Infrastructure Investment and Uncertainty

Lewis Evans
Victoria University of Wellington, New Zealand

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Outline

Context

- Infrastructure Characteristics
  - restrict to physical infrastructure
  - cost structure
    - substantial
    - irreversible
    - economies of scale
  - network effects
  - volatile utilisation
    - means capacity is not 1:1 with usage
    - means investment is risky
    - intermodal competition
- Economies of scale and uncertainty pose particular issues

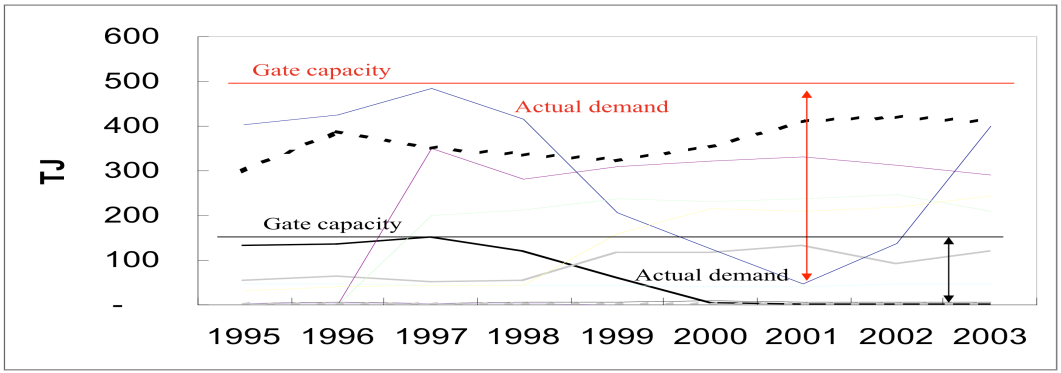
Sources of Volatility

Demand and Cost

- DEMAND is volatile although it varies across infrastructures:
  - electricity lines: is low (managed)
  - telecom exchange much higher (less managed)
  - gas
- COSTS
- technological change
- construction costs
- input prices

Demand Volatility
Example Gas Demand Volatility

Risk: example Capacity Determined by Historical Maximum Throughput



NGC Gate Station Gas Flows

Volatility in Network Costs

For the same quality?: vary with (PBA (2004))

1. price of inputs, such as labour and materials
2. the level of competition and with the level of supply and demand;
3. project size;
4. the location of the project;
5. with legal and regulatory requirements, and constraints imposed by local authorities;
6. as between new construction sites and established locations;
7. design and construction standards; and
8. with the efficiency of the project and contract management.

Cost Volatility
Examples

- Transit NZ (2006) for thirty projects in Auckland Wellington and Christchurch: range of tenders is 26% of the maximum tender.
- PWC (2004) Data on project quotes for or four categories of investment across six lines companies

Variation	Undergrnd.	Tnsfm.UpGd	11kV urban	11kV rural
Coefficient of	17.8%	40.1%	27.8%	27.62%

- Looking forward there is uncertainty about technological change effects on costs

Project Evaluation

Variance matters:

The social cost-benefit criterion

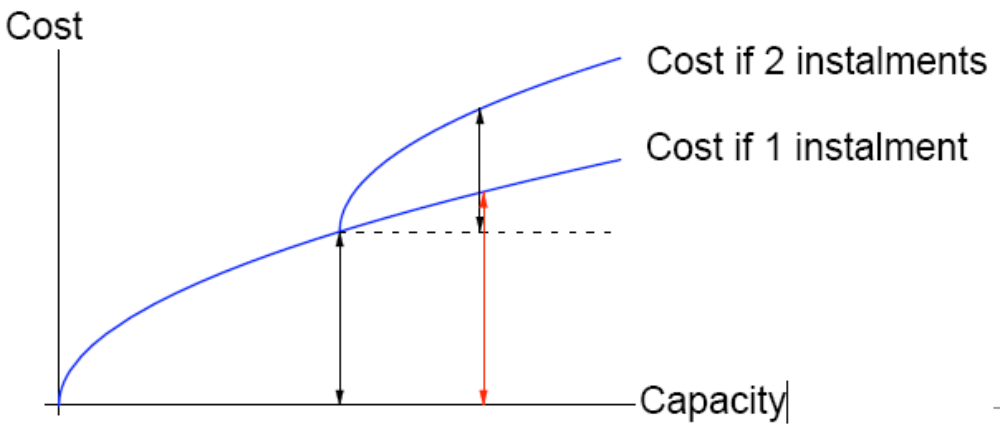
- is the expected net present value of total surplus
- must reflect demand response to costs including external costs (congestion) and quality
- timing of infrastructure investment is one of the critical elements
- is affected by volatility
  - affects the timing of investment
  - larger the volatility the more valuable the option to "wait"
  - is another reason why demand affecting instruments are important
  - interacts with economies of scale to affect the quantum of investment

Natural Monopoly
Reconciliation of Static and Dynamic Origins

- Traditional static natural monopoly theory:
  - fixed costs plus low marginal costs imply
    - declining average cost
    - pricing must be above marginal cost
- But where does declining cost come from?
  - organisational economies: unlikely given capital intensity
  - input price scale effects
  - economies of scale in investment
- Economies of scale in investment
  - Definition: the larger the investment to expand services the lower the average incremental cost
  - Add that the investment is irreversible (sunk)
  - Accords with the static form of natural monoply

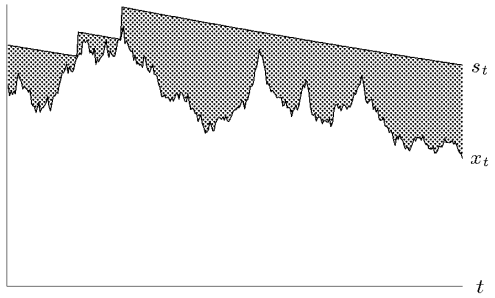
Economies of Scale

Arises in a wide range of investment



Investment Rule

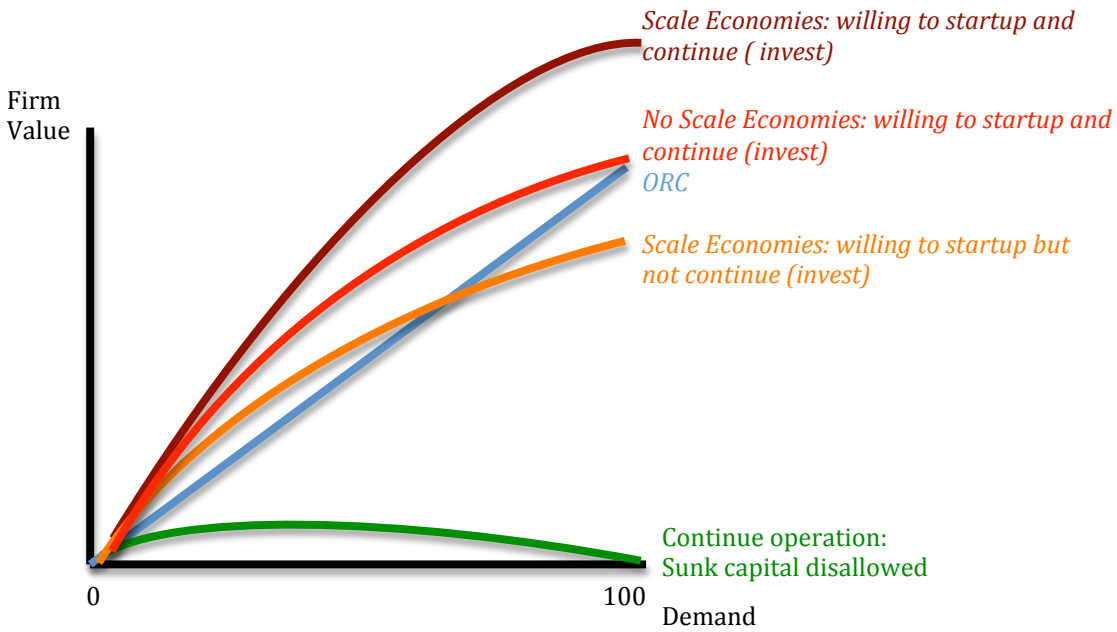
Demand must be met



- Capacity **s** depreciates
- Demand **x** is volatile
- Investment with economies of scale:
  - investing extinguishes the option to wait: but may lose cost benefits of scale economies
  - invest more than meets demand at the time of investment

Investment Issues: Replacement Cost Pricing

Value of the Firm: as output varies over fixed (sunk) capacity (100): capital base is optimised replacement, cost and demand uncertain



Summary

- Replacement cost pricing: serve all customers no feedback
  - economies of scale imply investment conflict; unless
  - allowed an unrealistically high high rate of return, or
  - subsidy as in the static model
- Replacement cost pricing: invest excess demand threshold:
  - substitutes consumer loss for financial loss or subsidy
  - requires shortage allocation mechanism for consumers
  - prices have the usual advantages of
    - efficient allocation among consumers
    - revealing quantified demand for the infrastructure investment
  - cases where prices may reduce the incentive to invest at the right time.
- Historical-cost pricing: shifts risk to consumers, leaves the scale/risk trade-off

Institutional Settings Affect Investment

Risk, and economies of scale taken as given

- generally pure private investment
  - must prospectively be funded by consumer charges (demand) and subsidy
  - difficult to fund on historical cost
    - consumers carry all the risk
    - who determines investment?
  - congestion price
  - carries most of the risk
  - -enables contestability where feasible
- generally mixed private investment plus government
  - choice of historical cost or replacement cost pricing
  - conjestion pricing

Final Comment

- Volatility engenders much uncertainty, affects timing of socially optimal investment
- Economies of scale are widely present and affect policy toward infrastructure
- Treatment of demand is critical to efficient investment in infrastructure
- Where economically possible demand should be sensitised to cost and benefits by pricing

References

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