EnergyVille

Simulating investment decision making in the power sector under imperfect foresight

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Myopic optimization: limited window of foresight

- Capture imperfect foresight and short-term focus of decision makers
  - More realistic decision making?
  - Simulation paradigm

- Reduce computational complexity
  - Allows to increase level of detail
  - Trade-off LT time horizon versus level of ST detail
  - Either optimization or simulation paradigm
Complementing optimization models

- Optimization: what is the cost-optimal transition pathway?

- Simulation: which policies are needed to realize this transition?

- Assess effectiveness and efficiency of policies
Liberalized electricity markets

Investment decision makers are private utilities

Invest if projected revenues allow a reasonable internal rate of return IRR (incl. risk premium)

Generation assets have a long lifetime

Future revenue streams are uncertain
Methodological analysis

- 2 scenarios:
  - Perfect foresight (PF)
  - Myopic foresight (MF10)
- Focus on period 2020-2055
- 5-year periods
- Power system inspired by the Belgian system
- Increasing carbon price
- LUSYM Investment planning model:
  - Partial equilibrium
  - 8 representative days
  - Clustered unit commitment
Impact on results

Perfect foresight

10-year foresight
Liberalized electricity markets

Investment decision makers are private utilities

Invest if projected revenues allow a reasonable internal rate of return IRR (incl. risk premium)

SR profits = revenues – operational costs

\[ \sum_y \{ E[SR\ Profits_y] \times \frac{1}{(1+IRR)^{y-z}} \} \geq fixed\ costs \]
Perfect foresight scenario

Perfect foresight of:

- Electricity prices (and capacity remuneration) in each time step and all years (implicit)
- Generation during each time step and all years
- Generation costs (fossil fuel prices, maintenance, etc.)

=> Exactly know SR profits

\[ \sum_y \{ SR \ Profits_y \times \frac{1}{(1+IRR)^{y-z}} \} = fixed \ costs \]
Perfect foresight scenario
Perfect foresight scenario
Perfect foresight scenario

Factors which can impact the SR profits:

- Fossil fuel prices
- Carbon price
- Timing of decommissioning existing plants
- Type, timing and amount of newly built capacity
- Technological progress
- Evolution of the electricity demand
- Policy interactions
- Market design changes
- Interconnections

Private utilities do not have perfect information
- The assumption of perfect foresight is not realistic
Perfect foresight scenario

![Graph showing value changes over years from 2020 to 2055 with different lines for 2020, 2025, 2030, and fixed costs.](image-url)
Perfect foresight scenario - conclusions

\[ \sum_y \{SR \text{ Profits}_y \times \frac{1}{(1+IRR)^{y-z}} \} = \text{fixed costs} \]

Perfect foresight for private utilities is unrealistic

Can lead to unrealistic simulation of investment decisions
Myopic foresight model

\[ \sum_{y=a}^{a+MF-1} \left( \text{SR Profits}_y \times \frac{1}{(1+IRR)^{y-z}} \right) = \text{fixed costs} - \text{salvage value} \]

Calculation of salvage value typically based on two assumptions:

1. Total discounted value of an asset equals the total discounted cost
2. Value is distributed homogenously over the asset's life time

\[ \sum_{y=a}^{a+MF-1} \left( \text{annualized fixed cost} \times \frac{1}{(1+IRR)^{y-z}} \right) \]
Myopic foresight scenario
Myopic foresight scenario

![Graph showing projected SR profits and actual SR profits for coal SC, along with fixed costs, over years 2020 to 2050. The graph illustrates the decline in value from 2020 to around 2030, with a subsequent stabilization.](image-url)
Myopic foresight scenario - conclusions

\[
\sum_{y=a}^{a+MF-1} \left\{ SR \text{ Profits}_y \times \frac{1}{(1+IRR)^{y-z}} \right\} = \text{fixed costs} - \text{salvage value}
\]

- Salvage value is determined exogenously
- Homogeneous distribution of the value of an asset seems optimistic (implications for dynamic recursive models)
- => No extrapolation of observed trends
- Can lead to unrealistic simulation of investment decisions
- Additional issues:
  - What is the window of foresight?
  - Window of foresight identical for all uncertain parameters
Summary and conclusions

Investment criterion: \( \sum_y \{ E[SR \text{ Profits}_y] \times \frac{1}{(1+IRR)^{y-z}} \} \geq \text{fixed costs} \)

Perfect foresight

- \( \sum_y \{ SR \text{ Profits}_y \times \frac{1}{(1+IRR)^{y-z}} \} = \text{fixed costs} \)
- Private utilities do not have perfect foresight on short-run profits
- Can lead to unrealistic investment decisions

Myopic foresight

- \( \sum_{y=a}^{a+MF-1} \{ SR \text{ Profits}_y \times \frac{1}{(1+IRR)^{y-z}} \} \)
- \( = \text{fixed costs} - \text{salvage value} \)
- No extrapolation of observed trends in short-run profits
- Can lead to unrealistic investment decisions


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Open questions

Optimization Vs. Simulation:

- Should TIMES be used for simulation?
- What are the alternatives?