Coexistence of Service- and Facility-Based Competition: The Relevance of Access Prices for "Make-or-Buy"-Decisions

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What is it about?

Access regulation and "make-or-buy"-decisions

- Sector specific ex ante regulation only where "no effective and sustainable competition" develops
- Appropriate investment incentives and the "ladder of investment"

Economies of density

- Infrastructure-based competition in dense areas and cream-skimming
- Digital divide: Insufficient coverage in rural areas

➠ Linkage between investments, competition, and population density?

➠ Optimal trade-off between static and dynamic efficiency?

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What answers does economic literature provide?

"Make-or-buy" decisions

↪ Efficient investment decisions not necessarily based on cost-based access fee

↪ Impact of entrants' investments on subsequent retail competition

- Sappington (2005, *AER*), Gayle & Weisman (2007, *JRE*), Mandy (2009, *JRE*)

Economies of density

↪ Areas with different number of infrastructure providers

↪ Trade-off between static and dynamic efficiency:
Fiercer retail competition vs higher investment incentives

- Faulhaber & Hogendorn (2000, *JIE*), Valletti, Hoernig & Barros (2002, *JRE*), Götz (2009, *Working paper*)

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What is our contribution?

"Make-or-buy" decisions in the presence of economies of density

- Innovations and necessity for upgrades and extensions of networks
  - Possibility of investments of the incumbent and the entrant
  - Fixed (irreversible) investment costs
- Retail competition in markets with different population densities
  - Coexistence of service-based and facility-based competition
    - ↪ Entrant might choose both, reselling and investment
  - Consumer switching costs

Main Finding

- Higher access fees might yield both
  - ⇒ Higher investment incentives
  - ⇒ Lower retail prices based on intensified (facility-based) competition

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The Model in a Nutshell

Two firms

- Incumbent (I)
- Entrant (E)

Competition

- Broadband access market
- Regional markets with different population densities

Investment

- Incumbent upgrades legacy network
- Entrant might invest or buy access

Regional Markets

Population density and regional markets

- Continuum of regions
  - Uniformly distributed population densities $\delta \in [0, \overline{\delta}]$
  - Linear relation between "number" of region and density
- In each region linear demand $y(\delta, p) = \delta(\lambda\nu - p)$
- One infrastructure in each region to provide homogeneous services
  - Investment / upgrade increases reservation utility by $1 \leq \lambda \leq \hat{\lambda}$

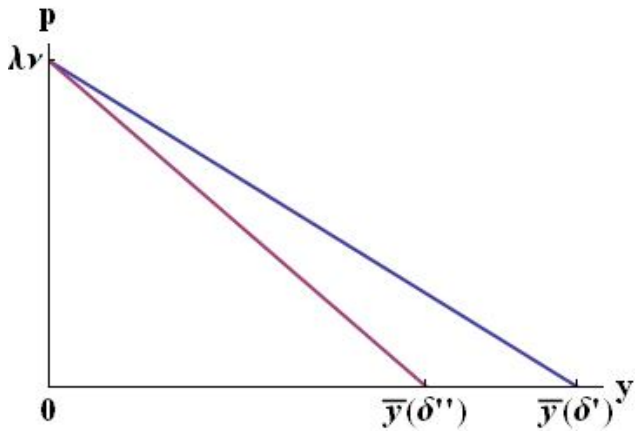

Illustration of the demand subject to the population density

- Demand in region δ: $\delta(\lambda\nu - p)$
- $y(\delta') > y(\delta'')$ for all $\delta' > \delta''$

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Demand - Consumers

Consumers in region δ

- Continuum of consumers with different reservation utilities $\nu_i \in [0, \nu]$
- Each consumer types ν_i incorporates a continuum of consumers with switching costs $\omega \in [0, \overline{\omega}]$
- No correlation between reservation utility and switching costs

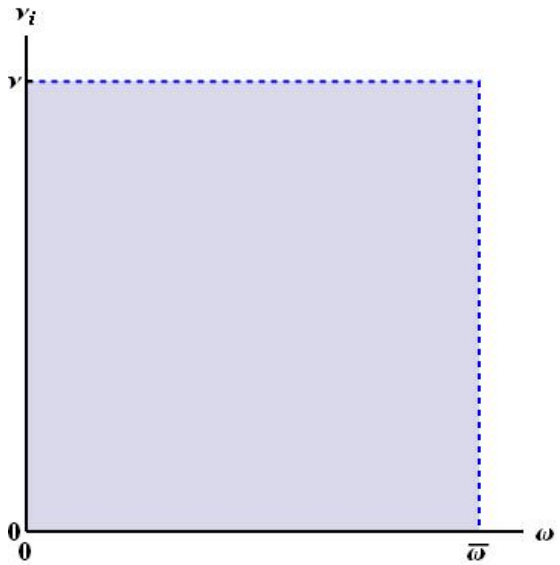

Illustration of the continuum of consumers

- Reservation utilities $\nu_i \in [0, \nu]$
- Switching costs $\omega \in [0, \overline{\omega}]$

$\Rightarrow$ Two-dimensional continuum $\mathbb{R}^2_+$

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Demand - Two Consumer Types

Consumers from a previous period with switching costs

- Switch provider if net utility is positive

$$\lambda\nu_i - p_E - \omega \geq \lambda\nu_i - p_I \quad \Rightarrow \quad \omega \leq \omega_k = p_I - p_E$$

- Share of switching consumers is given by $\frac{(p_I - p_E)}{\overline{\omega}}$
  - Not subject to the absolute but to the relative price level

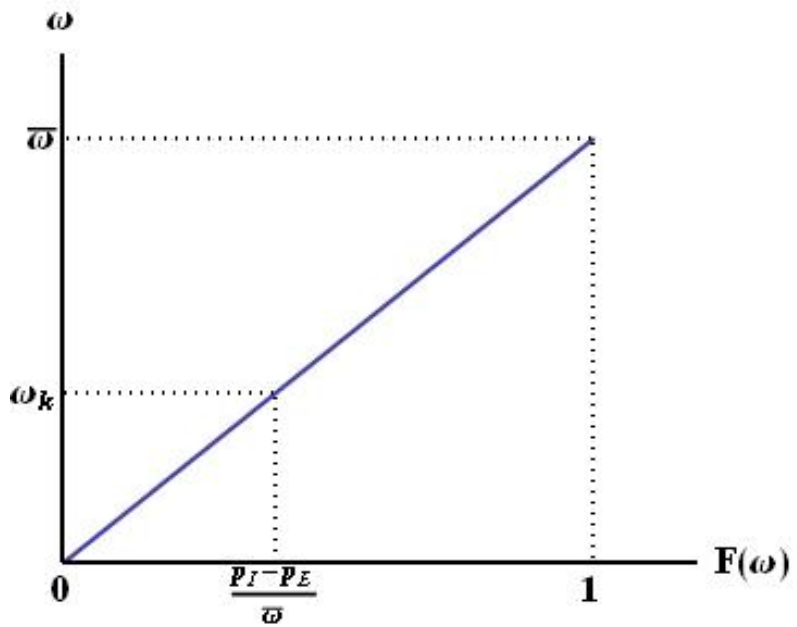

Illustration of the share of switching consumers

- Mass of all consumers equals 1
- Share of switching consumers $(p_I - p_E)\frac{1}{\overline{\omega}}$ with $0 \leq \frac{(p_I - p_E)}{\overline{\omega}} \leq 1$

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New consumers

- Buy if net utility is positive
- Choose the firm with the lower price, i.e. the entrant
- Demand of the unattached consumers $y(\delta, p_E) - y(\delta, p_{I0})$

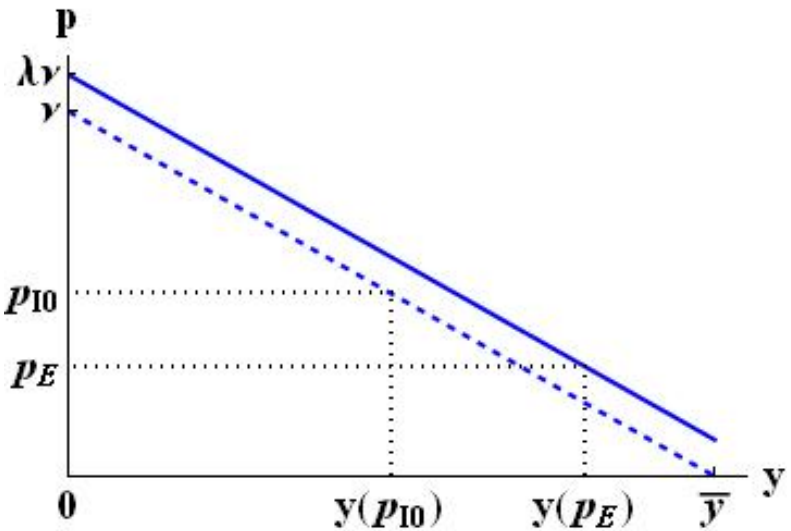

Illustration of the additional demand

- New consumers buy if net utility is positive
- Additional demand $y(\delta, p_E) - y(\delta, p_{I0})$

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Supply

Costs

- Marginal costs equal zero
- Investment costs F_j per region
- Access fee α per consumer in regions without own infrastructures

Demand

- Entrant's demand

$$\Rightarrow \quad y_E(\delta, p) = \delta \Bigg(\underbrace{\left(\frac{p_I - p_E}{\overline{\omega}} \right) (\nu - p_{I0})}_{\text{Switching consumers}} + \underbrace{(\lambda - 1)\nu + p_{I0} - p_E}_{\text{New consumers}} \Bigg)$$

- Incumbent's demand

$$\Rightarrow \quad y_I(\delta, p) = \delta \quad \underbrace{\left(1 - \frac{p_I - p_E}{\overline{\omega}} \right) (\nu - p_{I0})}_{\substack{\text{Consumers from previous period} \\ \text{minus switching consumers}}}$$

➠ *Firms maximize profits via prices p_j and investments δ_j*

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Timing of the Game

Previous period

- Incumbent serves market with legacy network as myopic monopolist

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1. Access Stage
   - Regulator sets access fee α
2. Investment Stage
   - Both firms set their investment level, i.e. the smallest covered regions δ_I and δ_E
3. Pricing Stage
   - Firms set their retail prices p_I and p_E

Benchmark

Only service-based entry

- Subset of the case with facility-based competition
- General insights into one-way access regulation

Incumbent

- Revenues from selling access in all covered regions

$$\Rightarrow \max_{p_I, \delta_I} \pi_I^{sbc} = \int_{\delta_I}^{\overline{\delta}} p_I y_I + \alpha y_E - F_I d\delta$$

Entrant

- Reselling in all covered regions

$$\Rightarrow \max_{p_E} \pi_E^{sbc} = \int_{\delta_I}^{\overline{\delta}} (p_E - \alpha) y_E d\delta$$

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Pricing Stage

Equilibrium prices

Mark-up based on switching costs + Entrant's marginal costs

Basic components

- Mark-up based on switching costs
  - Prices of both firms increase with the switching costs
  - Price difference increases with the switching costs
  - Switching costs equal zero yield Bertrand outcome
- Entrant's marginal costs α

Direct effect of the access fee

If the entrant acts as a pure reseller, i.e. only service-based competition is realized, the equilibrium prices of both firms increase with the access fee.

Investment Stage

Incumbent's investment decision

- Incumbent invests in all regions with non-negative profits

$$\pi_I(\delta_I^{sbc}, p^{sbc}) \stackrel{!}{=} 0 \quad \Leftrightarrow \quad \delta_I^{sbc} = \frac{F_I}{p_I^{sbc} y_I(p^{sbc}) + \alpha y_E(p^{sbc})}$$

- Investment only if investment costs are not too high, i.e. $F_I < F_I^{max}$
- Full coverage only if investment costs equal zero

Optimal coverage in the case of service-based competition

If the entrant acts as a pure reseller, i.e. only service-based competition is realized, the equilibrium coverage increases with the access fee as long as the access fee is not too high.

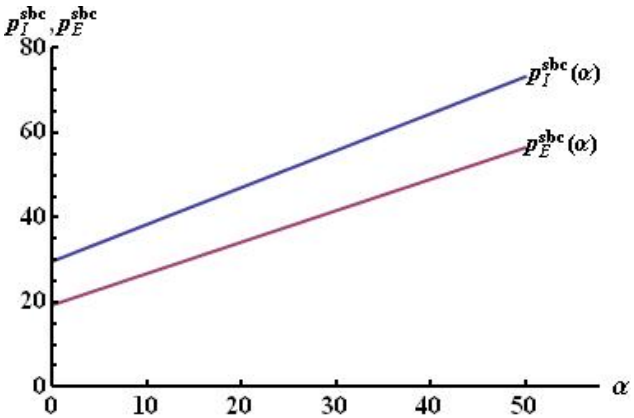
Static vs. Dynamic Efficiency

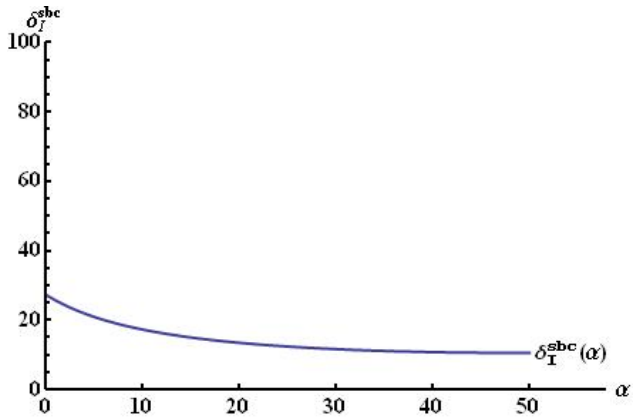
Trade-off between static and dynamic efficiency applies

Higher access fees with higher retail prices and higher total coverage

vs.

Lower access fees with lower retail prices and lower total coverage





(100 = no investment, 0 = full coverage)

Illustration of the equilibrium prices and coverage in the benchmark case

(for $\overline{\delta} = 100$, $\overline{\omega} = 40$, $\nu = 100$, $\lambda = 1$, and $F_E = F_I = 30000$)

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Coexistence of Service- and Facility-Based Competition

Incumbent

- Investment costs F_I to upgrade infrastructure facilities
- Revenues from its consumers and from selling access to the entrant

$$\Rightarrow \max_{p_I, \delta_I} \pi_I = \int_{\delta_I}^{\overline{\delta}} p_I y_I - F_I d\delta + \int_{\delta_I}^{\delta_E} \alpha y_E d\delta$$

Entrant

- "Make-or-buy"-decision in each region
  - Investment: Fixed investment costs F_E and no marginal costs
  - Reselling: No fixed costs and marginal costs equal access fee α

$$\Rightarrow \max_{p_E, \delta_E} \pi_E = \int_{\delta_E}^{\overline{\delta}} p_E y_E - F_E d\delta + \int_{\delta_I}^{\delta_E} (p_E - \alpha) y_E d\delta$$

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Pricing Stage

Equilibrium prices

Mark-up based on switching costs + Entrant's marginal costs × Ratio of service-based competition

Two effects of the access fee on prices

- Direct effect of the access fee on prices
- Second order effect of the access fee through entrant's investment

Effect of entrant's investment on equilibrium prices

If the entrant invests in own infrastructure facilities, the equilibrium prices of both firms decrease with the extent of facility-based competition.

Pricing Stage

Equilibrium prices

Mark-up based on switching costs + Entrant's marginal costs × Ratio of service-based competition

Equilibrium price curves subdivided in two parts

- Low access fees → Entrant acts as reseller in all regions
  - Entrant's marginal costs increase with the access fee
  - Prices increase with the access fee
- Sufficiently high access fees → Entrant starts to invest
  - Ratio of service-based competition decreases
  - Prices decrease with the access fee

Pricing Stage

- Sufficiently high access fees and investments of the entrant
  - Entrant realizes cost savings and lowers its price to attract more consumers
  - Prices are strategic complements
  - Incumbent becomes more aggressive and decreases its price to avoid the lose of too many of its consumers

➠ Retail competition is spurred

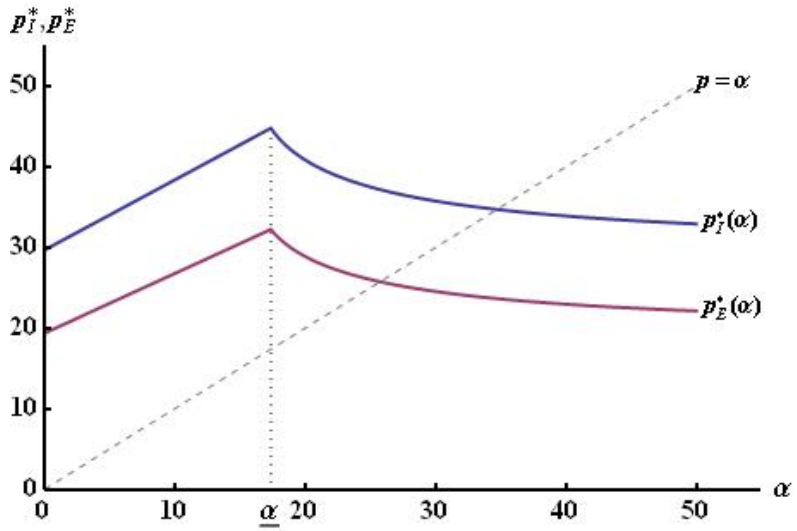

Illustration of the equilibrium prices (for $\overline{\delta} = 100$, $\overline{\omega} = 40$, $\nu = 100$, $\lambda = 1$, and $F_E = F_I = 30000$)

$\alpha < \underline{\alpha}$ Prices increase due to the direct effect of the access fee

$\alpha \geq \underline{\alpha}$ Investment lowers the weight of the entrant's marginal costs

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Investment Stage

Entrant's investment decision

- Solving $\frac{\partial \pi_E(p^*)}{\partial \delta_E} \stackrel{!}{=} 0$ for the optimal investment of the entrant yields a polynomial of degree three $\Rightarrow$ Three non-trivial solutions

Optimal investment of the entrant

A unique and optimal investment decision of the entrant, i.e. a best response to the incumbent's investment decision, $\delta_E^*(\delta_I)$ exists in the admissible range $[\delta_I, \overline{\delta}]$ if the investment costs not too high, i.e. for $F_E < F_E^{max}$.

- The optimal investment of the entrant ...
  - ... increases with the access fee
  - ... increases with the switching costs
  - ... decreases with the investment costs

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Investment Stage

Crucial access fee $\underline{\alpha}$

- Entrant is indifferent between buying access and investment
- For all access fees above $\underline{\alpha}$, the entrant invests in some regions
- The crucial access fee increases with the entrant's investment costs

Extend of facility-based competition

- Facility-based competition is restricted to densely populated regions if the entrant has no significant cost advantaged

Entrant faces a trade-off

- Investment lowers costs in regions with own infrastructures
- Investment fosters retail competition and decrease equilibrium prices

⇛ Entrant acts strategically and invests less to soften retail competition

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Investment Stage

Incumbent's investment decision

- Solving $\frac{\partial \pi_E(p^*)}{\partial \delta_E} \stackrel{!}{=} 0$ for the optimal investment of the incumbent yields a polynomial of degree five $\Rightarrow$ No analytical solution!

Optimal investment of the incumbent

A unique and optimal investment decision of the incumbent, i.e. a best response to the entrant's investment decision, $\delta_I^*(\delta_E)$ exists in the admissible range $[0, \overline{\delta}]$ for sufficiently low investment costs $F_I < F_I^{max}$.

- Investment decision of the incumbent is qualitatively the same as in the benchmark case
  - Incumbent invests in all regions with non-negative profits
  - Full coverage only if investment costs equal zero

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Investment Stage

Incumbent's optimal investment for $\alpha < \underline{\alpha}$

- Service-based competition
- Optimal investment of the incumbent increase with the access fee
  - Revenues per unit access increase
  - Benchmark case applies

Incumbent's optimal investment for $\alpha > \underline{\alpha}$

- Facility-based competition and fiercer retail competition
- Two effects on incumbent's profit in last covered region
  - Decreasing profits from its consumers
  - Increasing profits from selling access
    - Increasing revenues per unit access
    - Increasing demand for access in the last covered region

⇛ Total coverage increases despite intensified facility-based retail competition

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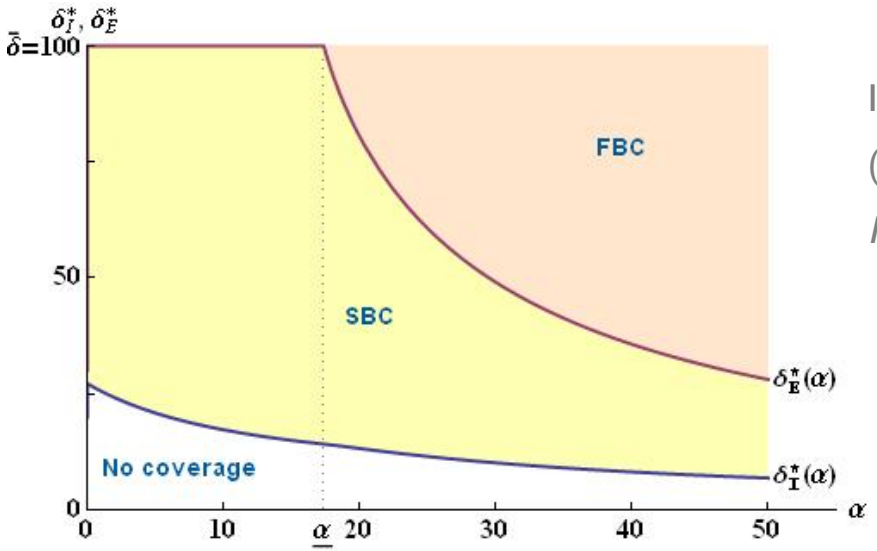
Investment Stage

- Access price determines the extend of black, gray and white areas
- Facility-based-competition is restricted to densely populated regions
- Full coverage is not achievable without additional instruments



(100 = no investment, 0 = full coverage)

Illustration of the equilibrium investments (for $\overline{\delta} = 100$, $\overline{\omega} = 40$, $\nu = 100$, $\lambda = 1$, and $F_E = F_I = 30000$)

$\alpha < \underline{\alpha}$ Service-based competition in all covered regions

$\alpha \geq \underline{\alpha}$ Facility-based competition in densely populated regions

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A Note on cost-based access fees

Average Costs

- Entrant's average costs ...
  - ... equals the access fee as long as the entrant does not invest
  - ... decrease with its investment
- Incumbent's average costs increase with the entrants investment

Crucial access fee $\underline{\alpha}$

- Approximately twice the incumbent's average costs

➠ Cost-based access fee is not sufficient to induce investment

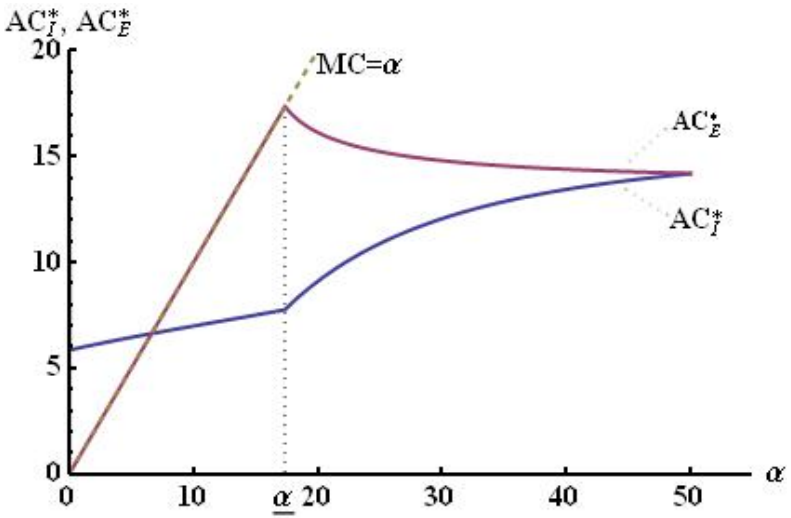

Illustration of the average costs
(for $\overline{\delta} = 100$, $\overline{\omega} = 40$, $\nu = 100$, $\lambda = 1$, and $F_E = F_I = 30000$)

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Voluntary Access

Firms' profits

- Entrant's profits decrease with the access fee
- Incumbent's profits...
  - ... increase with the access fee as long as the entrant does not invest
  - ... decrease with the access fee if the entrant starts to invest

➠ Incumbent has incentives to provide voluntary access

➠ Both firms might argue against higher access fees

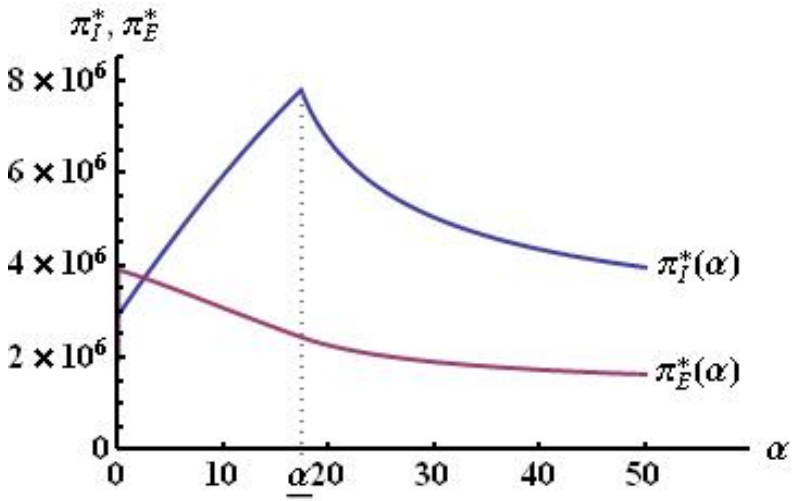

Illustration of the equilibrium profits (for $\overline{\delta} = 100$, $\overline{\omega} = 40$, $\nu = 100$, $\lambda = 1$, and $F_E = F_I = 30000$)

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Extensions

Geographically differentiated prices

- In opposite to related models with economies of density
  - Incumbent has no incentive for geographically differentiated prices
  - Entrant has incentives due to the different cost structures
- Equilibrium prices
  - Increase with access fee in regions with service-based competition
  - Constant prices in regions with facility-based competition
- Investment effects hold qualitatively

Variable price in period zero

- Incumbent has an incentive to lower its prices in the previous period
- Weakened effect of facility-based competition on total coverage
- Results hold as long as p_{I0} is not too low $\rightarrow$ Foreclosure

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Conclusion

- Entrant's make-or-buy decision comprise a trade-off
  - Investment lowers costs in regions with own infrastructures
  - Retail competition becomes fiercer in all regions

➠ Entrant faces a dilemma
↪ Possible explanation why entrants do not climb the ladder

➠ Higher (non cost-based) access fees
↪ Negative effect of fiercer retail competition might be dominated by the positive effect of the investments on costs

- Usual trade-off between static and dynamic efficiency does not hold in generals since higher access fees might yield both:

More intense retail competition with lower prices
and
Higher investments of both firms

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Questions & Remarks

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Equilibrium Prices

$$p_I^{sbc} = \frac{\overline{\omega}((2\lambda+1)\nu+4\overline{\omega})}{3\nu+8\overline{\omega}} + \frac{3(\nu+2\overline{\omega})}{3\nu+8\overline{\omega}} \alpha \frac{\delta_E^2-\delta_I^2}{\overline{\delta}^2-\delta_I^2}$$

$$p_E^{sbc} = \frac{\nu\overline{\omega}(4\lambda-1)}{3\nu+8\overline{\omega}} + \frac{3\nu+4\overline{\omega}}{3\nu+8\overline{\omega}} \alpha \frac{\delta_E^2-\delta_I^2}{\overline{\delta}^2-\delta_I^2}$$

with

α	Access fee
$\overline{\omega}$	Maximum switching costs
ν	Reservation utility
λ	Utility adjustment parameter
$\overline{\delta}$	Region with highest density
δ_I	Incumbent's last covered region
δ_E	Entrant's last covered region

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Investment Stage - Entrant's first order condition

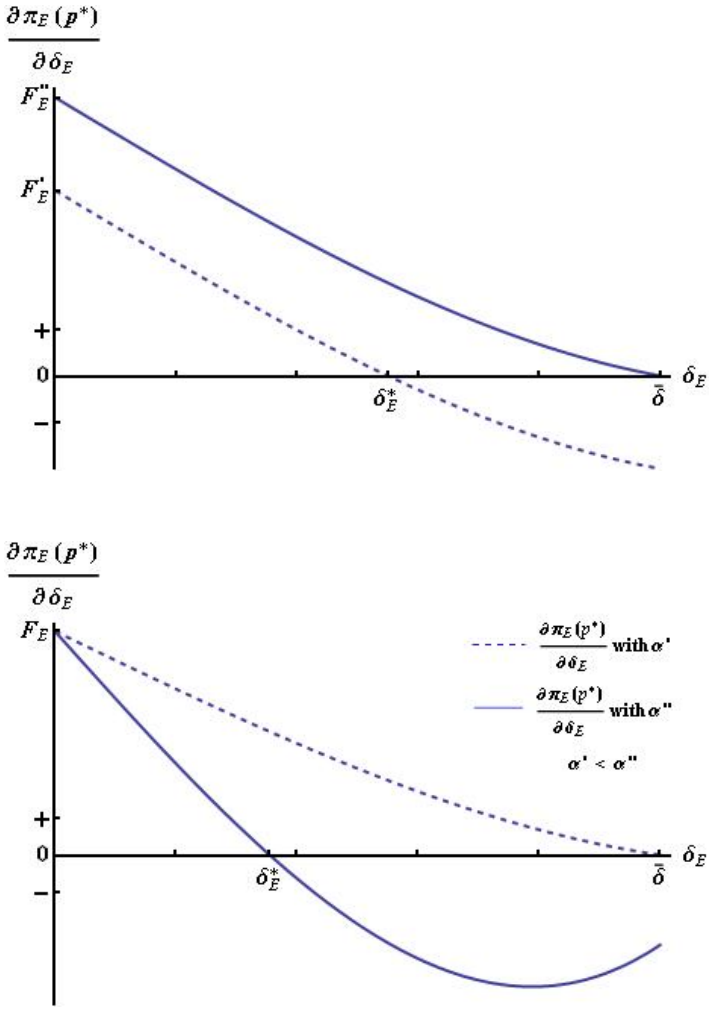

Illustration of the entrant's first order condition

- Different investment costs $F_E^{'} < F_E^{''}$
- Different access fees $\alpha^{'} < \alpha^{''}$

Intersection with abscissa represents optimal investment

Access Stage

- Crucial access fee $\underline{\alpha}$
  - Entrant is indifferent between buying access and investment
  - Increases with the entrant's investment costs

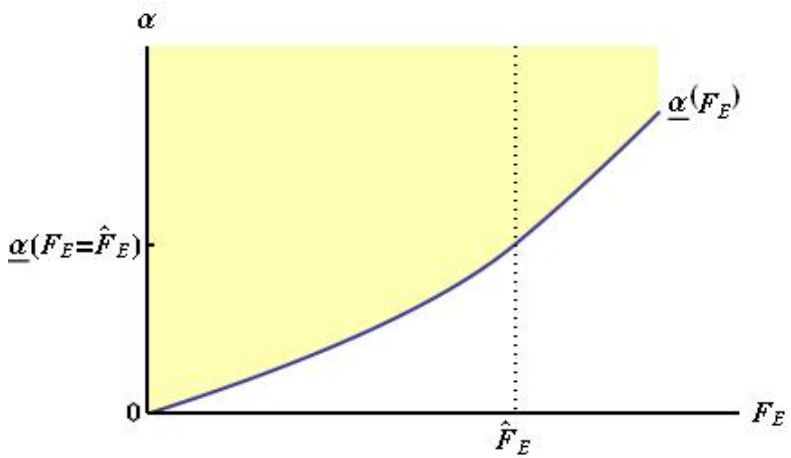

Illustration of the crucial access fee
(for $\overline{\delta} = 100$, $\overline{\omega} = 40$, $\nu = 100$, and $\lambda = 1$)

$\alpha > \underline{\alpha}$ Entrant invests in some regions
$\alpha = \underline{\alpha}$ Entrant is indifferent
$\alpha < \underline{\alpha}$ Entrant does not invest

- Initial investment (for $\alpha = \underline{\alpha}$)
  - Densest region for investment costs $0 \leq F_E \leq \hat{F}_E$
  - Range of regions for investment costs $\hat{F}_E < F_E \leq F_E^{max}$