Technology investment and alternative regulatory regimes with demand uncertainty

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A B S T R A C T

A vertically integrated incumbent and an OLO (Other Licensed Operator) compete in the market for broadband access. The incumbent has the option to invest in building a Next Generation Network that covers all urban areas with similar demand structures. The investment return in terms of demand increase is uncertain. We compare the impact of different access regulation regimes – full regulation, partial regulation (only the copper network is regulated), risk sharing – on investment incentives and social welfare. We find that, when the alternative for the OLO is using the copper network rather than leaving the market entirely, exclusion of the OLO does not necessarily happen in equilibrium even when the incumbent is better in offering value-added services. Risk sharing emerges as the most preferable regime both from a consumer and a social welfare perspective for a large range of parameters.

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1. Introduction

Telecommunications markets are experiencing a period of drastic technological development. The possibility to build a so-called Next Generation Network (NGN) gives firms the chance to exploit extremely faster transmission and thereby enrich their offer with more interactive and sophisticated services. However, the actual existence and importance of a demand for NGN applications is often uncertain.[1] The technology has been available for a while now, but given the high fixed costs needed to build the necessary infrastructure, and the risks associated with demand and regulatory uncertainty, the NGN deployment is progressing slowly in many countries.

The vexing issue as to how to provide firms with enough investment incentives, while eventually retaining the benefits of network development for final consumers, is highly debated by industry actors, regulators and scholars. In particular, access regulation is widely argued about its potential discouraging effect on regulated firms' investment. When obliged to share its network elements with facilities-free rivals at a regulated access price, the incumbent may feel reluctant to invest in NGN because of the spillover effect enjoyed by the Other Licensed Operators (OLOs). For these reasons, access regulation, mainly in the form of mandatory unbundling, may induce less or later incumbent's investment compared to an unregulated scenario, but also compared to the socially desired level (Chang et al., 2003; Crandall and Singer, 2003; Ingraham and Sidak, 2003; Bourreau and Doğan, 2005; Pindyck, 2007; Grajek and Röller, forthcoming; Nardotto et al., 2012). The European Commission seems to acknowledge these concerns for future investments in NGN. In the Recommendation C (2010) 6223 on "Regulated Access to

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[1] See for instance The Economist (2010) about lack of demand for NGN services in the United States.

NGANs" (September 2010), the possibility of relaxing – if not eliminating – *ex ante* regulation when a risk sharing agreement backs up the deployment of NGN is openly considered.

The issue of broadband investment and regulation has attracted and still attracts a lot of research attention.[2] Our paper contributes to this strand of literature by addressing the issue of access price setting when the incumbent has the option to invest in NGN and investment returns in terms of demand increase are uncertain. Using a model, where a vertically integrated incumbent and an OLO dynamically compete in the market for broadband access, we analyse the effect of three different access regimes on the incentives to invest by the incumbent: full regulation (mandatory unbundling for NGN), partial regulation (no mandatory unbundling for NGN) and risk sharing. We then compare their impact on social welfare, balancing the effect of each regulatory regime on static and dynamic efficiency.

In our paper, we follow the original set-up of broadband investment and access regulation developed by Foros (2004).[3] We develop a model with two firms having different ability to offer value-added services, and analyse the impact of access price regulation on the incumbent's investment incentive. Differently from Foros (2004), however, we adopt a dynamic model of technology adoption and we include demand uncertainty for value-added NGN services. Considering that NGN investment might fail to expand market demand, we also assume that the OLO can possibly switch back to the copper network if there is no demand for NGN applications and the access to copper is cheaper. We then conduct our analysis comparing the impact on investment of three alternative access regimes. In this respect, the paper closer to ours is Nitsche and Wiethaus (2011). The authors analyse a simple two-stage framework with identical firms, where the incumbent is the only firm entitled with investment option and investment success in terms of demand increase is uncertain. Their work compares the impact of different modes of regulation (access price based on costs, risk sharing and regulatory holiday) in terms of investment extent and consumer welfare outcomes. There are several differences between our work and Nitsche and Wiethaus's (2011) one. Firstly, in their model, following Klumpp and Su (2010), the access charge is determined *ex post* from the equilibrium quantities and it includes a partial allocation of the fixed costs borne by the incumbent. In our model, the regulator establishes *ex ante* the level of access price, via first-order conditions. As a consequence, the benchmark case for access regulation in our model is a marginal cost-based rule, as in much of the literature in this field (Foros, 2004; Kotakorpi, 2006 for instance). Secondly, our setting is dynamic and we investigate the timing of investment in a context with demand uncertainty, rather than

the extent of the investment. Moreover, we are able to carry out a complete welfare analysis, whereas Nitsche and Wiethaus's (2011) work only gives an overview of the different modes of regulation's implications in terms of consumer welfare. Lastly, our model includes quality differentiation á la Foros and considers its impact on equilibrium results, while, in Nitsche and Wiethaus's (2011) model, firms are undifferentiated.

The impact of uncertainty on the timing of telecommunications infrastructure development has also been analysed in several papers that feature dynamic race models between incumbent and entrant operators and focus on specific access pricing regimes, mainly regulatory holidays (Hori and Mizuno, 2006; Hori and Mizuno, 2009; Gans, 2001; Gans, 2007; Vareda and Hoernig, 2010). In our model, by contrast, we consider uncertainty in a dynamic setting, but we focus on services-based competition, while taking into account different possible regulatory regimes. Since the co-existence of the legacy network and the new fibre network is highly inefficient and not sustainable over a long period, we also analyse the case in which the switch to NGN is compulsory and compare it with the case in which the switch can be postponed and depends only on the access conditions. We find that, in case of compulsory switch, the OLO gets relatively worse access condition absent regulation.

Our paper also differs from a recent strand of studies that analyse an investment game where both the incumbent and entrants have the option to invest. Brito et al. (2012) examine the incentives of a vertically integrated firm (regulated at wholesale level) to invest and give access to a new (upgraded) wholesale technology, that is not subject to access regulation. Bourreau et al. (forthcoming) and Inderst and Peitz (2012a) analyse the incentives to migrate from an old technology to a new one, and examine how wholesale access conditions affect this migration. Finally, Manenti and Scialà (2011) study the impact of access regulation on entrant and incumbent's investment and show that, in absence of regulation, the incumbent would choose an access charge to the new infrastructure that prevents resale-based entry, thereby overstimulating entrant's investment which may eventually turn out to be inefficiently high.

Our model reveals that the differences in ability to provide value-added services and their absolute values with respect to the overall level of demand highly affect the investment choice. Since the OLO has the alternative to switch back to the copper network instead of leaving the market entirely, we find, in contrast to Foros (2004), that there are cases in which exclusion does not happen even when the incumbent is better in providing value-added services than the OLO. In case of mandatory switch to the NGN, we find that the OLO remains active in the market if and only if its ability to provide value-added services is higher than the incumbent's one. The equilibrium results show that the investment is always undertaken later than in the social optimum and that the presence of uncertainty has the effect of delaying the investment even further. Full regulation lowers the investment incentives due to a hold-up problem of the regulator who exploits the irreversibility of the incumbent's investment *ex post*. Due to

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[2] Cambini and Jiang (2009) provide a review of the theoretical and empirical literature on broadband investment and access regulation.

[3] A similar approach has been recently used by Mizuno and Yoshino (2012). In their model the authors analyse the incumbent's incentive to invest under regulatory non-commitment, generalising the results by Foros (2004). In our paper, instead, we use a dynamic investment model and demand uncertainty and we also compare different regulatory regimes in terms of their welfare implications. Our analysis is thus complementary to the Mizuno and Yoshino's one.