

Incentives to invest and to give access to new technologies

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Presentation

- 1 Introduction
- 2 Main Assumptions
- 3 Non-drastic Innovation
- 4 Drastic Innovation
- 5 Conclusions

Motivation

Sectoral regulators are considering three main approaches to regulate Next Generation Access Networks:

- *Continuity approach*
- *Equality of Access approach*
- *Forbearance approach*

In this article, we analyze, in the context of the forbearance approach, the incentives of a vertically integrated firm:

- to invest in the new technology
- to give access to the new technology to a downstream entrant

Questions

- 1 Will the vertically integrated firm voluntarily give access to the entrant, or should open access obligations be extended to the new technology?
- 2 Given that the vertically integrated firm must have incentives to invest, is it socially preferable to have a monopoly or a duopoly in the retail market?
- 3 In some circumstances, only the vertically integrated firm can invest, but in others, perhaps due to public policies, both firms can. Is it necessarily socially preferable to have both firms able to invest?

Demand

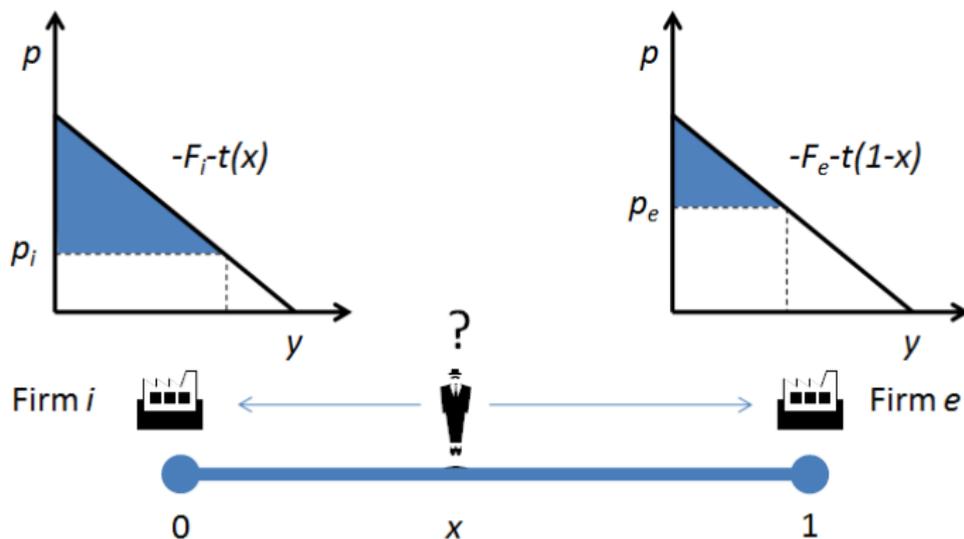
- Consumers have a linear demand function for retail services:

$$y_j = z - p_j$$

- Consumers pay a unit price, p_j , plus a fixed fee, F_j , when purchasing from firm j
- Consumers do not consider the services as perfect substitutes
 - Consumers are located on Hotelling's road, pay linear "transportation costs": tx
 - Consumers prefer the service produced with the new technology

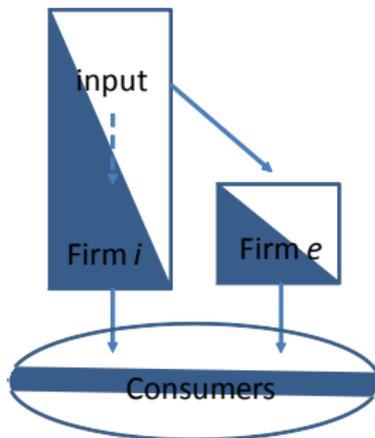
Demand

- Consumers select the firm that results in a higher consumer surplus, net of "transportation costs" and fixed payments



Firms

- Two firms: an incumbent, firm i , and an entrant, firm e , located on opposite ends of Hotelling line
- The incumbent is a vertically integrated firm that produces an input that (i) uses in the production of a final product and (ii) sells to an entrant



Firms

- The input can be produced using an old or a new technology

$$y_i = z - p_i \rightarrow y_i = z + v - p_i$$

- Measure of the quality improvement enabled by the new technology: $\chi = v(2z + v)$
 - If χ is on $(0, 6t)$: *non-drastic innovation*
 - If χ is on $[6t + \infty)$: *drastic innovation*
- Using the new technology implies making an investment I
- The entrant pays a unit price for the input
 - If the old technology is used, this access price is regulated (α_0)
 - If the new technology is used, the incumbent makes take-it-or-leave-it offer (α_n)

Firms

- We assume first that only the incumbent can invest in the deployment of the new technology, since the entrant has some disadvantage relative to the incumbent:
 - The entrant might not have access to financing
 - The entrant has to built the infrastructure required to support the new technology from scratch with a higher cost
 - Environmental or municipal regulation might prevent, or make too costly, the deployment by the entrant of the infrastructure required to support the new technology
- Later we will allow both firms to invest in the deployment of the new technology.

Regulator

- The regulator chooses α_0 to maximize welfare, which includes:
 - Consumer surplus
 - Firms' aggregate profit
 - Transportation costs
 - Investment costs
- Access to the new technology is not regulated
 - e.g.: in US, Verizon is deploying a next generation access network, but is only obliged to offer to entrants wholesale services equivalent to what it would offer through a traditional network

Timing of the game

The game unfolds as follows:

- Stage 1: The regulator sets α_0
- Stage 2: The incumbent makes an investment decision
- Stage 3: If investment takes place, the incumbent and the entrant negotiate over the access price to the new technology α_n
- Stage 4: Observing the access prices, α_0 and α_n , the entrant chooses which technology to use, if any
- Stage 5: The incumbent and the entrant compete on retail prices

The game is solved by backward induction, starting from last stage

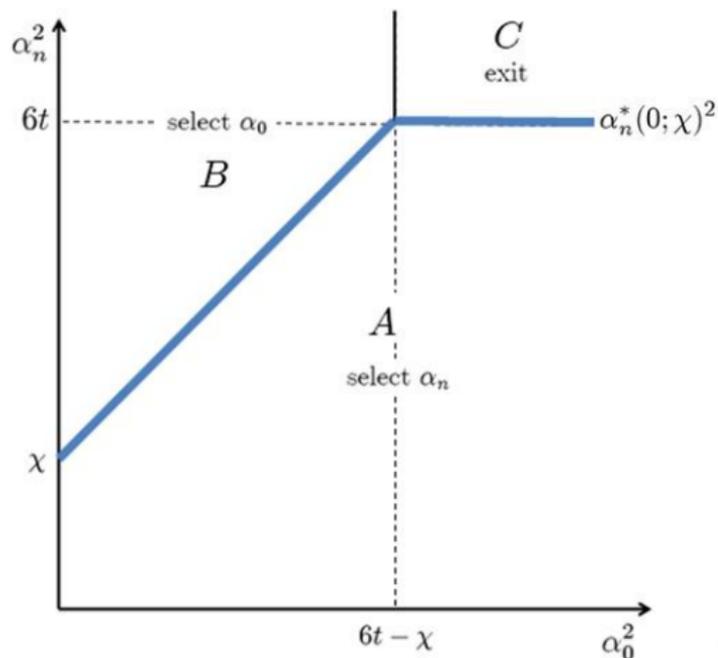
Price competition stage

In the price competition stage, five cases may occur:

- 1 The entrant chooses not to operate. Incumbent is monopolist and uses
 - 1 the new technology
 - 2 the old technology
- 2 There is no investment and both firms face a demand given by $y_j = z - p_j$. The entrant has costs α_0
- 3 There is investment and both firms use the new technology. Both firms face a demand given by $y_j = (z + v) - p_j$. The entrant has costs α_n
- 4 There is investment but the entrant does not use the new technology. The incumbent's demand is $y_i = (z + v) - p_i$ while the entrant's demand is $y_e = z - p_e$. The entrant has costs α_0

Technology choice stage

- Entrant's technology choice if there is investment:



Access price offer stage

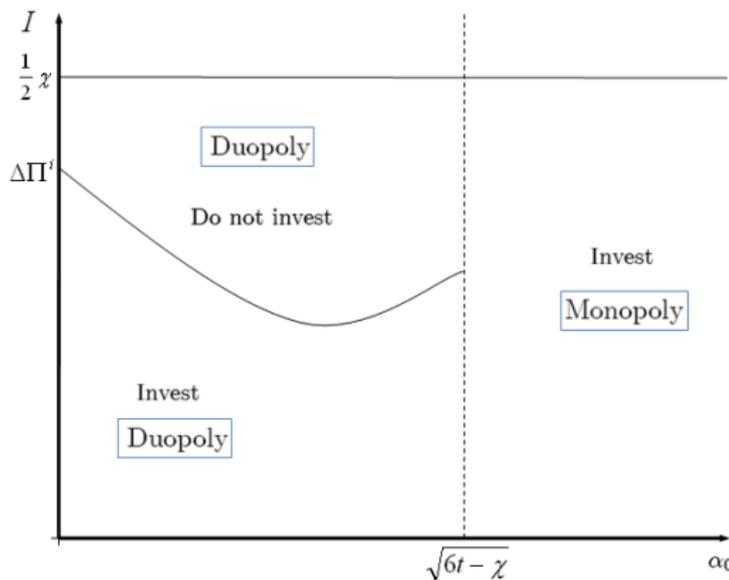
- In equilibrium, the incumbent offers:

$$\alpha_n^*(\alpha_o; \chi) = \begin{cases} \sqrt{\alpha_o^2 + \chi} & \text{for } \alpha_o \text{ on } [0, \sqrt{6t - \chi}) \\ \left[\sqrt{6t}, +\infty \right) & \text{for } \alpha_o \text{ on } [\sqrt{6t - \chi}, +\infty) \end{cases}$$

- If α_o is low, the incumbent cannot drive the entrant out of the market since it can always use the regulated old technology
- If the incumbent "gives" access to the new technology, it benefits from a higher access price
- Otherwise, it benefits from selling the product that is more valued by consumers. But... the previous effect dominates

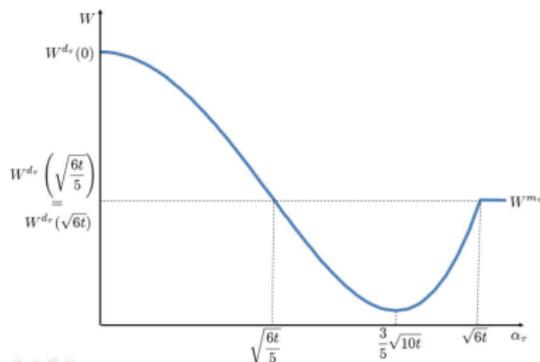
Investment stage

- Denote by $\Delta\Pi_i(\alpha_o) := \pi_i^{d_n}(\alpha_n^*(\alpha_o; \chi)) - \pi_i^{d_o}(\alpha_o)$. The incumbent:



Regulation stage

- Welfare function (when using the same technology)



- Increasing the access price has the following effects:
 - It increases transportation costs (-)
 - It reduces consumption for the consumers served by the entrant (-)
 - It makes some consumers shift from the entrant, where they face a higher marginal price, to the incumbent (+)

Regulation stage

- In equilibrium, the regulator sets:

$$\alpha_o = \begin{cases} 0 & \text{for } \chi \text{ on } \left[0, \frac{6}{5}t\right) \\ \text{on } [\sqrt{6t - \chi}, +\infty) & \text{for } \chi \text{ on } \left[\frac{6}{5}t, 6t\right) \end{cases}$$

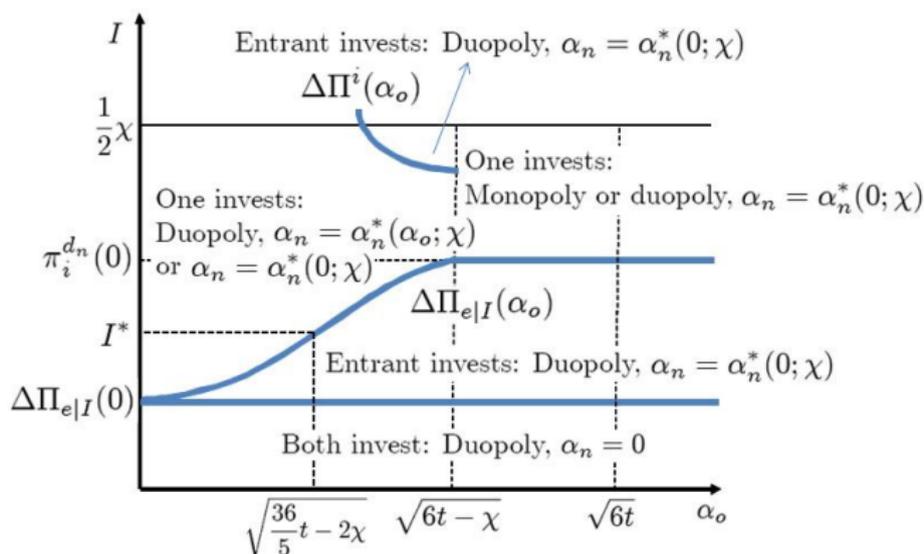
- for low values of χ , and therefore for low values of $\alpha_n^*(\cdot)$, the regulator sets $\alpha_o = 0$, which leads to a duopoly,
- for high values of χ , and therefore for high values of $\alpha_n^*(\cdot)$, the regulator sets an α_o on $[\sqrt{6t - \chi}, +\infty)$, which leads to a monopoly with the new technology
- it is never optimal for the regulator to induce no-investment, and thereby a duopoly with the old technology

Summing up...

- If χ is on $(0, \frac{6}{5}t)$: (i) the regulator sets $\alpha_o = 0$, (ii) the incumbent invests, (iii) the incumbent offers $\alpha_n^* = \sqrt{\chi}$, (iv) the entrant uses the new technology
- If χ is on $[\frac{6}{5}t, 6t)$: (i) the regulator sets α_o on $[\sqrt{6t - \chi}, +\infty)$, (ii) the incumbent invests, (iii) the incumbent offers α_n^* on $[\sqrt{6t}, +\infty)$, (iv) the entrant exits the industry

Two firms can deploy the new technology

- Assume that the entrant and the incumbent have the same investment cost. In equilibrium:



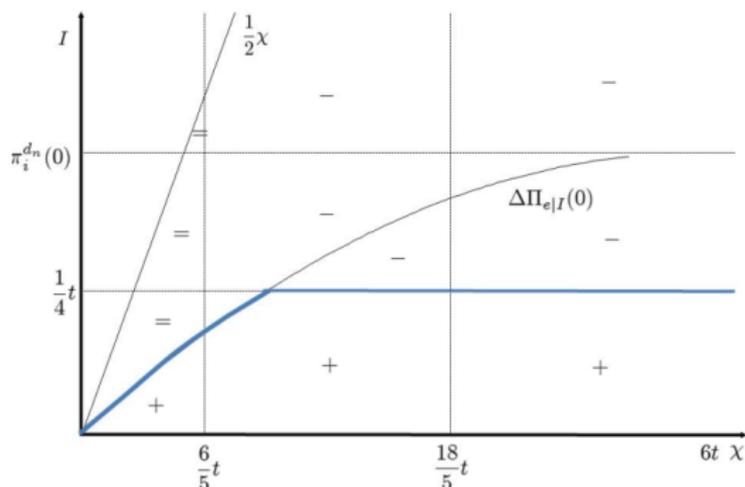
Two firms can deploy the new technology

Equilibria of the game:

		χ		
		$(0, \frac{6}{5}t)$	$[\frac{6}{5}t, \frac{18}{5}t)$	$[\frac{18}{5}t, 6t)$
I	$[0, \Delta\Pi_e _I(0))$	<i>any α_o</i> <i>both invest</i> $W^{dn}(0)$		
	$[\Delta\Pi_e _I(0), \pi_i^{dn}(0))$	$\alpha_o = 0$ or on $(\alpha_o^{**}, +\infty)$ <i>i or e invest</i> $W^{dn}(\alpha_n^*(0))$	$\alpha_o = \alpha_o^{**}$ <i>i or e invest</i> $W^{dn}(\alpha_n^*(\alpha_o^{**}))$ or $W^{dn}(\alpha_n^*(0))$	
	$[\pi_i^{dn}(0), \frac{1}{2}\chi)$	$\alpha_o = 0$ <i>i or e invests</i> $W^{dn}(\alpha_n^*(0))$	α_o on $[\sqrt{6t - \chi}, +\infty)$ <i>i or e invests</i> W^{mn} or $W^{dn}(\alpha_n^*(0))$	

Two firms can deploy the new technology

- Comparing the welfare levels of the case where both the incumbent and the entrant can invest and where only the incumbent can invest:



Equilibrium of the whole game

- Assume that only the incumbent can invest. In equilibrium:
 - (i) the regulator sets any α_o on $[0, +\infty)$, (ii) the incumbent invests and offers $\alpha_n^*(\cdot)$ on $[\sqrt{6t}, +\infty)$, and (iii) the entrant exits the industry.

- Assume that both the incumbent and the entrant can invest. In equilibrium:
 - If I is on $[0, \Delta\Pi_{e|I}(0))$: (i) the regulator sets any α_o , and (ii) both firms invest.
 - If I is on $[\Delta\Pi_{e|I}(0), \frac{1}{2}\chi)$: (i) the regulator sets any α_o , (ii) one of the firms invests and offers $\alpha_n^*(\cdot)$ on $[\sqrt{6t}, +\infty)$, and (iii) the rival exits the industry.

Welfare comparison

- If I is on $\left[0, \frac{1}{4}t\right)$, then, when both firms can invest in the new technology, compared with the case where only the incumbent can invest, welfare increases.
- If I is on $\left[\frac{1}{4}t, \Delta\Pi_{e|I}(0)\right)$, then, when both firms can invest in the new technology, compared with the case where only the incumbent can invest, welfare decreases.
- If I is on $\left[\Delta\Pi_{e|I}(0), \frac{1}{2}\chi\right)$, then, when both firms can invest in new technology, compared with the case where only the incumbent can invest, expected welfare is the same.

Policy Implications

- If the innovation is *non-drastic*, the concern that the industry might be monopolized is not justified
- If the quality improvement enabled by the new technology is *non-drastic* and low, a duopoly with the new technology is socially optimal, whereas if the quality improvement enabled by the new technology is *non-drastic* but high, a monopoly with the new technology is socially optimal
- When the innovation is *non-drastic*, the possibility of both firms investing, instead of just the vertically integrated firm, may or may not increase welfare, if the investment cost is low, and at best leaves welfare unchanged, if the investment cost is high

Policy Implications

- In some circumstances, the entrant's disadvantage regarding the investment cost can be overcome by public policies (e.g. the entrant can be given access to credit)
- Implementing such policies poses at least two types of practical problems:
 - sectoral regulators typically do not have the instruments required
 - these policies could be perceived as state aid, which is restricted in some jurisdictions
- Furthermore, if the innovation is *non-drastic*, the case for such public policies is not very strong, since the concern that the industry might be monopolized is not justified.

Policy Implications

- If the innovation is *drastic*, the concern that the industry might be monopolized by the vertically integrated firm is justified
- Two types of policies could be used to remedy this situation:
 - the regulator could promote investment by the entrant. However, the possibility of both firms investing solves the monopolization problem, but only if the investment cost is low
 - open access obligations could be extended to the new technology. However, unless the regulator can commit to a regulatory policy, open access obligations can reduce, or even eliminate, the vertically integrated firm's incentives to invest