



Investment under uncertainty and regulation of new access networks [☆]



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ABSTRACT

Contractual and regulatory provisions for access affect incentives to invest in an upgraded network and, in particular, a next-generation access network. Investment decisions are made under uncertainty and have to be made over time. This paper provides a framework for taking uncertainty, risk aversion, and the timing of investment explicitly into account. First, it evaluates various access price policies in a framework in which the incremental value over the legacy network is uncertain. There, policies that make usage by non-investing firms optional must ensure as well that this optionality is efficiently used. Second, introducing risk aversion, the access price structure turns out to be critical for the risk profile of the investing telecom operator and of the access-seeking alternative operator. Third, some implications of the time structure of access payments are derived. Policies must ensure that non-investing firms do not excessively delay seeking access. Generally, efficiency of usage can be increased when making fees contingent on observable characteristics of market development. To the extent that this is not based on volume, this need not dampen competition.

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1. Introduction

Uncertainty about the success of an investment is arguably an important obstacle to the roll-out of fiber networks and other investments to upgrade an existing network. In particular, investments in next-generation access networks are associated with highly unpredictable future profits after making the investment. Policy makers have acknowledged this. In particular, the European

Commission has observed that Europe lags behind the U.S. and Asia in such developments. In this regard, the European Commission states:

There are several reasons, the most evident being the uncertain commercial viability of substantial network investments, due to prevailing investment models and the EU market structure. But also because of doubts about consumers' short-term willingness to pay more for higher speeds, as new high value-added digital content and services are not necessarily available yet throughout the EU.²

This quote also highlights the importance of the uncertain development of complementary services made feasible by the new technology, as well as consumers'

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² Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, The Digital Agenda for Europe - Driving European growth digitally, December 18, 2012, COM(2012) 784 final, page 8.

uncertain take-up of these services. An investment's profitability also depends, more generally, on the speed of market penetration since the investment, for the most part, constitutes a sunk cost, and an efficient roll-out relies on quick take-up.³ While there may be immediate revenues, profitability depends crucially on a continuous revenue stream over a long period. This long time horizon tends to further increase the uncertainty that the investing party faces.

Uncertainty over the key parameters of a firm's decision and its implications also plays an important role in the modern theory of regulation. A large part of the literature considers private information held by the party that is subject to regulation.⁴ For example, a regulator may have to set access prices without perfectly knowing the cost function of the regulated firm. While this is a relevant issue, this paper will abstract from private information of this type. We focus, instead, on uncertainty about a new technology's potential that is shared by all parties. This uncertainty has direct implications for the way that particular regulatory interventions affect market outcomes. For instance, the regulator may oblige the investing network operator to grant access at a given fixed fee. Whether other firms will make use of this possible access is uncertain, as it depends on the future utility that consumers derive from additional services associated with the investment. Thus, at the moment of making the investment, its overall value depends both directly on its success with consumers and indirectly on the possibility of passing on costs to other firms. The extent to which this is possible depends, in turn, on the access regulation that is in place. This issue does not arise without uncertainty.

A key aspect in our analysis is the non-investing firms' decision of whether or not to use the new technology under the prevailing access conditions. More generally, a non-investing firm has to decide the extent and the timing of offering the new technology to its consumers. Efficient regulation increases the probability that another firm will use the new technology early (here, we abstract from limited capacity). If firms use the new technology symmetrically, then competition in each downstream market is intense. This tends to lead to a high consumer surplus and only small allocative inefficiencies, measured by a small deadweight loss. This observation hints at an important disadvantage of fixed access fees, which are optional in the sense that access-seeking firms decide *after* the investment whether they are interested in accessing the new technology. By contrast, contractual commitments prior to the investment do not suffer from these allocative inefficiencies. One way to implement non-optional payments is that both firms co-invest in the access network. Such co-investments have been proposed in the context of mobile communication networks.⁵

The inefficiency of optional fees may be reduced if the payment for access depends on the quantity of the access product that the access-seeking firm demands. However, introducing such variable access fees may lead to higher retail prices, on average. Thus, we find a trade-off between fixed and variable optional access fees. This trade-off might be attenuated by using general, non-linear tariffs. Also, from a social perspective, access fees that condition on relevant changes in market characteristics may be preferable to those that do so only indirectly (namely through conditioning on volume).

As an extreme alternative, we also discuss a fixed non-conditional upfront fee, which removes the optionality of the access payment. The marginal price of obtaining access can then be set equal to the corresponding marginal costs. With this regulatory policy, however, one should bear in mind several caveats. Most obviously, if, at the moment of the investment, the access-seeking firm does not yet exist, the mechanism is simply not applicable. Further, the fixed fee should be based on the expected demand of the access-seeking firm, if this is feasible. A policy that applies a fee to all firms indiscriminately will not allow small firms to operate profitably in the market. Finally, an induced high degree of competition, while being desirable from an ex post perspective, could lead to underinvestment or inefficiently postponed investment from a social welfare perspective.

Apart from the access price rules already mentioned, alternative rules exist, in particular as combinations of these. For instance, an access-seeking firm may acquire the option to obtain access under predefined conditions. This allows for a combination of optional and non-optional fixed payments. Also, the contract or the regulatory rule may specify certain quantities for which preferential access can be obtained by making a non-optional upfront payment.

When a wait-and-see strategy becomes more attractive for the access-seeking firm, it may use the new technology rather late, to the detriment of social welfare. Then, also the time structure of the access tariff may be used to improve dynamic efficiency by providing incentives for earlier and more-intensive use of the new technology. We discuss when non-linear tariffs based on access levels and front-loaded access tariffs can increase welfare.

As a final contribution, we discuss the optimal allocation of risk between firms. The allocation of risk depends, for example, on the degree to which the access of the non-investing firm remains optional and on the use of fixed fees versus incremental, usage-based payments. The allocation of risk may matter for efficiency, in particular, when firms appear to be averse even with respect to idiosyncratic risk—e.g., as they have limited access to capital markets.

The rest of this paper is organized as follows. Section 2 introduces the formal framework. Section 3 considers firms' optimal investment and contractual choice, as well as the impact of various access policies. Section 4 introduces optimal risk-sharing, while Section 5 provides an extension to a dynamic investment path. Section 6 concludes.

³ A high degree of uncertainty may already have been relevant at an earlier point in the development of local telecommunications networks. Pindyck (2007) emphasizes the relevance of uncertainty for such investments. However, some economists have challenged the general presumption that the network operator suffers from uncertainty; see Economides (1999).

⁴ For instance, Armstrong and Sappington (2007) provide an overview.

⁵ See for instance the study by Oxera (2011), which has been prepared for Vodafone.

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