Incentive Regulation: Asset Valuation and Investment in Advance

Graeme Guthrie

School of Economics and Finance
Victoria University of Wellington

Seminar based on:

Introduction

- How should we regulate prices?
- Keywords:
  - Incentive regulation
  - Uncertainty
  - Investment: irreversible; economies of scale
- Practical importance:
  - US and elsewhere: TELRIC
  - NZ: ODV, TSO
Outline

- A simple example
- Describe model structure
- Cost-minimizing investment
- Regulated firm’s cost structure
- What level of revenue is reasonable revenue?
- Implication for firm’s investment incentives
- Conclusion
A simple example

Investment with scale economies

- The one-period interest rate is $r$
- Customers demand 1 unit of capacity this period
- Demand equals $1 \pm \sigma$ units next period
- It costs $\sqrt{s}$ dollars to build $s$ new units of capacity

![Graph showing cost vs. capacity with cost if 1 instalment and cost if 2 instalments]
A simple example: Investment

- Suppose a firm must meet demand in both periods
  - It can build $1 + \sigma$ units now, costing $\sqrt{1 + \sigma}$
  - It can build 1 unit now, and only expand if needed

$$PV[\text{cost}] = 1 + \frac{1}{2} \frac{\sqrt{\sigma}}{1 + r}$$
A simple example: Investment

- Suppose a firm must meet demand in both periods
  - It can build $1 + \sigma$ units now, costing $\sqrt{1 + \sigma}$
  - It can build 1 unit now, and only expand if needed

$$\text{PV}[\text{cost}] = 1 + \frac{1}{2} \frac{\sqrt{\sigma}}{1 + r}$$

- The cost to the firm is the smaller of

$$\sqrt{1 + \sigma} \text{ and } 1 + \frac{1}{2} \frac{\sqrt{\sigma}}{1 + r}$$
A simple example: Incentive regulation

- The revenue which the existing firm is allowed to collect is often based on the cost structure of a hypothetical replacement firm.

- Contrast *optimized replacement cost* (ORC) and *historical cost* (HC).

- Consider a replacement firm next period.
  - If demand is *high*, a replacement firm builds $1 + \sigma$ units, costing
    \[ ORC_h = \sqrt{1 + \sigma} \]
  - If demand is *low*, a replacement firm builds $1 - \sigma$ units, costing
    \[ ORC_l = \sqrt{1 - \sigma} \]

It has an informational advantage.
A simple example: Incentive regulation

- If the existing firm locked in the economies of scale last period,

\[ HC_h = HC_l = \sqrt{1 + \sigma} \]

and

\[ HC_h = ORC_h \quad HC_l > ORC_l \]

- If the existing firm retained flexibility last period,

\[ HC_l = 1, \quad HC_h = 1 + \sqrt{\sigma} \]

and

\[ HC_h > ORC_h \quad HC_l > ORC_l \]

- The hypothetical replacement firm faces lower costs. Why?
A simple example: Lessons

Lessons so far

- Sometimes it is best to invest ahead of demand
- Sometimes it is best to retain flexibility (i.e. not invest too far ahead of demand)
- Hypothetical replacement firm has a cost and informational advantage
Model set-up

- A firm
  - faces uncertain future demand and capital prices
  - must satisfy all demand
- Investment in capacity
  - irreversible
  - economies of scale
  - physical depreciation
- The firm’s allowed revenue is set by a regulator
- Key issue: What revenue is ‘reasonable’ under a scheme of incentive regulation?
The implications of irreversibility

- Cost-minimizing investment policy
  - Existing firm: wait until it has no excess capacity, and then increase capacity to \( g \times \text{demand} \) for some \( g > 1 \)
  - Replacement firm: invest in capacity of \( h \times \text{demand} \) for some \( h > g \), then follow the policy above

- The consequences:
The implications of irreversibility

Cost-minimizing investment policy
- Existing firm: wait until it has no excess capacity, and then increase capacity to $g \times \text{demand}$ for some $g > 1$
- Replacement firm: invest in capacity of $h \times \text{demand}$ for some $h > g$, then follow the policy above

Optimal investment is lumpy, builds excess capacity

A new firm has an informational advantage and can exploit more economies of scale than the existing firm
Cost functions

- We are interested in three different measures of cost
  - Cost of *continuing* in business:
    \[ PV[\text{Future invt expenditure}] \]
  - Cost of *replicating* the network (with one which is identical):
    \[ RC + PV[\text{Future invt expenditure}] \]
  - Cost of *replacing* the network (with one which is efficiently configured):
    \[ ORC + PV[\text{Future invt expenditure}^*] \]
Cost functions
What revenue is ‘reasonable’?

- ‘Reasonable’ *rate of return regulation*:
  \[
  PV[Revenue] = \text{historical cost of existing assets} + PV[\text{Future costs}]
  \]

Regulated firm is guaranteed cost recovery

- ‘Reasonable’ *incentive regulation*?
  - Form of revenue function:
  \[
  PV[Revenue] = R(\text{independent of firm’s past and future decisions})
  \]
  
  - Firm has incentive to minimize cost
  - What form should \( R \) take?
Incentive regulation: Possibility #1

- Requirement: Firm must be willing to continue in business

\[
PV[\text{Future revenue}] 
\geq PV[\text{Future total costs of regulated firm}]
\]

- Minimum rate of return allowed on ORC is

\[(\text{Irreversibility multiplier #1}) \times (\text{riskfree rate} + \text{ORC sys. risk premium} - \text{ORC trend})\]
Incentive regulation: Possibility #1

Since

$$PV[\text{Future total costs of regulated firm}] < PV[\text{Future total costs of replacement firm}]$$

if the regulator allows the minimum possible revenue, then

$$PV[\text{Future revenue}] = PV[\text{Future total costs of regulated firm}] < PV[\text{Future total costs of replacement firm}]$$

But this means that the firm would not start business in the first place, or regard future revenue rules as assured.
Incentive regulation: Possibility #2

- Requirement: Firm must be willing to *start* in business

\[ PV[\text{Future revenue}] \geq PV[\text{Future total costs of replacement firm}] \]

- Minimum rate of return allowed on ORC is

\[(\text{Irreversibility multiplier #2}) \times \]

\[(\text{riskfree rate} + \text{ORC sys. risk premium} - \text{ORC trend})\]
Incentive regulation: Possibility #2

The value of the regulated firm is

\[ PV[\text{Future revenue}] - PV[\text{Future total costs of regulated firm}] = PV[\text{Future total costs of replacement firm}] - PV[\text{Future total costs of regulated firm}] \]
Incentive regulation: Possibility #2

- The value of the regulated firm falls as capacity runs out
  - Cash inflows increase, while there are no cash outflows, so why does firm value fall?
  - Investment becomes more likely as capacity runs out
  - The firm must be making an expected loss whenever it has to invest

- Explanation: The firm’s revenue is based on the cost structure of a hypothetical replacement firm, which has a fundamental cost advantage

- Perverse incentives: Firm wants to avoid investment

- Implication: Allowed rate of return on ORC needs to be higher to compensate for the ‘low’ value of ORC
Incentive regulation: Possibility #3

- Requirement: Firm must at least *break-even* whenever it has to invest
- Minimum rate of return allowed on ORC is

\[
(\text{Irreversibility multiplier #3}) \times \left( \text{riskfree rate} + \text{ORC sys. risk premium} - \text{ORC trend} \right)
\]
What is the firm worth?

Market value

Poss #3
ORC
Poss #2
Poss #1
Demand

Incentive Regulation: Asset Valuation and Investment in Advance – p. 22/23
Concluding remarks

- Results appropriate for rate of return regulation or reversible investment do not necessarily apply to firms subject to incentive regulation.

- Optimized replacement cost is artificially low as a cost measure, due to:
  - uncertainty
  - irreversibility
  - economies of scale

- The allowed rate of return applied to ORC must be increased accordingly.

- Speculative comment: The allowed rate of return may be lowered if the firm can delay satisfying demand.