Regulation incentives for investment and technological change

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An old, but timely regulatory problem

• In the U.S. regulation started with the investment issue: Franchise contracts.

• Doubts about investment incentives were replaced by “Hope” decision (1944), which provided a stable base for rate-of-return regulation.

• When I started working on regulation in the 1970s the main problem tackled by economists was that of regulatory incentives for excessive investment under rate-of-return regulation (Averch-Johnson effect).

• Rate-of-return regulation has been replaced by incentive regulation with an emphasis on cost reduction and efficient pricing. Has investment been neglected? What about the over-investment in Telecommunications before 2000/2001?

• Contested German telecommunications law provides a regulatory holiday for innovative investment as does current practice of the U.S. Federal Communications Commission.
Overview

• Basic Considerations about Regulation and Investment

• Regulation Under Full Commitment

• Long-term Investment and Variable Commitment

• Conclusions
Specific investment problems in network industries

• Economies of scale lead to lumpiness
  – in size of increments and to (wasteful) duplicate investments
  – in lead time and duration

• Sunkness implies competitive risks and risks associated with real options

• Examples
  – Electricity transmission and distribution networks (weak competitive risks)
  – Broadband telecommunications access and backhaul (strong competitive risks)
  – Fibre networks in the late 1990s: Race to be first → overcapacity

• Tradeoff: Investment benefits are potentially high relative to benefits from short-term cost reductions and efficient pricing.
Different types of investment may be affected differently by regulation

- **Investment in cost reduction, replacement investment**
  - Positive effect under price-cap or yardstick regulation likely (Cabral/Riordan, Borrmann/Brunekreeft)

- **Investment in quality improvements**
  - Lower quality is substitute for price increase
  - Empirical effects inconclusive

- **Investment in new products and new infrastructure**
  - Regulation constrains upside opportunities.
Regulation and investment

• Regulation can have ambivalent investment effects
  – Facilitates race for investment between incumbent and entrants (by creating entrants with less cannibalization problem)
  – Lowers expected investment returns; increases or decreases risks
    • Truncation of investment outcomes under uncertainty
      – Price constraints
      – Risk shifting
      – Increased WACC to compensate?
    • Lack of commitment

• Effects are result of incentives and governance. We concentrate on
  – Prices as regulatory incentive variables
    • Signal for expected price, which in turn determines output and therefore investment (in absence of non-price rationing)
    • Source of revenues for financing investment
    • Truncation of price distribution lowering expected returns and affecting investment risk
  – (Lack of) regulatory commitment as regulatory governance variable
    • Regulators want investment (in fact, too much so!)
    • Regulators also want low prices
    • Ex post conflict with ex ante desire
Types of incentive regulation

• Basis for incentives is asymmetric information.

• Non-Bayesian approach (Baumol, Vogelsang/Finsinger, Littlechild):
  – Based on simple principles
  – Directed towards welfare improvement, not optimization
  – Geared for application, but investments have generally not been addressed explicitly

• Bayesian approach (Baron/Myerson, Laffont/Tirole):
  – Uses principal-agent framework
  – Full constrained welfare optimization:
    • No direct applicability, but addresses investment incentives via commitment
    • Qualitative insights usable for non-Bayesian approach in this talk
Strength of incentives and tightness of regulation

**Strength of incentives:**
- The percentage of cost reductions the firm may keep or of cost increases that it may have to suffer
  - Strong incentives = high percentage
  - Weak incentives = low percentage

**Tightness of regulation (participation constraint):**
- The profit rate*) that the regulator is conceding to the firm in case normal expectations are fulfilled
  - Tight regulation = a low or zero expected profit rate = low price
  - Soft regulation = a high expected profit rate = high price
  - Intermediate regulation = between tight and soft

*) economic profits = profits in excess of capital costs
Risk/incentives for different types of price regulation

• Rate-of-return regulation/cost-plus regulation
  – Low risk/weak incentives

• Profit-sharing regulation
  – Medium risk/incentives

• Price-cap regulation
  – Medium/high risk/incentives

• Yardstick/benchmarking regulation (including engineering cost models)
  – High risk/strong incentives

While these are ranked from low risk/weak incentives to high risk/strong incentives, the regulator can make compensating adjustments.
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My approach to regulation and investment

• The literature on the relationship between regulation, investments and innovation suggests many different case-specific outcomes (see recent survey by Cambini and Jiang). Keeping the cases apart and deriving case-specific regulations is highly information-intensive and may be subject to moral hazard and adverse selection on the side of the regulators.

• The theoretical literature finds the effects of regulation on investments under rate-of-return regulation and under all types of incentive regulation to depend on the tightness of regulation and therefore on the way regulation is handled by the individual regulators. Dependable empirical findings would therefore be most helpful.

• My approach is to use simple economics and insights from the literature for extracting some fairly general properties and to come up with a few rough-and-ready rules. They may do injustice to the individual case but are more likely to be feasible for implementation and less subject to commitment problems than more specific case-dependent rules.
A simplified view of infrastructure investment as a function of price: Soft vs. tight regulation

Price, Costs

\[ P_{\text{Monopoly}} \]

\[ P_{\text{soft}} \]

\[ P_{\text{intermediate}} \geq \text{LRAIC} \]

\[ P_{\text{tight}} = \text{MC} \]

Investment function

Demand (output demand)

MC

Shape of investment function affected by cost and demand risks: Corridor in the horizontal portion ⇒ Asymmetric effect of tight vs. soft regulation
Two types of infrastructure investment

• Bottleneck infrastructure (access regulated)
  – Bottleneck = essential facility: A necessary input (fixed proportions) that is owned by an incumbent and cannot be duplicated economically by potential entrants
  – Legacy and innovative infrastructures of incumbent
  – Bypass infrastructure by competitors (“Merchant investment”)
    • Ladder-of-investment aspect (Cave)
    • Replacement effect (Bureauau and Dogan, Hori and Mizuno)
  – Competition for the market vs. competition in the market

• Downstream/upstream of bottleneck (not regulated)
  – Infrastructure of vertically integrated incumbent
  – Competitors’ infrastructure
  – Access-related infrastructure
Best bottleneck regulation for infrastructure investment

- Bottleneck infrastructure of incumbent
  - Tight regulation may prevent investment (financing).
  - Soft regulation will lead to higher prices and lower than optimal investments.
  - Intermediate regulation overcomes both problems.

- Bypass infrastructure of competitors
  - Tight regulation makes bottleneck access more attractive.
  - Ladder-of-investment aspect:
    - Soft regulation makes bypass attractive if bypass is fully possible.
    - Intermediate regulation makes bypass attractive if bypass is partially possible.
  - HOWEVER: Sappington critique

- Downstream infrastructure (of incumbent and competitors)
  - Tight regulation increases downstream output and downstream investment.

- Best overall approach depends on relative weight and relative sunkness of bottleneck infrastructure vs. other infrastructure
  - Intermediate regulation generally best compromise
### Effects of tightness of bottleneck regulation on infrastructure investment in the absence of end-user regulation

<table>
<thead>
<tr>
<th>Investment Type</th>
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<th>Competitive Bypass (Make or Buy)*)</th>
<th>Incumbent Downstream</th>
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<tr>
<td>tight</td>
<td>-(+)</td>
<td>- Sappington: 0</td>
<td>-(+)</td>
<td>+</td>
</tr>
<tr>
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<td>+</td>
<td>0 Sappington: 0</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
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<td>+(-)</td>
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<td>-</td>
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*) Competitors tend to have higher cost for bypass investment.
How can soft regulation provide efficiency incentives?

• Profit-sharing regulation
  – Soft definition of (excess) profit: Preserves incentives
  – Soft = more sharing → rate-of-return regulation: Reduces incentives
  – Soft = asymmetric in favor of firm → distortions (?)

• Price-cap regulation
  – Cost-reducing incentives largely independent of price-cap level
  – End-user regulation: Allocative inefficiency balanced by competitive pressure
  – Bottleneck regulation: Reduced downstream competition balanced by bypass incentives

• Regulation based on analytical cost model
  – Intrinsic efficiency incentive if model independent of incumbent’s costs
  – Soft regulation via built-in rate of return (more than risk surcharge?)
  – Uncertainty from replacement cost approach (Evans, Guthrie)

• Benchmarking (Yardstick)
  – Allow pre-set distance from efficiency frontier
  – Base on Ø rather than frontier

• Bayesian regulation: Allow for positive profit at participation constraint → Similar incentives but higher expected profits
How can soft/intermediate regulation be implemented?

- Soft/intermediate regulation may require regulatory discretion: Commitment problem treated later

- Verifiable criteria hard to come by

- Two-step procedure
  - Step 1: Establish and apply criteria for applicability of tight vs. soft/intermediate regulation
  - Step 2: Choose specific type of soft/intermediate regulation
    - Ex post regulation
    - Apply competition law criteria (German Telecommunications Act of 2003)
    - Efficient Component Pricing Rule (ECPR)
    - Use pricing approach where clear differentiation of criteria is possible (e.g., benchmarking)

- Choice of pro-industry regulator (Evans, Levine and Trillas)
Ordinary investments vs. innovative investments

• Ordinary investments: Legacy infrastructure
  – Known costs
  – Known demands
  – Nevertheless, some problem of sunk costs → surcharge for real options?
  – Unbundling and competitive network access feasible → downstream competition + downstream deregulation

• Innovative investments: New type of infrastructure
  – Costs highly uncertain
  – Risk of low penetration
    • Low capacity utilization → high average costs
    • Penetration pricing problem
  – Unbundling and access regulation inherently difficult
  – More likely case of symmetry between market players → possible race for investment

• Innovative investments as case for deregulation?
### Properties of regulation

<table>
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<tr>
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<th>Advantages</th>
<th>Drawbacks</th>
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<tr>
<td>Ex ante remedies</td>
<td>• Immediacy, precision, dependability, prevention</td>
<td>• Reduction of freedom to compete, too much intervention</td>
</tr>
<tr>
<td>Specialized agency</td>
<td>• Specialized knowledge, speed of intervention</td>
<td>• Influence of interest groups, (too little or) too much intervention</td>
</tr>
<tr>
<td>Prescriptive intervention (affirmative duties)</td>
<td>• Strong influence on desired behavior, precision</td>
<td>• Reduction of freedom to compete, inefficient prescriptions because of asymmetric information; too much intervention</td>
</tr>
<tr>
<td>• Pricing</td>
<td></td>
<td></td>
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<tr>
<td>• Quality</td>
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### Inappropriateness of general competition law

<table>
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<tr>
<th>Property of competition law</th>
<th>Competition law inappropriate if...</th>
<th>Relevant for...</th>
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| **• Requirement to show violation** | • Large, irreparable damages *(compensated by large penalties?)*  
• Difficult to prove abuses, e.g. denial of access hidden by slowing down negotiations  
• Frequent and repeated abuses | • Access to monopolistic bottlenecks  
• Predation against competitors |
| **• Inability to set prices** | • Lack of comparable markets  
• Economies of scale and scope  
• Long duration of intervention in a changing environment | • Access to monopolistic bottlenecks  
• Market dominance in access market  
• Monopoly in end-user market |
| **• Inability of supervision** | • Considerable information requirements  
• Continuous supervision requirements | • Access requirements  
• Price regulation |
Investment and technological change

• Choice between sector-specific regulation and general competition policy always involves tradeoffs.
  – Other advantages of regulation and the disadvantages of competition policy less relevant if regulation is associated with no/insufficient innovation.

• Two arguments for deregulation of or regulatory holidays for innovative infrastructure:
  – Patent argument: You get more innovation, and that is more valuable than the potential deadweight loss from monopoly pricing.
  – Error argument: Regulation of innovative infrastructure is inherently more complicated than regulation of legacy infrastructure. Also, potential benefits from innovation are much higher than benefits from regulation. The error from false and distorting regulation is therefore more likely and more severe than in the case of legacy infrastructure.

• How to distinguish ordinary and innovative investments?
  – The notion of “emerging markets” under the EU communications framework takes an extremely narrow view of innovations (“Three-criteria test cannot be applied.”)
  – Weaker concept: Creation of new market
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Incentive regulation and investment: The role of commitment

• Inability to commit
  – Legal constraints on commitment
  – Change in regulatory personnel
  – Impossibility of complete contracts

• Sub-optimality of (exercising) commitment
  – Value of flexibility in a changing environment: Learn from mistakes
  – Inability under commitment to adapt to new situation

• Lack of commitment
  – Exogenous - Change in outside variables: Inflation, political elections
  – Endogenous – Change in regulatory variables: Profit, investments (Grajek/Roeller)
  – Potential drivers for the effects of lack of commitment: Efficiency, fairness, political influence
**Relationships between investment and commitment**

• **Commitment can be good for investment:**
  – Provides a reliable basis, overcomes dynamic inconsistency
  – Prevents ex post bias against profits
    • Particularly relevant for infrastructure innovations with potential for high profits or high losses
      – Example: Symmetric profit and loss sharing can overcome the regulatory truncation problem. However, loss sharing cannot fully insure the firm (because consumers can opt out).
    • Relevant for cost-reducing incentives that potentially increase profits

• **Lack of commitment can be good for investment**
  – The effects of lack of commitment depend on political/legal environment (“institutional endowment”). In a culture of symmetric fairness regulated firms may be shielded against large losses.
  – Lack of commitment can deal with unexpected technological/market changes and can correct mistakes.

• **Commitment needs balancing with sensible flexibility/incentives**
  – Strength of due process (U.S. approach)
Incentive regulation and investment: The role of commitment

- (1) The longer the time horizon the less regulators can commit.
- (2) Infrastructure investment has long lead time and long life.
- (1) + (2) → Full regulatory commitment for time horizon of investment not possible.
- (3) General result of the literature on Bayesian Incentive Regulation: The less the regulator can commit to incentives (and the associated profits and losses) the weaker should incentives be.
- (1) + (2) + (3) → Compatibility of incentive regulation and efficient investment is in doubt
A two-period framework

• The short period
  – Regulatory lag, (RPI-X)-type adjustments or profit sharing
  – Firm decisions on operations, repairs and maintenance costs
  – Full regulatory commitment
  – Steep incentives for cost reductions feasible

• The long (commitment) period
  – Revisions of (RPI-X)-adjustments and of incentive mechanisms at the end of each long period
  – Length of long-term contracts
  – Almost full commitment to incentives feasible inside a long period

• Beyond the long period
  – Infrastructure investments go beyond several long periods
  – Only very basic regulatory commitment possible beyond a long period
  – Little or no cost-reducing regulatory incentives feasible beyond a long period
Tightness of regulation and the two-period framework

• Too soft regulation likely to lead to excess profits over time → Reduces length of commitment period

• Too tight regulation likely to lead to losses over time → Reduces length of commitment period

• Intermediate regulation viable for longer than either soft or tight regulation

• Consequences of the two-period framework for investment:
  – Intermediate regulation enhances commitment power and investment incentives
  – Intermediate regulation is compatible with short-term incentive regulation
  – However: How can regulators commit to “intermediate regulation” in the first place?
**Intermediate regulation with some commitment: Solution I**

- In the U.S. rate-of-return regulation has provided strong commitment for many decades (with allowed rate of return $\geq$ cost of capital; Evans/Garber).

- Combine rate-of-return regulation (intermediate to soft regulation) with a used-and-useful criterion for including assets in the rate base.
  - Rate-of-return regulation credible because of Supreme Court decisions ("Hope")
  - Used-and-useful criterion subject to court review
  - Gilbert/Newbery: Efficient approach

- Rate-of-return regulation need only be applied to RPI-X updates or to other incentive-regulation updates. $\rightarrow$ Some incentives and flexibility

- Use of historic cost standards to reduce investment risks (with downward flexibility through price caps)?
Intermediate regulation with some commitment: Solution II

• Regulatory holidays*)
  – Regulation begins with a lag after regulatory requirement has been met.
  – Lag can be viewed as short period, for which commitment is feasible.
  – Holidays unlikely to be long enough for financing large sunk investments
    • Unless they provide incumbent with an insurmountable lead
  – Regulatory holidays could be combined with intermediate regulation after holidays expire. Combination of intermediate regulation with regulatory holidays could spur investment.
  – Verifiable standards for regulatory holidays needed
    • Example: Non-applicability of EU communications framework three-criteria test

*) Peruvian regulator Thornberry: What is that? I have not had a holiday in 2 ½ years!
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Conclusions

• I take a fairly general rather than case-specific approach to the relationship between regulation and investment. Nevertheless, the regulator will have to determine if investment problems and/or innovations play a major role in the particular industry.

• If that is the case then there are two main regulatory concerns for investment/innovation:
  – Uncertainty
  – Regulatory commitment over the long time horizon associated with investment

• Uncertainty leads to the truncation issue and thereby to an asymmetric error distribution that favors intermediate over tight and soft regulation.

• The regulatory commitment problem favors
  – Intermediate regulation
  – A regulatory review cycle with true-ups based on actual costs and based on rate-of-return criteria
  – Deregulation or regulatory holidays for innovative investments
## Reserve 1: Effects of tightness of end-user regulation on infrastructure investment

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Reserve 2: Tool for separating allocation and financing incentives: Two-part tariff price-caps

- Two-part tariff pricing constraint can be combined with any type of price-level regulation, such as benchmarking.

- Marginal price as main determinant of demanded quantity affects amount and direction of expansion investment (for given number of customers).

- Flexible fixed fee helps keep average price fairly stable and thereby allows for financing of investment and increases regulatory commitment.

- Two-part tariffs can reduce price truncation problem under uncertain demand.

- Price-cap weights substantially affect marginal price and average revenue (revenue/usage quantity).

- At wholesale level two-part tariffs have economies-of-scale effects that can distort competition (e.g., under imputation, compared to the incumbent).

- One-off charges are not as flexible as two-part tariffs, but can reduce financing problems.
Reserve 3: Example of intermediate regulation with some commitment

• LRAIC/TELRIC approach to access pricing has provided a credible cost standard
  – LRAIC >> Marginal costs
  – LRAIC/TELRIC follow progress in state-of-the-art risk evaluation
    • Inclusion of input price changes (Mandy/Sharkey)
    • Inclusion of real options in WACC (Hausman; Pindyck)?
    • Adjustment of rate base for excess capacity (Evans, Guthrie)?
  – Problem with forward-looking approach: Takes new technology as given
  – As handled by regulators LRAIC standard is closer to tight than to intermediate regulation.
Reserve 4: Other solutions to the commitment problem

• Basic question: To what extent does regulation of infrastructure access change the overall risk of innovative infrastructure investments (rather than only its distribution)? Applicability of Modigliani-Miller theorem?

• Infrastructure sharing between incumbent and access seekers
  – Infrastructure sharing commitments can cover the investment period.
  – Genuine risk sharing ex ante
  – Reduces ex ante (first-mover) competition
  – More or less competition ex post?
  – Complex transaction with monitoring and collusion problems

• Long-term contracts (ex ante) between incumbent and access seekers
  – Mandated short-term access = risk-free options for access seekers → long-term contracts desirable or surcharge for short-term access
  – Long-term supply contracts probably cannot cover the investment period.
Reserve 5: Other solutions to the commitment problem

• Repair models for insufficient investments under regulation
  – Widespread universal service subsidies in telecommunications; now under discussion for broadband access
  – 2009 stimulus packages for broadband access in several countries
  – Investment commitment by regulated telecommunications carriers in exchange for favorable regulation, e.g., in New York state around 1990
  – Generation resource adequacy regulation to compensate investment disincentives from electricity generation spot pricing