this first level of access. The entrants then climb the investment ladder, and acquire access at the next level, and so on.

Since its introduction, the LOI approach has rapidly gained a strong influence in the European telecommunications policy arena. For instance, in its 2006 annual report, the French regulator ARCEP cited the LOI as a key element of its regulatory policy since 2004.² In 2005, the European Regulators Group (ERG) also used this approach to analyze the development of the broadband market in 13 European countries. The ERG argued that the approach was implemented in most of the EU countries, and that there has been a [positive] relationship between the implementation of the LOI approach and the pace of development of the broadband market (ERG, 2005).³

Two prominent professional organizations in the sector, the European Competitive Telecommunications Association (ECTA) and European Telecommunications Network Operators (ETNO), have expressed opposing views on the LOI approach. ECTA, which represents new entrants in the sector, shares the vision of the ERG that the LOI has contributed to the development of competition in

¹Cave's report was subsequently revised and published under the title "Remedies for Broadband Services" (2004), he then detailed his concept in an article, "Encouraging infrastructure competition via the ladder of investment" (Cave, 2006). Some of the ideas were also developed in earlier articles, Cave and Prosperetti (2001) and Cave and Vogelsang (2003).

²According to ARCEP, "the development of competition in France since 1998 is a good illustration of the theory of the ladder of investment". See ARCEP (2007), p. 36.

³ERG (2005) writes: "[the ladder of investment] explains recent developments in European broadband markets quite well and can serve as a good regulatory model" (ERG, 2005, p. 1). We found the first explicit mention of the ladder of investment by the ERG in a document published one year earlier, in "ERG Remedies" (ERG, 2004a).

the broadband market in some European countries.⁴ ETNO, which represents the incumbent firms, questions the effectiveness of the LOI and points at its weak theoretical foundations and the lack of supporting empirical evidence.⁵ According to ETNO, the LOI approach would actually delay investment by new entrants and maintain a fragmented and inefficient market structure. ETNO does not, however, provide any theoretical or empirical foundations for their claims either.

A sound criticism of the LOI approach comes from Oldale and Padilla (2004), who set out four propositions that should hold altogether for the LOI approach to succeed: (1) facility-based competition is the only means to sustainable competition in telecommunications, (2) service-based competition is a necessary prerequisite for infrastructure competition, (3) service-based competition is only possible through a regulated infrastructure, and (4) the trade-off between service-based competition and facility-based competition is reconciled by the "ladder of investment." According to Oldale and Padilla, the plausibility of these propositions boils down to the question of whether the regulators have the information, time, and competence to micro-manage the evolution of a market from service-based to facility-based.

In this paper, we do not argue whether facility-based competition is the only form of competition that can be self-sustainable,⁶ we rather begin with the presumption that the realization of facility-based competition is indeed desirable from the social welfare point of view. Also, we do not view Propositions (2) and (3) of Oldale and Padilla as underlying assumptions of the LOI approach. According to our take on it, the LOI approach does not claim service-based competition as a necessary prerequisite for facility-based competition. Instead, it claims that service-based competition (through the implementation of the LOI approach) would be a *sufficient condition* to achieve facility-based competition -though not *necessary*.⁷ Additionally, even if service-based competition can be achieved in the absence of regulation, there would still be a role for the LOI approach, as it involves the regulatory task of "burning up" the rungs (neutralizing the replacement effect) as much as it involves placing higher rungs on the investment ladder (providing the entrants with higher access levels).⁸ Finally, rephrasing Proposition (4) of Oldale and Padilla confers the ultimate aim of the LOI approach: reconciling the trade-off between service-based competition and facility-based

⁴See, for example, ECTA (2006).

⁵See, for example, ETNO (2005).

⁶This is Proposition (1) in Oldale and Padilla (2004).

⁷In the absence of service-based competition, one could still expect facility-based entry if, for example, costs of investing in alternative infrastructures become sufficiently low, or if the facility-based entry is heavily subsidized.

⁸Oldale and Padilla implicitly put an emphasis on the latter task. However, even if the regulators were not effectively in charge of the this task (say, because the incumbent firms had private incentives to provide access to their infrastructure), the former task would still be key in achieving facility-based competition.

competition, i.e., ensuring that favorable conditions for the former does not hinder the latter.

In this paper, we lay out two key assumptions of the underlying mechanism of the LOI approach⁹: i) service-based competition serves as a stepping stone to facility-based entry if the replacement effect is neutralized, and ii) the regulator has the instruments to neutralize the replacement effect. Note that these assumptions are crucial even in the absence of any problems regarding *implementation*. In other words, even in a "perfect" world where the regulators have complete information and capacity to take necessary decisions and can overcome any commitment issues they might face in implementing the LOI approach, the approach would not achieve its end unless these two assumptions are not valid. We discuss the validity of these assumptions with references to the related industrial organization literature.

The remainder of the paper is organized as follows. In Section 2 we begin by describing the LOI approach. In Section 3, we unfold the two key assumptions of the LOI approach and briefly review the related empirical literature. In Section 4 we touch on the constraints that might limit the implementation of LOI and also discuss other related concerns. Finally, we conclude.

2 The Ladder of Investment

In a nutshell, the ladder of investment can be defined as *a regulatory approach on one-way access which ensures that service-based entry and facility-based entry are complements in promoting competition*. That is, by adopting the LOI approach, a regulator reconciles the trade-off between promoting two forms of competition, and hence, short-term gains from service-based competition can be realized without impeding facility-based entry in the longer term. It is important to note that the LOI approach put forth by Cave (2006) does not presume that service-based competition is a stepping stone to facility-based entry per se, rather, it describes how this could be achieved with regulation.¹⁰ Neither does it claim that the approach itself is the unique way to achieve facility-based competition.

In line with most regulators in industrialized countries, Cave (2006) regards facility-based competition as the only means to achieve sustainable competition.¹¹ Facility-based competition creates

⁹We focus on Cave's original description of the approach. As we discuss later, some policy makers have adopted a modified version of the LOI approach proposed by Cave.

¹⁰As we discuss in Section 3, this is a point which seems to be overlooked in some of the empirical studies that test the validity of the LOI approach.

¹¹See Oldale and Padilla (2004) for a discussion on this: Among others, they cite ERG and the former Commissioner Mario Monti, both of whom argue that facility-based competition is the only form of competition that is self-sustainable.

a superior potential for service and product innovations than does service-based competition, where entrant firms rely on the incumbent's infrastructure in providing their services.¹² Perhaps, more importantly, as (almost) each operator obtains complete control over the infrastructure it uses, facility-based competition is also expected to lead to a partial -if not complete- deregulation of the sector. There is also empirical support of the positive impact of facility-based entry on competitive outcomes, often measured by the penetration rate, in the context of the broadband market. A number of studies show that facility-based competition between a DSL network and a cable network leads to a higher penetration than service-based competition.¹³

Nevertheless, facility-based competition is unlikely to develop very rapidly due to high network costs and/or the fact that telecommunications markets are by and large dominated by historical operators. Therefore, some form of "transitory entry assistance" might be necessary.¹⁴ Service-based competition can play this role,¹⁵ allowing new entrants to obtain access to the incumbent's network, which reduces the entry costs and therefore, competition develops more quickly.

The potential problem with promoting competition with access regulation is that once entrants enjoy profits from service-based competition, their incentives to invest in their own infrastructures may be hindered, in particular, if access prices are set too low. This is because profits obtained under service-based competition represent an opportunity cost to facility-based entry, which creates a so-called "replacement effect"¹⁶ that has been pointed out by many studies.¹⁷ Cave (2006) himself also acknowledges this potential problem: "if comprehensive access products are too cheap, competitive investment will not materialize," as he puts it. Therefore, two forms of entry end up as substitutes in promoting competition (i.e., favorable conditions for service-based entry hinders facility-based entry), and the regulator is then forced to choose whether to promote service-based competition *or* facility-based competition.

¹²For instance, Oftel (2001) writes: "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."

¹³See Aron and Burnstein (2003) for the evidence in the US, and Distaso et al. (2006) and Höffler (2007) for the EU.

¹⁴This argument was heard in the US too. According to the FCC: "[Congress] recognized implicitly that the purchase of unbundled network elements would, at least in some situations, serve as a transitional arrangement until fledging competitors could develop a customer base and complete the construction of their own networks" (FCC, 1999, §6).

¹⁵As we mentioned above, according to the LOI approach, service-based competition is just one way to achieve this goal. Alternatively, the government could, for example, subsidize entrants' investments in infrastructure to encourage facility-based competition.

¹⁶Originally, the replacement effect was first introduced by Arrow (1962) in the innovation literature. Everything else constant, a monopoly firm is argued to have lower incentives to invest in drastic innovations than a competitive firm, as it involves "replacing itself." See Tirole (1988).

¹⁷See Bourreau and Doğan (2005, 2006) and the references cited in these two articles. See also Hori and Mizuno (2006) and Varela and Hoernig (2007), who find a similar effect in investment races between ex-ante symmetric firms.

The LOI approach aims at solving this dilemma so that service-based competition can be promoted (and hence its benefits can be enjoyed) without hindering the incentives for facility-based entry. Even better, the implementation of the approach would promote facility-based entry.

With the LOI approach, new entrants are provided with transitory entry assistance, and they are incentivized to build their own networks in the medium or long run.¹⁸ With the transitory entry assistance, the regulator takes the necessary measures to ensure that any significant replacement effect resulting from service-based competition would be only transient. The regulator gives the entrant an initial "lift up" on the investment ladder by ensuring its access to the incumbent's infrastructure at reasonable terms, but then, to make sure that the entrant climbs up the ladder, the regulator gives it another lift up to the next rung. This second time, lifting up the entrant involves not only ensuring its access to the incumbent's infrastructure at a higher level, but also burning up the rung on which the entrant was standing (that is, neutralizing the replacement effect). The entrant would then make the necessary infrastructure investment to climb up to the next highest rung. The process continues until the entrant reaches the top of the ladder (i.e., until it by-passes all parts of the incumbent's infrastructure), after which point facility-based competition begins. As the entrant's investments take place progressively, i.e., are spread over time, facility-based entry is achieved without the entrant having to incur very high investment costs at once.

Typically, the first level of access to the incumbent's infrastructure is set at a level which requires the lowest investment by new entrants, e.g., resale. The terms of access are regulated to ensure that the phase of service-based competition begins and the entrants start building their customer bases. When the regulator deems by-passing this part of the incumbent's infrastructure economically feasible, it lifts up the entrant to the next rung.¹⁹

Note that, according to Cave's original LOI approach, regardless of the instrument is used to burn up the rungs, only one level of access to the incumbent's network is available to new entrants at any given time. The ERG, as well as many national regulators, have embraced a modified version of this original approach -one which ensures provision of access to the entrant at *multiple* levels at any given time.²⁰ According to the ERG, the coexistence of multiple levels of access is necessary due to the

¹⁸In the words of ERG: "The framework's concept of the ladder of investment links a pro-competitive regulation with investment which in turn is pushing broadband penetration, in other words a virtuous circle is created." (ERG, 2006).

¹⁹For broadband networks, for instance, the different rungs might signify access to the copper local loop and the incumbent's IP network.

²⁰ERG claims that "the more complete the chain of available access products is, the higher the competitive dynamic is (e.g. France, UK, Spain)" (ERG, 2005, p. 1). The French regulator ARCEP emphasizes the need to maintain multiple levels of access to help entrants have a national coverage (see: ARCEP (2007)). New entrants have also

presence of geographical differences in telecoms markets and to the fact that different levels of access may correspond to different business models or phases of market entry.²¹ The underlying difference between Cave's approach and the one which is widely adopted by regulators is fundamental, as the presence of multiple access levels may hinder the regulators' ability to lift up the entrant to higher rungs on the investment ladder. Furthermore, due to the potential price-squeezing practices, regulators should be diligent in their access price regulation, as consistency across different levels of access is now necessary. In the remainder of the paper we will focus on the original approach of the LOI as outlined by Cave (2006).²²

3 Two critical assumptions of the LOI approach

In our view, the mechanism underlying the LOI approach is based on two key assumptions, which are as follows

Assumption 1. *Service-based competition serves as a stepping stone to facility-based entry if the replacement effect is neutralized.*

Assumption 2. *The regulator has the instruments to neutralize the replacement effect.*

Note that unless both assumptions are satisfied, the LOI approach will most likely fail, even in the absence of any obstacles that might hinder its implementation. Below, we discuss these two assumptions.

3.1 The stepping-stone hypothesis

According to the first assumption of the LOI approach, in the absence of any (significant) replacement effects, service-based competition is a stepping-stone to facility-based entry. For this to be true, there must be benefits of competing on the basis of services that accrue in the longer term—upon the entrant's facility-based entry. Note that, even if the aforementioned benefits exist, service-based competition may not serve as a stepping-stone to facility-based entry, unless such benefits are relatively large compared to the replacement effect. This is why we consider the regulatory task of

argued in favor of multiple levels of access (see: ECTA (2006)).

²¹For example, for the broadband market, ERG (2004b) states: "[Bitstream access and local loop unbundling] may fit as different input products for different business models or for different phases of market entry."

²²We will, therefore, ignore some distinct aspects of the ERG's LOI approach, such as the problems of geographical coverage or of setting coherent prices between different levels of access.

neutralizing the replacement effect as a precondition to the stepping-stone hypothesis.

Two significant benefits that facility-based entrants may enjoy by engaging in service-based competition prior to their entry relate to (i) building a customer base and reputation, and (ii) resolution of uncertainty in the market conditions (e.g., demand, technology). The ERG (2004a) highlights both:

"Due to the high risk involved in investments with a high share of sunk costs, alternative operators are likely to follow a step-by-step approach, continuously expanding their customer base and infrastructure investments. The initial availability of the incumbent's infrastructure at low prices will make it easier for alternative operators to enter the market and develop a customer base. Equipped with a customer base, uncertainty is considerably reduced and the operator may then be ready to take further investments."

Moreover, the incumbent firms may have superior technologies (e.g., in production, marketing, etc.) due to their accumulated experience in the market over the years, and hence, without acquiring comparable experience, entrants might not find facility-based entry viable. Therefore, a phase of service-based competition can give entrants a chance to *invest in experience* before investing in their own physical infrastructure. Since the benefits of learning by doing accrue in the longer term, the phase of service-based competition may, indeed, serve as a stepping-stone to facility-based entry.

In the theoretical literature, the stepping stone argument has two slightly different readings. According to its first reading, having a service-based competition phase ensures facility-based competition, which would not emerge in the absence of such a phase. A set of studies with two-period competition models study how having service-based competition in the first period affects the incentives for facility-based entry in the subsequent period. According to its second reading, service-based competition accelerates facility-based entry, which otherwise would emerge at a later time. Studies that adopt competition models with an infinite horizon, study how the timing of facility-based entry can be influenced by a preceding phase of service-based competition.

Below, we refer to both sets of theoretical studies that touch on one of the two benefits that favors the stepping stone argument in the telecoms setting.

Progressive acquisition of market share and reputation Bourreau and Drouard (2009) provide a dynamic model, where the service-based entrant gradually acquires a market share. The progressive acquisition of its market share can be explained by increasing consumer awareness of the entrant's services over time. Alternatively, the entrant's quality of service may initially be perceived

as inferior to that of the incumbent, but consumers may gain a better assessment of it over time. The entrant could also build reputation over time, which would increase the consumers' willingness to pay for its services.

In this setting, as the entrant gradually builds a customer base during the phase of service-based competition, this phase can serve as a stepping stone to facility-based entry, despite the replacement effect it creates. However, Bourreau and Drouard show that the phase of service-based competition does not necessarily accelerate the facility-based entry of the entrant. This is because the entrant might find it profitable to prolong the phase of service-based competition to accumulate a larger customer base. The profitability of this strategy depends on whether facility-based entry would occur earlier or later without a phase of service-base competition. The authors show that having service-based competition prior to facility-based competition accelerates (slows down) facility-based entry if the cost of building a new infrastructure declines sufficiently rapidly (slowly).

Avenali et al (2009) consider a two-period setting, where the cost of building infrastructure is sufficiently high and facility-based entry is not feasible unless the entrant competes on the basis of services in the first period and builds reputation on its quality of service. In other words, the authors consider a setting where service-based competition in the first period is a prerequisite for facility-based entry. They then study the impact of access pricing on the entrant's incentive to invest in its own infrastructure in the second period, and show that an access price that increases over time is key to achieve facility-based entry. Therefore, although building a reputation through a phase of service-based competition may be a necessary condition (as assumed by Avenali et al at the outset), it may not be sufficient to ensure that service-based competition serves as a stepping stone to facility-based entry. As we noted earlier, the replacement effect should be restrained -if not neutralized- to make sure that facility-based competition emerges.²³ Having said that, as the analysis by Bourreau and Drouard shows, neutralizing the replacement effect, alone, might not be sufficient to bring about facility-based entry at the socially desirable date.

Resolution of uncertainty Prior to entering the market, entrants might face some uncertainty, for example, about the state of the demand or their own costs,²⁴ which make the returns to their

²³One potential drawback of two-period models, is that they cannot address the question of how the *timing* of the facility-based entry can be effected by the terms of service-based competition.

²⁴Vareda (2007), for example, studies a two-period model, where the entrant learns about the state of demand once it enters in the market. Therefore, service-based competition in the first period resolves the uncertainty of demand, after which the entrant decides whether or not to build its facility. Since Vareda's focus is on the asymmetric information between the service-based entrant and the regulator, we do not review the paper in this section.

investments highly uncertain.

Schutz and Tregouët (2008) consider a two-period model with an entrant, who is uncertain about its marginal cost and who can enter the market in either with service-based competition or facility-based competition. The uncertainty is resolved with service-based competition in the first period, after which the entrant decides whether or not to build its own facility. When facility-based entry is viable (i.e., if the cost of building infrastructure is not too high), the resolution of such an uncertainty can be either good or bad news for infrastructure investments. If the entrant obtains favorable information on its marginal cost, the service-based competition serves as a stepping stone to facility-based competition. Otherwise, facility-based entry may be hindered by having a preliminary phase of service-based competition. That is, an entrant who would build its own facility in the absence of service based competition (that is, in the absence of "bad news" of its cost structure), would remain as a service-based competitor in the second period. Note that, however, bad news for the entrant, may be good news for the society, as facility-based entry by relatively inefficient firms would be prevented as service-based entry resolves the uncertainty.

3.2 Instruments to neutralize the replacement effect

As we mentioned earlier, lifting up the entrants to the next (higher) rung requires (i) the existence of such next rung to step on (i.e., access to the incumbent's infrastructure at a higher level at reasonable terms), and (ii) burning up the preceding rung on the ladder (i.e., neutralizing the replacement effect created by the current level of access to the incumbent's facility), simultaneously.²⁵ Since regulators can achieve the former task by standard means of access regulation, we focus on the latter task, and discuss whether regulators have the necessary tools to accomplish it.

Cave proposes two alternatives tools to neutralize the replacement effect: (i) setting an access charge that increases over time, which *gradually* burns up the rung (or reduces the replacement effect over time), and (ii) setting a sunset clause at the given access level, that is, by committing to deregulate the access to the given rung after a pre-determined date, after which the rung burns up *immediately*. Different studies favor one instrument over the other.²⁶

²⁵In Cave's words: "... entrants are encouraged to climb the ladder driven both by the attractiveness of the rungs above (relative to staying where they are) and by fear that the rung on which they are currently standing will be less comfortable." See Cave (2006).

²⁶For example, Hausman and Sidak (2005) recommend regulators to allow the prices (for fixed unbundled elements) to increase over time in order to achieve transition to facility-based competition. Whereas Jorde, Sidak and Teece (2000) suggest that mandatory unbundling should sunset after the passage of two years or upon the entry of a facility-based competitor.

Note that these instruments are typically discussed in the context of broadband markets, where there are significant asymmetries between the incumbent, who owns an infrastructure, and the entrant, who initially does not own one. Some markets, however, display a more symmetric structure, in that neither of the firms initially own an infrastructure (for example, next generation access networks). In this section we focus on the asymmetric markets, and defer the discussion on symmetric markets to Section 4.

Access price regulation Cave argues that one way to incentivize the entrants to climb to the next rung is to increase the access charge of the current access level over time.²⁷ Indeed, the impact of access charges on the entrants' investment decisions is well-recognized in the telecommunications literature.²⁸ The conventional wisdom is that the higher the access price (i.e., the lower the service-based profits of the entrant are), the greater the incentives for an entrant to invest in its own network, as the opportunity cost of facility-based entry decreases with a higher access charge.

According to Sappington (2005), this general view, i.e., the impact of access charges on make-or-buy decisions of entrants, is rather a presumption. In a Hotelling setting, he shows that the access price has no influence on the make or buy decision of an entrant, which is always efficient,²⁹ regardless of the level of access price. What leads to this somewhat striking result is the quasi-inelastic feature of the demand in the Hotelling model: if the incumbent gains one customer in the retail market (under service-based competition), it loses exactly one customer in the wholesale market. Therefore, the perceived marginal costs of the incumbent and the entrant are equal to the access charge plus their downstream cost. Since equilibrium profits do not depend on the perceived marginal costs, they do not depend on the access price either. Consequently, the incentives for the entrant to build its own infrastructure do not depend on the access price.

Gayle and Weisman (2007) argue that Sappington's result does not hold if one adopts different types of competition models than Hotelling (e.g., Bertrand competition with vertical differentiation, or Cournot competition). Although this is a valid point, the take away from Sappington's paper is that the (positive) relationship between the access charge and the make-or-buy decisions should not be taken for granted.

²⁷There is also a literature on the impact of access prices on the incumbents' investment incentives which we do not review in this paper. See Section 3.2 of Cambini and Jiang (2009) for a recent review.

²⁸E.g., see Gruber (2007). For a general discussion of the relation between access pricing and investment, see also Cave and Vogelsang (2003), Valletti (2003) and Guthrie (2006).

²⁹That is, the entrant decides to bypass the incumbent's network if and only if it can produce the upstream input at a lower cost than the incumbent.

Both Sappington (2005) and Gayle and Weisman (2007) study investment incentives of the entrants in a static framework. In a dynamic setting, Bourreau and Doğan (2005) have shown that the access charge may influence the facility-based entry date of the entrant. Therefore, when the regulator sets the access charge, it faces a trade-off: on the one hand, a high (low) access charge speeds up (slows down) facility-based entry, but it also reduces (increases) the consumer surplus in the phase of service-based competition. Bourreau and Doğan (2006) propose a formal model to analyze the effect of service-based competition on facility-based entry, and show that an access charge increasing over time can resolve this trade-off.³⁰ At the social optimum, the regulator sets the access fee that maximizes the welfare flows until the optimal date of investment; from that date on, the regulator sets an access charge high enough or, equivalently, bans access to the incumbent’s network, so that the investment takes place.

In a more recent paper, Avenali et al. (2009) use a two-period model and also show that an access charge that increases over time can be critical to entrants’ incentives to invest in alternative infrastructures. Different than Bourreau and Doğan, they assume that the ability of the entrant to engage in facility-based competition depends on the phase of service-based competition, during which the entrant builds its reputation. They also consider sequential entry, and argue that the access price should not only depend on time but also on the entry period to ensure that each entrant is provided with the same access price schedule.

Although there are no other theoretical studies that deal with this question, those few that exist support Cave’s suggestion that an access price that increases over time, may indeed burn up the rung in question (i.e., neutralize the replacement effect) over time.

Sunset clauses A sunset clause is a predetermined deadline after which access to the incumbent’s network will no longer be regulated. The main purpose of a sunset clause is to make service-based competition less attractive for new entrants after a certain period of time (set by the sunset clause), and hence, to give them the incentives to build their own infrastructure. This mechanism implicitly assumes that with the deregulation of access, the incumbent would set a higher commercial rate—or would even deny access by setting a prohibitive access price—and hence, the entrants would build their own infrastructures.

Bourreau and Doğan (2006) show that sunset clauses are ineffective if the competition between

³⁰Bourreau and Doğan (2006) propose a formal model of investment with a vertically-integrated operator and an entrant, in which the investment cost decreases over time, and where the incumbent or the regulator can commit to a time-dependent access charge.

the incumbent and the entrant is more intense under facility-based competition than under service-based competition. The idea is that if facility-based entry represents a threat for the incumbent, in the absence of access regulation (or upon removal of it after the sunset) the incumbent provides the entrant with favorable conditions for access—as opposed to setting too high a price for it. By doing so, the incumbent increases the entrant’s opportunity cost of building an alternative infrastructure, and hence retards facility-based entry. In a similar vein, Avenali et al (2009) also show that a sunset clause dilutes the investment incentives of the entrant, and hence, is counterproductive.

Implementation of sunset clauses also raise a problem of commitment, which we discuss in Section 4.

Banning access? As we mentioned above, Bourreau and Doğan (2006) argue that the regulator could ban access to the incumbent’s network (or set too high a price for it) after the desired date for facility-based entry, instead of committing to remove regulation at that date. Such a regulatory strategy will be socially desirable when the entrants do not have the incentives to climb up the ladder,³¹ as such a ban would indeed burn up the rung in question and force entrants to climb up to the next rung on the ladder. Having said that, banning access to the incumbent’s infrastructure may not be practical.³² Avenali et al. (2009) also point out that this strategy is not very realistic.

3.3 Empirical evidence

Testing the validity of the LOI empirically is very challenging, mainly because of the imperfections in its implementation. As we have been emphasizing in the paper so far, the approach requires regulators to neutralize the replacement effect to the extent that service-based competition serves as a stepping stone to facility-based competition. Also, as Cambini and Jiang (2009) put it, the lack of data at the local exchange level does not permit one to attain empirical estimates of the evolution of different modes of entry over time. An ideal test of the LOI approach would both use micro-data at the local exchange level and focus on countries where access regulation (at the very least) resembles that laid out by the LOI approach. To our knowledge, there is no study that meets both criteria.

A number of studies look at the relationship between the two modes of entry, and reject the stepping stone hypothesis. For example, Hausmann and Sidak (2004) focus on five countries, the

³¹See Bourreau and Doğan (2006) for the analysis in an asymmetric framework with one vertically-integrated firm (the incumbent) and one pure downstream firm (the entrant). Vareda and Hoernig (2007) propose a similar analysis in a symmetric setting with two ex-ante identical firms.

³²Perhaps, an irony here is that meeting the long term target of deregulation (via encouraging facility-based competition) would involve a very heavy-handed regulation in the short-term.

US, the UK, New Zealand, Canada and Germany (from 1993 to 2003), and test whether entrants migrate progressively towards facility-based competition. They conclude that there is no evidence of such a migration, and hence no evidence for the LOI hypothesis. Hazlett and Bazelon (2005) use data from US states (from December 1999 to December 2004), and reject the stepping stone hypothesis as they do not find evidence that regulated unbundled access leads to facility-based competition.³³ Crandall and Sidak (2007) use data from 15 European countries (from 2002 to September 2006), and test whether the ratio of LLU-based lines to the total number of new entrants' service-based lines increases over time.³⁴ They find that this is the case in only nine countries out of fifteen during this period. Additionally, they find a crossover point between bitstream access and LLU during the period for only five countries out of these nine.³⁵ They then conduct a case study on these five countries, and conclude that there is weak or no evidence of a LOI.

In a more recent study, Friederiszick et al (2008) use firm-level data and find that for 180 telecom firms in 25 European countries (from 1997 to 2006) pro-entry regulation has discouraged infrastructure investments by the entrants in the fixed-line segment.³⁶ Similarly, Wallsten and Hausladen (2009) also find a negative impact of unbundling obligations on new infrastructure investments in 27 European countries (from 2002 to 2007)

While reviewing these results, it is important to keep in mind that the LOI approach does not claim that service-based entry and facility-based entry are complements in promoting competition, per se. That is, it does not claim that favorable terms of service-based entry would stimulate facility-based entry. It rather claims that implementing the LOI approach can achieve this. The stepping-stone hypothesis underlying the LLU approach entails the neutralization of the replacement effect created by service-based competition, and it is not clear if the approach was implemented in any of the countries in the aforementioned studies. Hence, our takeaway from them is that the perceived benefits of service-based competition that may accrue upon the entrant's facility-based entry are less pronounced relative to the replacement effects it creates.

A different set of studies look at the relationship between access prices and facility-based invest-

³³They use the number of facility-based lines as the dependent variable and find that the lagged values of the number of service-based lines have an ambiguous effect; there is no effect of service-based lines one period earlier, a negative effect for the number of lines two periods earlier, and finally a positive effect for the number of lines three periods earlier lags. It seems difficult to interpret these ambiguous results.

³⁴They do not take into account facility-based lines.

³⁵The crossover point is defined as the point in time where the share of bitstream access becomes lower than the share of LLU-based lines.

³⁶However, Friederiszick et al. (2008) measure entry regulation with a rather general regulatory index (the Plaut index).

ments. For example, Crandall, Ingraham and Singer (2004) show that in the US (from 2000 to 2003) service-based competition through mandatory unbundling decreases facility-based competition, and that the growth of facility-based lines were higher in the states where access prices were higher relative to facility-based investments. Waverman et al. (2007) use data on LLU prices and new access lines for new entrants in 27 European countries (from 2002 to 2006), and show that a 10% reduction in the LLU prices leads to an 18% decrease in the share of new entrants' facility-based lines (cable, fiber, WLL, etc.). These studies can be viewed as support for access price increases over time as an effective tool to mitigate the replacement effect, and hence, as a validation of the second assumption of the LOI approach we have laid out in this paper.

Finally, Distaso et al. (2008) test whether entrants climb the rungs of the LOI over time in 12 European countries (from January 2005 to July 2007). More specifically, they test whether entrants migrate first from bitstream access (BA) or resale offers to LLU or shared access offers, and then to the development of their own access network. In parallel, they evaluate whether the change in access prices over time is consistent with the LOI, that is, whether the ratio of BA prices to LLU prices increases over time. Their graphical results suggest that in only two countries, France and Spain there is a migration towards higher rungs of the ladder associated with increasing access charges over time at lower rungs of the ladder.

4 Implementation of the LOI approach

In the previous Section, we focused on the underlying mechanism of the LOI approach and assumed away any constraints the regulator might face in its implementation. In this Section, we will discuss two major concerns that have been raised in the implementation of the approach: i) heavy informational requirements, and ii) lack of credible commitments. We also touch on two other concerns related to the implementation of the LOI, namely, the issues of "late" entrants, and the applicability of the LOI approach to symmetric networks such as next generation access networks.

Cave (2006) proposes a practical method for setting up the LOI,³⁷ which can be summarized as follows. Before setting up the LOI, the regulator should determine the degree of replicability of each network element. According to Cave, there are three types of network elements: network elements that are easy to replicate, non-replicable network elements and network elements that

³⁷Gallo and Pontarollo (2005) argue that shedding light on operational concerns has been a key factor which helped to attract the interest of European regulators to the LOI approach.

belong to an intermediate category. The implementation of the LOI concerns the last category.³⁸ After identifying the replicable elements of the network, the regulator can then implement the 6-step method of the LOI, which involves, in particular, determining the different rungs of the ladder and deciding on the regulatory instruments to entice entrants to climb the ladder.³⁹

Although the last step of Cave's method relates to the issue of credibility, the method implicitly assumes that regulators have the necessary information to follow the proposed steps.

4.1 Information

Oldale and Padilla (2004) provide an elaborate discussion on this major concern. They argue that the LOI approach requires regulators to micro-manage the industry, which in turn requires a considerable amount of information, time, and expertise. Therefore, regulators might find it very difficult to decide on the "right sequence" of rungs of the investment ladder.

In addition to the standard problems related to the asymmetric information between the regulator and the regulated firm, there might be problems due to the asymmetric information between the regulators and the entrants, who enjoy transitional entry assistance with the LOI approach.

To our knowledge, the only study which formally raises this concern is by Vareda (2007). Vareda considers a two-period model, where the service-based entrant, who has a superior information on the state of the demand, can manipulate the regulator to obtain favorable access prices. This would in turn, make the entrant reluctant to build its own infrastructure. The regulator, who is uncertain about the demand, aims at setting an access price scheme that promotes service-based competition in both periods if facility-based entry is not viable (which is the case if the state of demand is low in the paper). It also aims at setting one that ensures service-based competition occurs only in the first period (followed by facility-based entry in the second period) if facility-based entry is viable. In this second-best world, access price in the first period should guarantee realization of service-based competition during that period. The access price in the second period can be conditioned on the market share that is captured by the entrant in the first period, which is only an imperfect signal of the state of demand⁴⁰. It turns out that the second-best access scheme involves setting a lower price (than the first-best) in the first period, and a higher price in the second period conditional on

³⁸Note that the replicability of a network element may change over time if demand or costs also change.

³⁹See Cave (2006) for the detailed discussion on these six steps.

⁴⁰This is because when the demand is high, the entrant might find it profitable to "shirk" in the first period, as obtaining a low customer base in this period might signal to the regulator that the demand is low. In turn, the regulator would set a low access charge in the second period, from which the entrant would benefit, if it remains a service-based competitor.

a low market share in the first period. By using such an access scheme, the regulator increases the cost of shirking in the first period and decreases the benefit of shirking in the second.

One important take-away from Vareda's paper is that asymmetric information between the service-based entrants and the regulator (e.g., on the demand for entrants' services) may further complicate implementing the LOI approach, even if one assumes that the regulator possesses all the relevant information regarding the incumbent's infrastructure.

One can only imagine how such informational asymmetries on the cost side would also complicate the implementation of the LOI. For example, when facing multiple potential entrants, potentially with different cost structures, determining the right sequence of rungs, as well as deciding on the time (and mechanism) at which to burn existing rungs would be extremely complicated.

4.2 Credibility

The issue of credibility relates to the last step of Cave's proposal. Cave notes that "...[a credible commitment] is required as entrants must believe that mandated access will be temporary or that its price will rise if they are to factor this into their investment decisions." He argues that commitments to change the relative prices of more replicable network elements can be made credibly, if they rely upon consistent definitions and are not made too far in advance. However, Oldale and Padilla argue that regulators would still be likely to renege on their commitments (for example, those related to removal of the rungs), in particular, when the entrant firm remains dependent on favorable access terms. Indeed, experience with sunset clauses in the Netherlands and Canada confirm this point. The regulators in both countries withdrew their commitment and maintained the regulation of access beyond the deadlines that were set by the clauses.⁴¹

Implementation of the LOI can be successful only if regulators stick their ex-ante commitment to burn up the rungs ex-post. Avenali et al. (2009) provide a formal study of this issue. They extend their basic model to consider sequential entry, and the regulator's incentives to renege on its commitment to increase the access price over time. They show that, facing a late entrant, the

⁴¹OPTA, the Dutch regulatory authority, specified a five-year period after which the incumbent operator, KPN Telecom, would be "in principle, free to set a tariff on a commercial basis" (See Guidelines on Access to the Unbundled Loop, March 1999). However, OPTA announced in April 2001 that at the end of the five-year period, it would review competition in the local loop to decide whether to continue or to stop regulating the rental rate (See OPTA (2001), and Poel (2006) for details on LLU regulation in the Netherlands). Similarly, the Canadian Radio-Television and Telecommunications Commission issued a decision (CRTC-97-8) in 1997, which stated that following a five-year mandatory unbundling, the incumbent's services and components that were deemed to be essential facilities (including local loops in certain areas) would not be subject to mandatory unbundling and the rental rate would not be regulated any longer. In March 2001, however, CRTC extended this sunset period without specifying a termination date (See Order CRTC 2001-184).

regulator's commitment to increase the access price over time would not be credible unless the regulator attaches a relatively high value to firm's profits. They propose a remedy to this problem, which involves setting an access price which depends not only on time, but also on the period of entry to the market. Therefore, a late entrant would face the same access schedule as the early entrant, but one that is set at its entry date (and not at that of the early entrant).

In the remainder of this section, we briefly review two other concerns that have been raised in the LOI discussions.

4.3 Other concerns

4.3.1 "Late" entrants and the emergence of wholesale markets

One other concern about the implementation of the LOI approach relates to the "late entrants" to the industry; as with the implementation of the LOI approach, there would be only one level of access available to entrants at any given moment in time. Therefore, in the absence of an access offer at low rungs of the ladder, the entrants that enter the market at a later date would have no other possibility of entry than by investing heavily in network elements to enter at the current (and high) level of access.⁴² As we mentioned above, Avenali et al (2009) suggest that this problem could be solved if the access prices did not only depend on time but also on the entrant's entry date. Putting it differently, they suggest that the regulator should offer the same ladder to each entrant upon their entry date. This would mean that at any given time, lower rungs of the ladder would be exclusively available to late entrants, and at similar conditions that were set for earlier entrants.⁴³

Differently, Cave (2006), who also acknowledges this concern, argues that the most advanced entrants would enter the wholesale market at the level of the LOI that has been deregulated. Therefore, a competitive wholesale market would emerge, and the late entrants would be able to obtain access at reasonable prices and benefit from similar conditions to early entrants. Cave writes:

"This approach may appear harsh to later entrants, whose arrival on the scene may be associated with less favorable access conditions—the relevant assets being deemed, by that stage, to be replicable. However, such later entrants will have the opportunity to seek access either from the initially dominant firm or from earlier entrants, which may

⁴²This important issue has probably led European regulators to amend Cave's original concept to authorize access at various levels of the incumbent's network at any given time.

⁴³One potential problem with this idea is that such access policy might not be optimal if the cost of facility-based entry varies (for example, decreases) over time.

have excess capacity which they are eager to sell."

Consider an industry setting with two vertically-integrated operators and a pure service-based firm. In this context, vertically-integrated firms would be the historical operator and the entrant which has climbed the ladder, and the service-based firm would be a "late entrant." With this industry configuration, there may potentially be competition both at the wholesale level (between the two vertically-integrated firms), and at the retail level (between the three firms). Then, the question is whether a competitive wholesale market as suggested by Cave, would indeed emerge. This question, in turn, can be broken down into two questions. First, can we expect a wholesale market to emerge in the absence of any regulatory intervention? Second, given that such a wholesale market emerges, can we expect it to be competitive? Ordover and Shafer (2007) and Brito and Pereira (2006) provide insights to the first question, whereas Bourreau et al. (2007) study the second question.

Ordover and Shafer (2007) consider a setting where one of the vertically integrated firms has a larger customer base than the other. The new (late) entrant can enter the market only service-based, but in two different ways. It can either engage in "own-supplier cannibalization" (i.e., cannibalize only the sales of its upstream supplier), or in "proportional cannibalization" (i.e., cannibalize the sales of the two integrated firms in equal proportions). They show that there is entry in equilibrium and the wholesale market is perfectly competitive in the latter case, whereas the entrant remain out of the market in the former (as no integrated firm makes a wholesale offer).⁴⁴ This is because, in the former case, the benefits from selling at the wholesale market (i.e., wholesale profits) do not compensate for the costs associated with it (i.e., the reduction in the resale profits). Brito and Pereira (2006) consider a different setting with circular differentiation between the firms at retail competition, and yet obtain similar results.

Bourreau et al. (2007) consider a similar setting to that of Ordover and Shafer (2007) and Brito and Pereira (2006), but differently, they assume that the integrated firms cannot deter the entrant from entering the market.⁴⁵ They then study whether the wholesale market is likely to be competitive. Their main result is that, even if a wholesale market emerges, chances are high that it will not be competitive. They show that the competitiveness of the wholesale demand depends on the magnitude of the "softening effect," which is described as follows. When an integrated firm

⁴⁴Therefore, if the entrant can choose its positioning (own-supplier or proportional cannibalization) there is entry only if the entrant can commit to its positioning.

⁴⁵The authors argue that this might be the case either when the entrant has the outside option of entering facility-based, or when there exists a regulated access offer.

supplies the wholesale market, it becomes a softer competitor in the retail market (as it internalizes the impact of a loss of a customer in the retail market, which can be recovered in the wholesale market), which in turn, benefits the other integrated firm. In a very general setting, it turns out that the integrated firm that serves the wholesale market makes lower retail profits than its integrated rival. Therefore, an integrated firm faces the following trade-off when it decides to serve the wholesale market: serving the wholesale market generates additional wholesale revenues, but at the opportunity cost of lower retail revenues. When the softening effect is strong, the aforementioned opportunity cost is high, and hence, competition is unlikely to take hold.⁴⁶

The insights provided by these studies suggest that Cave's presumption about the emergence of a wholesale market is quite debatable. Note that, however, if a wholesale market emerges, and if it is monopolistic, the incentives of the first entrant to climb the ladder might actually be higher (e.g., as it might expect higher wholesale revenues in the future). Similarly, as the entrant's service-based profits would be low in such a monopolistic wholesale market, its incentives to bypass the current rung of the ladder might also be higher. Therefore, it is not clear whether the emergence of competitive wholesale markets at the low rungs of the ladder is desirable from a social point of view. We believe this question is an important one and deserves further research.

4.3.2 Next generation access networks and the LOI approach

Until now, we have focused on asymmetric markets, where the incumbent firm has an infrastructure and the entrant firms don't. In some "symmetric" markets both, the historical operators and the new entrants may need to invest in a new access infrastructure, for example, in next generation fiber-optic networks.⁴⁷

There is a relatively recent debate on whether the "leaders" in fiber investments should provide "followers" with access to their infrastructure. One can argue that under such access obligations, service-based competition may hinder the followers' incentives to build their own infrastructure (as well as the leaders' incentives), and hence, may create room for the LOI approach.

Although we do not attempt to contribute to this debate in this paper and will not address whether Cave's LOI approach (or a modified one) is appropriate for such symmetric markets we review the existing formal papers that study this issue.

⁴⁶The authors give an example of a competition setting with differentiated retail products and show that the wholesale market is competitive in equilibrium if differentiation on the retail market is high enough, and is monopolistic otherwise.

⁴⁷The incumbent operator may own some strategic assets, such as civil engineering. However, just like the entrant firms, it does not own a fiber optic access network prior to the investment race, which makes the firms symmetric.

Hori and Mizuno (2006) study a model of dynamic investment à la Dixit and Pindyck (1994) with two ex-ante identical firms and an access obligation to the firm that invests first (the leader). Under certain conditions⁴⁸, they show that there is "access-to-bypass" equilibria.⁴⁹ That is, the follower begins by leasing access to the leader's infrastructure, and later builds its own infrastructure. They show that a higher access price accelerates the investment by the leader, whereas it delays service-based entry by the follower, which in turn accelerates the follower's facility-based entry. This is because a higher access price increases the leader's profit and reduces the follower's profit under service-based competition. Hence, the follower delays its service-based entry. Since the opportunity cost of facility-based entry is reduced, a higher access charge also accelerates the investment of the follower. In this setting, therefore, similar to the asymmetric firms setting, the regulator could burn a particular rung on the ladder by setting an access price that increases over time, or by banning access to the leader's network at that level.⁵⁰

Vareda and Hoernig (2007) study a slightly different model, adapted from the model of technology adoption of Fudenberg and Tirole (1985). Similar to Hori and Mizuno (2006), they consider two symmetric firms, and study the effect of an access obligation imposed on the leader of the investment race.⁵¹ The authors show that the nature of the equilibrium depends on the access price: there is a preemption equilibrium if the access price is sufficiently high, and a "waiting equilibrium" otherwise. As a higher access price always accelerates the investment of the follower,⁵² the regulator can induce the follower to invest at the socially-optimal date if it is likely to invest too late from a social point of view.

However, Vareda and Hoernig (2007) argue that it is also possible that the follower invests too soon. This could be the case, for instance, if the incentives for the follower to capture the customers of the leader were too high (that is, if there is a "business stealing" effect). The regulator could delay the investment of the follower by lowering the access price, but it would then reduce the leader's profit under service-based competition, and hence, it would delay the leader's investment. To restore the incentives for the leader to invest early, Vareda and Hoernig suggest setting up a

⁴⁸In particular, when the leader obtains a higher profit under service-based competition than under facility-based competition, and when the access price is sufficiently low and/or the investment cost sufficiently high.

⁴⁹"access-to-bypass equilibria" (since the firms are symmetric ex ante, there are 2 equilibria). So it's a preemption equilibrium with a first phase of SBC (access) and then a phase of FBC (to-bypass).

⁵⁰This point is not discussed by Hori and Mizuno (2006), but it is a direct consequence.

⁵¹Different than Hori and Mizuno (2006), who consider a variable access charge, Vareda and Hoernig (2007) consider a fixed access charge (i.e., a lump sum transfer from the follower to the leader).

⁵²In contrast, the leader's investment date depends on the nature of the equilibrium. See Vareda and Hoernig (2007) for the details.

period of "regulatory holidays."⁵³ The idea is to prohibit the follower from accessing the leader's network during a period of time starting immediately after the investment of the leader.

Given the insights provided by these studies, the regulator can use tools such as increasing access prices, to encourage the followers to climb the ladder, just like in the asymmetric markets. However, if followers climb the LOI too fast (which might happen if the incentives for facility-based entry are mainly driven by a "business stealing" effect) other instruments such regulatory holidays could be used. Yet, we believe that further research is called for on the application of the LOI approach in symmetric networks.

5 Concluding Remarks

In this paper, we have proposed a critical review of the theory of the LOI approach. In our view, the approach relies on two key assumptions. First, if the replacement effect created by service-based competition is neutralized, then service-based competition is assumed to serve as a stepping-stone to facility-based entry. The critical point in this assumption is that the removal of the replacement effect is a precondition for the so-called stepping-stone argument. This is why it is difficult to reject this hypothesis simply by testing the relationship between two forms of competition empirically. Furthermore, there are a couple of arguments in support of this assumption from a theoretical point of view: the benefits of establishing a reputation and customer base, learning-by-doing, and gaining experience in the market with service-based competition. Gaining experience in the market prior to facility-based entry may be particularly important in the presence of any uncertainty about the market conditions.

The second key assumption of the LOI approach relates to the existence of regulatory instruments that can neutralize the replacement effect. Cave has suggested two instruments that could serve this purpose: access prices that increase over time, and sunset clauses. Although the first instrument receives some support from the theoretical literature, the latter has been argued to be either ineffective or counterproductive.

While the validity of these two assumptions is necessary for the success of the LOI approach, it is far from being sufficient. There are additional factors that may hinder the implementation of the LOI approach. Although the main focus of this paper is the preconditions for the functioning of

⁵³In Germany, the incumbent operator, Deutsche Telekom, asked for such regulatory holidays for the deployment of its VDSL network, which led to a dispute between the European commission and the German regulatory authority in 2006.

the mechanism behind the LOI approach, and not for its implementation, we have reviewed several concerns that relate to its successful implementation, namely, credibility of regulatory commitments, and informational requirements.

Despite its strong influence in the regulation of the electronic communications sector, the LOI approach still lacks some economic foundations. The mechanism, itself, seems to have prospects in broadband markets if one can overcome the problems related to its implementation. Given the current discussions on whether the implementation of LOI should be extended to symmetric markets, such as next generation fiber optic networks, further research—both theoretical and empirical—is indispensable.

Finally, in this paper we have focused on the original LOI approach, with which entrants are provided access to the incumbent's infrastructure one level at a time. A modified version of the approach—that which ensures multiple access levels at any given time—is embraced in the policy arena. Therefore, further research is needed to improve our understanding of how the underlying differences between the two approaches matter, both in terms of the working mechanism and the implementation of the LOI.

References

- ARCEP, 2007. Rapport public d'activité 2006. http://www.arcep.fr/uploads/tx_gspublication/rap2006-light.zip.
- Aron, D.J. and Burnstein, D.E., 2003. Broadband adoption in the United States: an empirical analysis. In: Shampine, A.L. (ed), "Down to the Wire: Studies in the Diffusion of Telecommunications Technologies," Nova Science Publishers, Hauppauge, NY, 119-138.
- Arrow, K., 1962. Economic Welfare and the Allocation of Resources for Invention. In: NBER Conference, "The Rate and Direction of Inventive Activity: Economic and Social Factors," Princeton University Press, Princeton.
- Avenali, A., Matteucci, G., & Reverberi, P. (2009), Dynamic access pricing and incentives to invest in alternative infrastructures. Forthcoming in *International Journal of Industrial Organization*.
- Boureau, M. and Doğan, P., 2005. Unbundling the local loop. *European Economic Review*, 49, 173-199.

- Bourreau, M. and Doğan, P., 2006. "Build-or-Buy" Strategies in the Local Loop. *American Economic Review*, 96(2), 72-76.
- Bourreau, M. and Drouard, J., 2009. Stepping Stone or Stonewall? Progressive Entry and the Incentives to Invest in Alternative Infrastructures. Mimeo.
- Bourreau, M., Hombert, J., Pouyet, J. and Schutz, N., 2009. Upstream Competition Between Vertically Integrated Firms. Mimeo.
- Brito, D. and Pereira, P., 2006. Access to Bottleneck Inputs under Oligopoly: A Prisoners Dilemma? Working Papers from the Portuguese Competition Authority, No 16. Also forthcoming in *Southern Economic Journal*.
- Cambini, C. and Jiang, Y., 2009. Broadband investment and regulation: A literature review. Forthcoming in *Telecommunications Policy*.
- Cave, M., Majumdar S., Rood H., Valletti T. and Vogelsang, I., 2001. The relationship between access pricing regulation and infrastructure competition. Report to OPTA and DG Telecommunications and Post, http://www.opta.nl/download/relationship_accesspricing_infrastructure_260301.pdf
- Cave, M. and Prosperetti, L., 2001. European Telecommunications Infrastructures. *Oxford Review of Economic Policy*, 17(3), 416-431.
- Cave, M. and Vogelsang, I., 2003. How access pricing and entry interact. *Telecommunications Policy*, 27, 717-727.
- Cave, M., 2006. Encouraging infrastructure competition via the ladder of investment. *Telecommunications Policy*, 30, 223-237.
- Crandall, R.W., Ingraham, A.T. and Singer, H.J., 2004. Do Unbundling Policies Discourage CLEC Facilities-Based Investment? *Topics in Economic Analysis and Policy*, 4(1), article 14.
- Crandall, R.W. and Sidak, J.G., 2007. Is Mandatory Unbundling the Key to Increasing Broadband Penetration in Mexico? A Survey of International Evidence. Mimeo. <http://ssrn.com/abstract=996065>.
- Crandall, R.W. and Waverman, L., 2006. The Failure of Competitive Entry Into Fixed-Line Telecommunications: Who is at Fault? *Journal of Competition Law and Economics*, 2(1), 113-148.

Distaso, W., Lupi, P. and Manenti, F.M., 2006. Platform competition and broadband uptake: Theory and empirical evidence from the European Union. *Information Economics and Policy*, 18, 87-106.

Distaso, W., Lupi, P. and Manenti, F.M., 2008. Static and Dynamic Efficiency in the European Telecommunications Market: The Incentives to Invest and the Ladder of Investment. Handbook of Research on Telecommunications Planning and Management - (AEBR) Book Series, forthcoming.

Dixit, A.K. and Pindyck, R.S., 1994. Investment under Uncertainty. Princeton University Press.

ECTA, 2006. ECTA response to the ERG Broadband market competition report. http://www.erg.eu.int/doc/publications/consult_regprinc_nga/etno.pdf.

ERG, 2004a. ERG Common Position on the approach to Appropriate remedies in the new regulatory framework. ERG (03) 30rev1, http://erg.ec.europa.eu/doc/whatsnew/erg_0330rev1_remedies_common_position.pdf

ERG, 2004b. Bitstream Access and ERG Common Position. ERG (03) 33rev1.

ERG, 2004c. Explanatory Memorandum to ERG (03) 30rev1. ERG (04) 14.

ERG, 2005. Broadband market competition report. ERG (05) 23.

ERG, 2006. Revised ERG common position on remedies - Explanatory memorandum. ERG (06) 19.

ETNO, 2005. Reflection Document on re-assessing the "ladder of investment" in the context of broadband access regulation. <http://www.etno.be/Portals/34/ETNO%20Documents/Regulatory%20Environment/RD227%20RPO%20Ladder%20of%20Investment.pdf>.

FCC, 1999. Implementation of the Local Competition Provisions of the Telecommunications Act of 1996, Third Report & Order & Fourth Further Notice of Proposed Rulemaking, 15 FCC Rcd. 3696, 3700 (1999).

Friederiszick, H., Grajek, M., and Roller, L.-H., 2008. Analyzing the Relationship between Regulation and Investment in the Telecom Sector. ESMI White Paper No. WP-108-01.

Fudenberg, D. and Tirole, J., 1985. Preemption and Rent Equalization in the Adoption of New Technology. *Review of Economic Studies*, 52(3), 383-401.

Gallo, E., and Pontarollo, E., 2005. Ladder of Investment or Equality of Access: The Italian Way. Paper presented at the 2005 ITS Conference, Porto, Portugal.

- Gayle, P.G. and Weisman, D.L., 2007. Are input prices irrelevant for make-or-buy decisions? *Journal of Regulatory Economics*, 32, 195-207.
- Gruber, H., 2007. European sector regulation and investment incentives for broadband communication networks. Mimeo.
- Guthrie, G., 2006. Regulating Infrastructure: The Impact on Risk and Investment. *Journal of Economic Literature*, 44, 925-972.
- Hausman, J. and Sidak, J., 2005. Did mandatory unbundling achieve its purpose? Empirical evidence from five countries. *Journal of Competition Law and Economics*, 1, 173-245.
- Hazlett, T., and Bazelon, C., 2005. Regulated unbundling of telecommunications networks: A stepping stone to facilities-based competition?. George Mason University. Available at: <http://mason.gmu.edu/~thazlett/pubs/Stepping%20Stone%20TPRC.10.04.05%20.pdf>.
- Höfler, F., 2007. Cost and benefits from infrastructure competition, Estimating welfare effects from broadband access competition. *Telecommunications Policy*, 31, 401-418.
- Hori, K. and Mizuno, K., 2006. Access pricing and investment with stochastically growing demand. *International Journal of Industrial Organization*, 24, 795-808.
- Jorde, T., Sidak, J.G. and Teece, D., 2000. Innovation, Investment, and Unbundling. *Yale Journal on Regulation*, 17(1), 1-37.
- Odale, A. and Padilla, J., 2004. From state monopoly to the "investment ladder": competition policy and the NRF. LECG Europe, The Pros and Cons of Antitrust in Deregulated Markets, in "Swedish Competition Authority," 51-77.
- Oftel, 2001. Delivering a competitive broadband market - OFTEL's regulatory strategy for Broadband. <http://www.ofcom.org.uk/static/archive/oftel/publications/broadband/other/stratb1201.htm>
- OPTA, 2001. Guidelines for Tariff Regulation of Interconnection and Special Access Services, 13 April 2001, http://www.opta.nl/download/guidelines_tariffregulation_130401.pdf/.
- Ordovery, J. and Shafer, G., 2007, Wholesale access in multi-firm markets: When is it profitable to supply a competitor? *International Journal of Industrial Organization*, 25(5), 1026-1045.

Poel, M., 2006. Regulation of the local loop in the Netherlands. In: Baake, P. and Preissl, B. (eds) Local loop unbundling and bitstream access: Regulatory practice in Europe and the US. DIW Berlin: Politikberatung kompakt 20.

Rey, P., 2005. Consultation de l'ART sur les méthodes de valorisation de la boucle locale cuivre, contribution faisant suite à la réunion organisée par l'ART le vendredi 13 mai 2005, http://www.arcep.fr/uploads/tx_gspublication/patrickrey.pdf.

Sappington, D. E., 2005. On the Irrelevance of Input Prices for Make-or-Buy decisions. *American Economic Review*, 95(5), 1631-1638.

Schutz, N. and Trégouët, T., 2008. The Ladder of Investment in Telecoms: Stairway to Heaven or Highway to Hell? Mimeo.

Valletti, T., 2003. The theory of access pricing and its linkage with investment incentives. *Telecommunications Policy*, 27, 659-675.

Vareda, J., 2007. Access Regulation under Asymmetric Information about Demand, FEUNL Working Paper Series from Universidade Nova de Lisboa, Faculdade de Economia, <http://portal.fe.unl.pt/FEUNL/bibliotecas/BAN/WPFEUNL/WP2007/wp525.pdf>.

Vareda, J. and Hoernig, S., 2007. The race for telecoms infrastructure investment with bypass: can access regulation achieve the first best? Mimeo.

Wallsten, S. and Hausladen, S., 2009. Net neutrality, unbundling and their effects on international investment in next generation networks. *Review of Network Economics*, 8(1), 90-112.

Waverman, L., Meschi, M., Reillier, B., and Dasgupta, K., 2007. Access regulation and infrastructure investment in the telecommunications sector: an empirical investigation. Report by LECG Consulting, London, UK. Available at: http://www.etno.be/Portals/34/ETNO%20Documents/LECG_Final%20Report.pdf.