Infrastructure Investment and Uncertainty

Lewis Evans
Victoria University of Wellington, New Zealand

July 13, 2010
Presentation at the IPS/Motu Workshop
Victoria University of Wellington
Outline

1. Context:

2. Volatility

3. Project Evaluation

4. Economies of Scale

5. Investment Issues

6. Final Comment
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.

<table>
<thead>
<tr>
<th>Variation</th>
<th>Undergrnd.</th>
<th>Tnsfm.UpGd</th>
<th>11kV urban</th>
<th>11kV rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient of</td>
<td>17.8%</td>
<td>40.1%</td>
<td>27.8%</td>
<td>27.62%</td>
</tr>
</tbody>
</table>

- 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 monopoly
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
  - congestion 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


