Asset Life and pricing the use of infrastructure: the case of Electricity Transmission in Chile

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Outline

- Chilean ESI
- Asset life in electricity transmission
- Asset life concepts
- Asset life and regulation
- Main policy lessons
Chilean ESI

In the early 1980’s Chile pioneered the process of privatization and deregulation of the world-wide electric industry.
<table>
<thead>
<tr>
<th>Electric Systems in Chile (2006)</th>
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<tbody>
<tr>
<td><strong>Installed capacity (MW)</strong></td>
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<td><strong>SIC</strong></td>
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<tr>
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* 2005
Industry structure

• Three segments

  – Generation, developed as a competitive sector
  – Transmission, first a competitive sector with open access obligation and agreed tariffs.
  – Distribution, regulated natural monopoly

  – SO, dispatch follows the power plants merit order, independently of the generators electricity supply contracts
– In 2004 changes the business model that governs the transmission segment.

  – A sector developed on a competitive basis →
  – A sector developed following a centrally defined electricity transmission expansion plan with regulated tariffs. Investments, cost of capital and the *economic asset life* define tariffs, where
  a) tariffs for current transmission infrastructure, consider efficient investments at their new replacement value; and
  b) tariffs for new investments are based on the winning bid received among those interested to build new infrastructure, where tariffs are set for next the twenty years.

– The requirement to use *economic asset life* for each type of installation, becomes a dead letter; and instead of that tariffs have been calculated using statistical data on the aging of electricity transmission investments.
With a 6% discount rate, if equipment useful life increases from 30 to 50 years, tariffs diminished by 12.73%; and if equipment useful life increases from 30 to 40 years, tariffs diminished by 8.50%. Thus, using the right useful life is as important as the choice of the capital cost, the efficient amount of investments, etc...
Asset life in electricity transmission

Currently estimates of an asset life is a bequest of what were the standard lives within the old vertically integrated and State monopoly industry.

- The main electricity transmission study did not determine the economic useful life for each type of installation, and instead of that used estimates for economic useful life looking at the ageing of electricity transmission facilities reported in the Cigre study “Ageing of the System Impact on Planning”, Working Group 37. December 27, 2000, Cigre.

- The Cigre study collects electricity transmission infrastructure data for some few countries, and provides a description of the age or antiquity of the components of different electrical systems.
<table>
<thead>
<tr>
<th>Sub-transmission equipment useful life</th>
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Asset life concepts

Technical

The technical useful life of an asset is determined by the moment when expires or collapses its capability to supply the service according with the characteristics it was envisaged. A simple example of what is the technical useful life of an asset is given by the duration of a light bulb.

Accounting

In accounting the concept useful life of an asset is in the recognition of the period of time over which it is hoped that the assets should give services in the company and to register the transfer of the above mentioned assets to expenses. Also, it is defined within tax purposes.

Economic

The economic useful life of the equipment is determined by the period of time at which money is gained replacing or abandoning it.
Asset life and regulation

Two period model of optimal investment, abandon and replacement policy
- Benevolent Social Planner (Ramsey)
- Monopoly
- Long and short term planning of investments

Decision variables
- Capacity $t = 0$ and 1
- Use of capacity $t = 0$ and 1
- Economic life of the equipment

Parameters
- Demand
- Discount rate
- Capacity, operational – maintenance costs
- Scale economy parameters
- Technical life

Effects on
- Economic life of the equipments
- Capacity investments
Model I

\[
\text{Max } \int_{0}^{q_0} (a_0 - b_0 q - b_{00} q_0) dq + \beta \int_{0}^{q_1} (a_1 - b_1 q - b_{11} q_1) dq - \\
\{ \rho_0 q_0^\alpha + c_{00} q_0^\gamma + \beta \rho_1 q_1^\alpha + \beta c_{01} (Q_0 \phi \theta)^\gamma + \beta c_{11} Q_1^\gamma \}
\]

s.a.

C1 \quad q_0 P_0 + \beta q_1 P_1 - \{ \rho_0 Q_0^\alpha + c_{00} q_0^\gamma + \beta \rho_1 Q_1^\alpha + \beta c_{01} (Q_0 \phi \theta)^\gamma + \beta c_{11} Q_1^\gamma \} \geq 0

C2 \quad q_0 \leq Q_0

C3 \quad q_1 \leq Q_0 \phi \theta + Q_1

C4 \quad \theta \leq 1

C5 \quad q_0 \geq 0

C6 \quad Q_0 \geq 0

C7 \quad q_1 \geq 0

C8 \quad Q_1 \geq 0

C9 \quad 0 \leq \theta
Model III

$$\max \{ q_0 P_0 + q_1 P_1 - \rho_0 Q_0^\alpha + c_{00} q_0 \gamma + \rho_1 \beta Q_1^\alpha + \beta c_{01} (Q_0 \phi \theta)^\gamma + \beta c_{11} Q_1^\gamma \}$$

s.a.

C1 \quad q_0 \leq Q_0
C2 \quad q_1 \leq Q_0 \phi \theta + Q_1
C3 \quad \theta \leq 1
C4 \quad q_0 \geq 0
C5 \quad Q_0 \geq 0
C6 \quad q_1 \geq 0
C7 \quad Q_1 \geq 0
C8 \quad 0 \leq \theta
Experiments

- Cost of capital \( (\rho_0, \rho_1, \alpha) \)
- Operational costs \( (c_{00}, c_{01}, c_{11}, \gamma) \)
- Demand \( (a_i, b_i) \)
- Substitutes and complements \( (a_{ii} \times b_{ii}) \)
- Regulatory framework, pro or anti competitive \( (a_{ii} \times b_{ii}) \)
- Technical life \( 1+\phi \)

The economic life of first period investments is \( 1+ \theta \phi \)
Simple closed form solution

In the case where $\alpha = l$ and $\gamma = l$, from first order conditions for problems I and III, it can be verified that:

$$\theta = \frac{1}{\phi} \frac{b_0}{b_1} \frac{a_1 - b_{11} q_{11} - c_{01}}{a_0 - b_{00} q_{00} - c_{00} - \rho_0}$$
Experiments

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Conclusions

Equipment useful life can not be anchor to what was the practice within the old vertically integrated state monopoly industry, which basically has a replacement policy defined by the technical life of the equipments.

Within a competitive industry, even if there is a segment with regulated tariffs, equipment life should be match to its economic life, where efficiency calls for an earlier replacement of electricity transmission equipment, requiring in tariff calculation to use shorter lives.
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