Generation Investment and Access Regulation in the Electricity Market: A real Option Approach

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Berlin, 10th October 2009-INFRADAY

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Motivation-Research Questions

- Penetration of renewable energy will constrain existing transmission networks
- Green producers and Gray producers will compete for network access
- Should Gray producers be compensated if (subsidized) Green producers enter the market later, and congest the network?
  - If Gray producers do not have certainty about network access, there might be a risk of hold-up. Especially given that there are no long-term transmission rights
- Should particular places in the network, for instance locations with high wind-speed, be reserved for *Green energy*?
  - We can forbid Gray producers to build new power-plants in those locations.
- Nodal pricing complemented with financial transmission rights is considered as the state of art system to organize electricity markets that is applied in large number of electricity markets worldwide.
  - Does nodal pricing, with or without financial transmission rights, lead to efficient investment levels? If not, is there any other regulatory scheme that restore efficiency?

Outline

- Introduction
- Framework of the model: A game theoretic approach
- Basic assumptions
- Socially optimal outcome
- Scenarios
- Policy Implications
- Conclusions

What do we do

- Model entry decisions of Gray and Green energy producers in one location of the network
- Two period stochastic model with two firms
  - Gray energy producer decides first whether it enters the market or to postpone decision until second period.
  - Green energy producer decides whether it enters the market only in second period
  - Cost of Green energy producer is unknown
- We compare different regulatory frameworks for regulating network access
  - Nodal Pricing
  - Nodal Pricing + Financial Transmission Rights (FTR)
  - Counter-Trading
  - Nodal Pricing + Physical Transmission Rights (PTR)

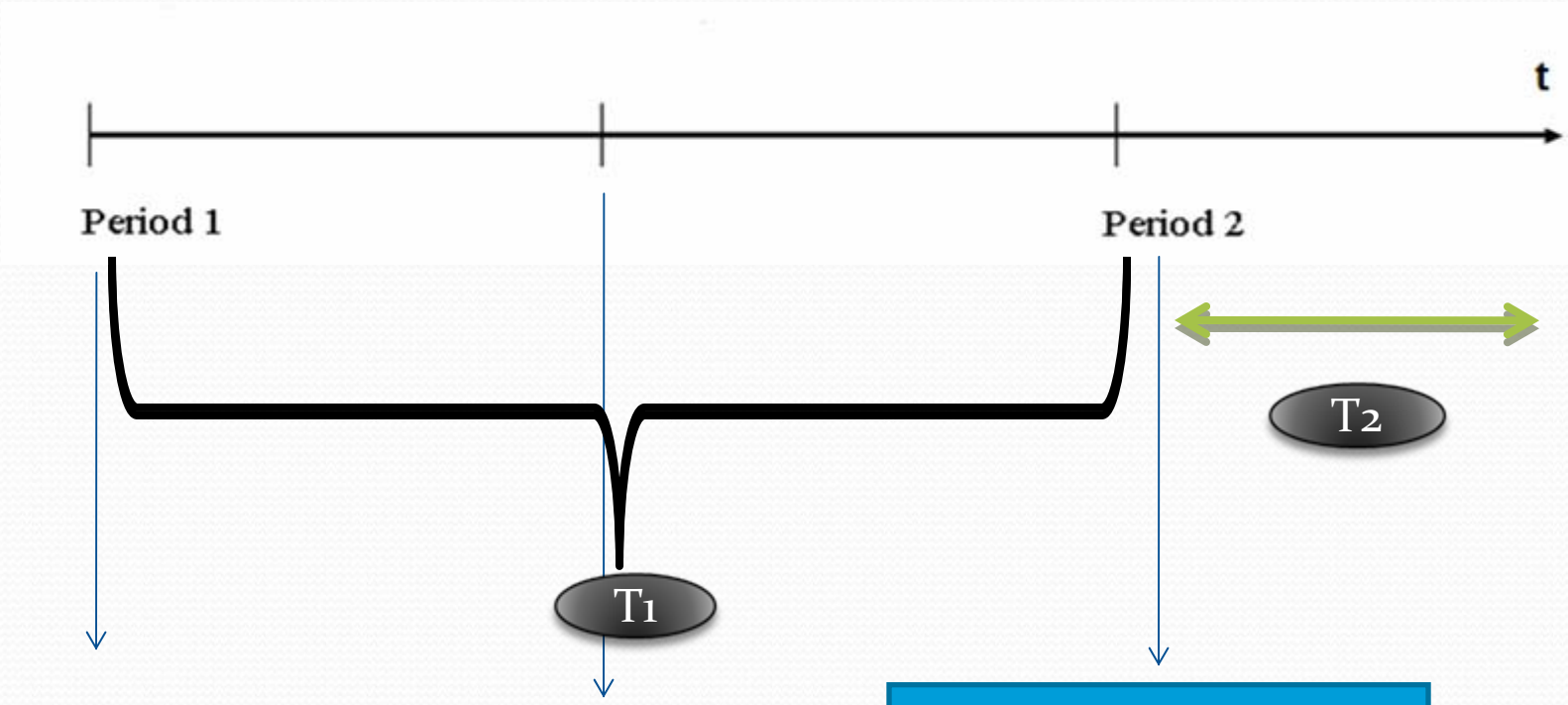
The two firms

- Marginal and fixed cost of the Gray producer: c_I and F_I
- Marginal cost of the Green producer: c_E
- The fixed cost of the Green is considered as a discrete stochastic variable:

$$F_E = \begin{cases} F_E^L & \text{with probability 1-p} \\ F_E^H & \text{with probability p} \end{cases}$$

- Downstream market
  - Competitive, price of electricity C = constant

Timing of the Game



- Gray producer enters, or waits

Nature draws the fixed cost of the Green producer

- Green producer and Gray producer decide about entry
- Bertrand competition for energy

Investment decisions

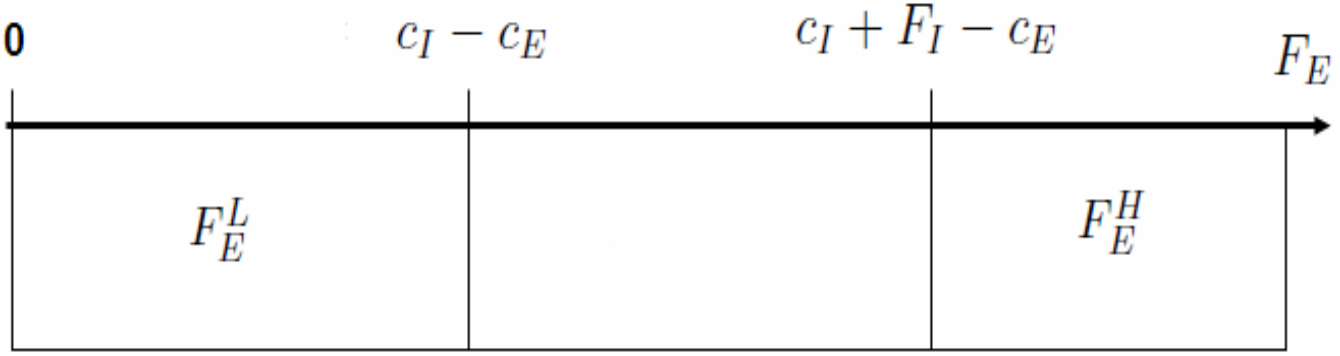
- The two driving forces of investment decisions:
- Real option of waiting
  - Social planner would like the Gray producer (the incumbent) to wait with investments, so it can learn more about the cost of the Green producer (the entrant).
  - If real option value too high → Hold up problem!
- First mover advantage
  - The Gray producer will enter the market too often, as they can deter entry by the Green producers. (= Strategic effect)

Main Assumptions

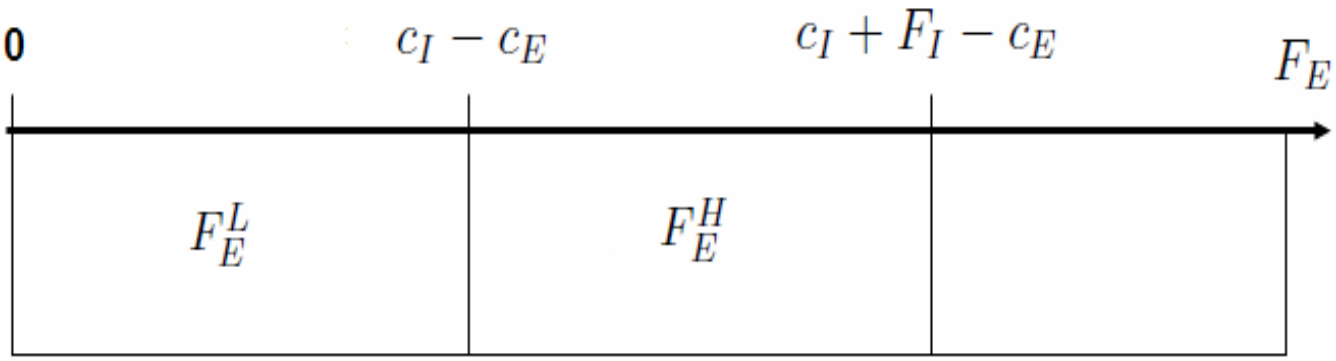
- The low cost Green has lower total cost than the marginal cost of the incumbent: $F_E^L + c_E < c_I$
- The least efficient entrant has total cost: $c_I < F_E^H + c_E$
- Entry is profitable for each firm individually
- The Gray producer cannot profitably enter the market unless it is active during the second period

Cost Uncertainty

- Case A:



- Case B:



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Social Optimal Outcome

- Social value of waiting
- Benefit: Decisions which are ex-post suboptimal can be avoided
  - If efficient green producer is present
- Cost: Investment decision is postponed.
  - Foregone profits during first period
- Waiting is more beneficial
  - The quicker the information is revealed (T1 short)
  - The Green firm is very efficient
    - Probability p very low
    - The high cost Green producer is very efficient
  - The production cost of the Gray firm is higher

Scenario 1: Nodal pricing

- There are no long term transmission rights
- The Gray firm focus on the maximization of its own profit ignoring the negative externality effect when it decides to invest in period one
  - Deviation from the social optimal behavior
- Over-entry by Gray producers
  - First mover advantage outweighs the real option value of waiting.
  - No need to compensate the Gray producers to prevent hold-up. Entry by green energy producers is normal market risk

Scenario 2: Nodal Prices with FTR

- FTR insures the Gray firm against price changes in the transmission rights market.
- Situation becomes even worse then with nodal prices alone
  - Gray producer receives congestion rents on transmission line.
  - Gray Producer will be hedged against entry by the Green Producer.
  - It will enter even more often than before

Scenario 3: Counter Trading

- Both firms receive the right to obtain a price for their electricity products independently on the amount of congestion. Hence, in period two the most efficient firm uses the transmission line, while the other firm is fully compensated for not using the transmission line in period two.
- The incumbent over-invests (identical payoffs as in FTR case)
- The entrant is indifferent. No externality effect!!

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Scenario 4: Nodal Prices with PTR

- Optimal Entry by the Gray Producer
  - Gray producers obtains the property right for network access.
  - PTR gives the Gray Producer the right to prevent the Green Producer to access the network
  - Gray producer internalizes the option value of waiting.
  - Value of not using the PTR, and reselling the right to green producer
- Problem: Possible violation of article 82EC

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Policy implications

- Obviously the regulator has a lot of job to do!!
- Possible solutions:
  - Taxing the Gray Producer at the moment it enters
  - Subsidizing entry of the Green Producer
    - Does only work if subsidies are committed before Gray producer can enter
  - Requires a lot of information
  - Level of taxes depends on the specific distribution of the entry cost of the Green Producer

Conclusions

- With a standard model of nodal prices, we will not obtain the right level of investments in the network
  - Too much entry by Gray Producer
  - Too little entry by Green Producer
- Physical transmission rights can be used to restore social optimum.
  - Optimal entry by all producers
  - Abuse of market power by the Gray Producer possible
- Making transmission rights financial, reduces the incentives of firms to foreclose the market (short-term efficiency), but leads to over-entry (long-term inefficiency)
- Although counter-trading is inefficient method, it eliminates the first mover advantage and real option value of waiting! There is no uncertainty over the future rewards.
- First mover advantage dominates real option of waiting (no hold up problem).

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Thank you!!!