Strategic Investment in Merchant Transmission: the Impact of Capacity Utilization Rules

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Aim of the paper

- To offer policy perspectives on how to regulate capacity utilization when there are private investments in electricity transmission.
  - Specifically, we characterize the performance (competition, capacity, welfare) of must-offer and non-must offer provisions in transmission capacity utilization.
- To add to the debate on merchant investment and the subsequent regulation in the electricity transmission.

Why is this relevant: policies

- Australia, United States, and Europe have adopted MTI.
  - The EU has recently authorized five merchant projects (BritNed, Estlink, the East West Cables, NorNed, and the Tirano-Campolongo).
- Several other countries are at various stages of MTI adoption.
  - For example, in India, some states (Gujarat) have adopted private investment in transmission, while others are still contemplating it.
- EU is reluctant to allow generators themselves to invest in the transmission sector:
  - on the ground of their potentially anti-competitive effects.

Relevant literature

- Brunekreeft and Newbery (2006): a *Mo* provision in an MTI context:
  - decreases welfare under uncertainty and demand growth;
  - may increase it under pre-emption.
- Van Koten (2012): vertical integration may provide more incentives for grid expansion.
- De Hauteclocque and Rious (2011):
  - the ban by the EU on MTI by generators should be removed.
  - Potential anti-competitive effects mitigated by a must offer or use-it-or-lose it provisions.

Our contribution

- Which of the following regulatory provisions is preferable:
  - when the investor is allowed to withhold some amount of capacity installed;
  - when the investor cannot withhold any capacity.
- We analyze this question in terms of entry opportunities for competitors, total capacity installed and welfare thereof under the following conditions:
  - pre-emptive investment;
  - monopoly investment under time varying demand;
  - pre-emptive investment under time varying demand;
  - potential for collusion.
- We extend B&N by considering stylized facts of the industry.

Overview of main results

- Single period demand, sequential entry:
  - *Mo* (weakly) increases first mover's profit.
  - *Mo* (weakly) decreases competition (decreases entry)
  - however, depending on model parameters, increases or decreases welfare.
- Time-varying demand, monopoly:
  - *Mo* (weakly) decreases investment, but may increase capacity utilization
- Time-varying demand, sequential entry:
  - *Mo* may increase or decrease competition, welfare results are ambiguous.
- Collusion:
  - as the discount factor increases, *Mo* increases welfare as it precludes the use of capacity as a threat in case of deviations

Model - single period demand

- Standard setting.
  - Two-node network, no losses.
  - Optimal dispatch and nodal energy prices.
  - Perfect competition in wholesale energy markets.
- Assumptions:
  - two (profit-maximizing) merchant investors: I and E;
  - identical affine capacity cost functions: $C_i(k_i) = F + rk_i$;
  - linear revenue functions: $R_i(q_I, q_E) = \underbrace{\eta(q_I + q_E)}_{\text{nodal prices difference } (CR)} q_i$
    - The main source of revenue for investors is price difference between the two nodes.
    - Sufficiently large transmission network implies no price difference.

Model - timing

- Sequential entry is key

1	E	2	SO
I chooses transmission capacity k_I	E decides whether or not to enter	Active firms simultaneously choose flows q_i (and capacity k_E and $\Delta k_I \geq 0$)	Equilibrium nodal prices are set and payoffs accrue
↓	↓	↓	
Sunk capacity costs rk_I	Fixed set-up cost F	Output marginal cost 0 up to capacity r otherwise	

Results - single period demand I

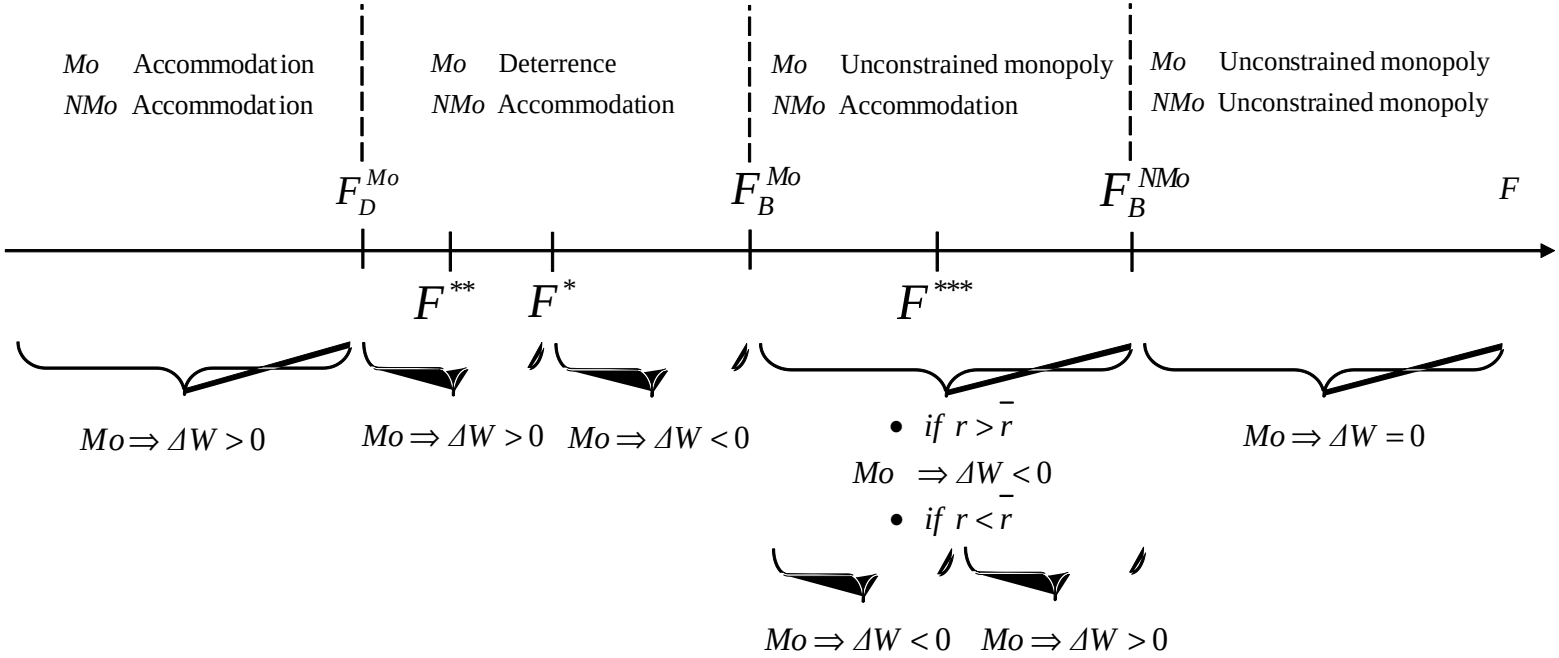
- The first mover has the following three strategies:
  - block entry;
  - deter entry;
  - accommodate entry;
- Result I: Block and deterrence under *Mo* are feasible for a larger set of outcomes than they are under *NMo*.
  - *Mo* arrangement provides first mover with a strong source of commitment towards the supply of a higher capacity. Hence, *Mo* expands the feasible set of deterrence outcomes for first mover.
  - Under *NMo*, the asymmetric Cournot ouptut is the upper bound to credible capacity
- Result II: The first mover's profits are weakly higher under a *Mo* arrangement than under a *NMo* scheme.
  - *Mo* (weakly) expands the deterrence options

Results - single period demand II

- Result III: A *Mo* rule on transmission capacity induces (weakly) less entry into merchant transmission investments.
  - *Mo* expands the deterrence opportunities
- Result IV: consumer surplus and welfare may increase under *Mo*
  - output under accommodation larger under *Mo* (Stackelberg vs Cournot: commitment)
  - under deterrence in *Mo* and accommodation in *NMo*, output may still be larger under *Mo* (higher profit for the first mover)
- Key takeaway: consumer surplus/welfare can improve even if entry does not take place.

Results - single period III

Case $r < \alpha\beta/5$



Time-varying demand

- Two demand functions in two different time periods.
- Period 1 is peak, period 2 is lean demand.

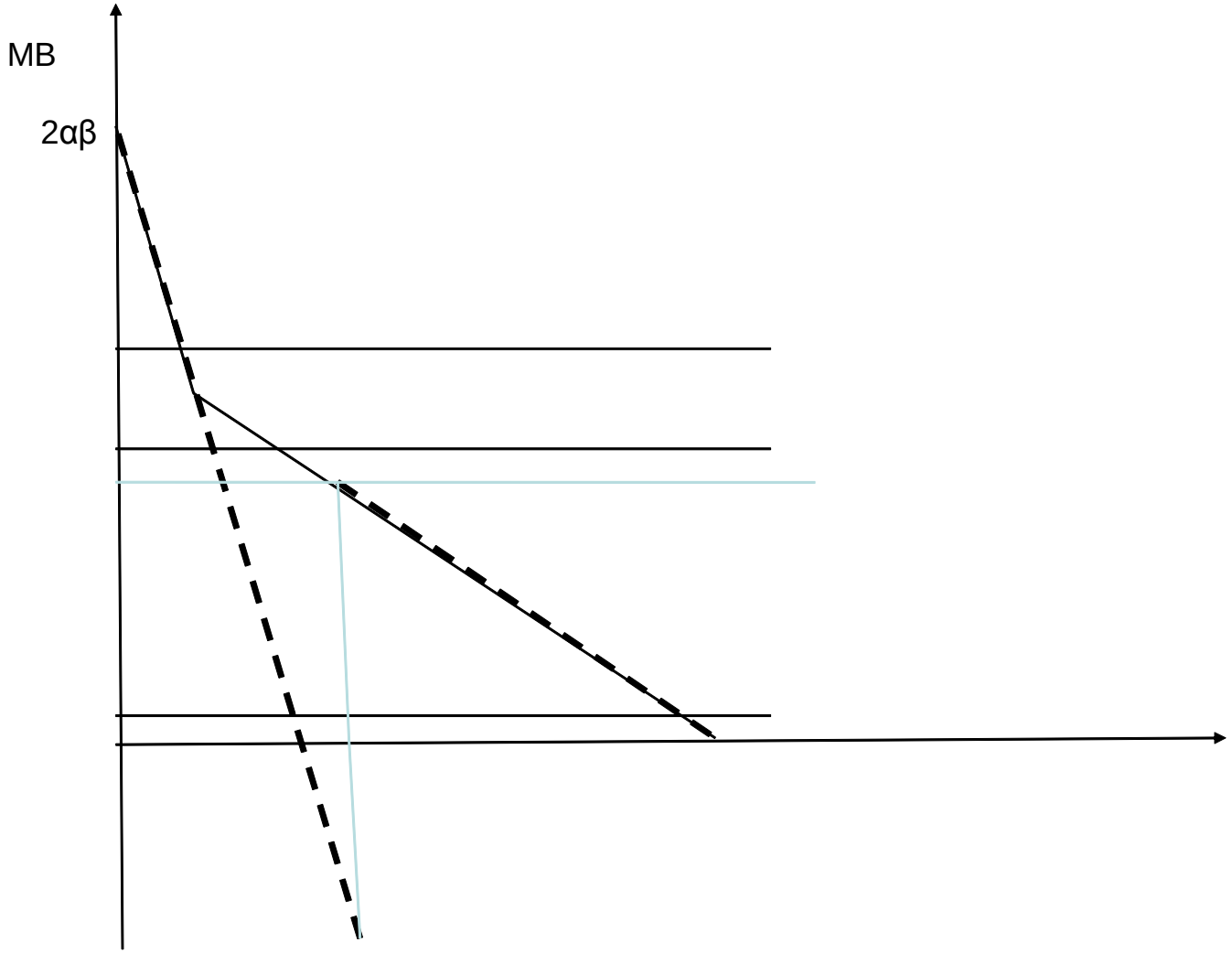
$$
\begin{aligned}
P_1 &= \alpha\beta - \beta_1 Q_1 \\
P_2 &= \alpha\beta - \beta_2 Q_2
\end{aligned}
$$

Monopoly - Results I

- Profits are (weakly) larger under *NMo* than they are under *Mo*:
  - *Mo* provides an additional constraint to firms' strategies.
- Investment in capacity is (weakly) larger under *NMo* than it is under *Mo*.
- As to which provision (*Mo* or *NMo*) enables greater amount of transmission made available, the answer is not unambiguous.

Key takeaway: *Mo* definitely provides an incentive to underinvest.

Monopoly - results - graphical representation



Sequential entry - Results

- Result I: Under which provision (*Mo* or *NMo*) is block more feasible?
  - The answer is ambiguous and depends on the parameter values.
  - For block to be more feasible under *NMo*, when compared to Mo, a necessary condition is that capacity under *NMo* is larger than capacity under *Mo*.
  - The following incentives have to be emphasized:
    - *Mo* provides the first mover with a commitment to aggressiveness, and to capacity utilization (increased potential for block under *Mo*, as in the single period demand).
    - *Mo* imposes and additional constraint that decreases the potential entrant's profit (increase potential for block under *Mo*, as in the single period demand).
    - Monopoly capacity is weakly higher under *NMo* than under *Mo* (increased potential for block under *NMo*, differently than the single period demand).

Sequential entry - Results

- Results II: While *Mo* (weakly) increases the feasibility of entry prevention, it does not always increase the range of fixed costs under which entry is prevented in equilibrium
  - The opportunity cost of entry deterrence under *Mo* can be higher.
- Results III: Welfare ranking across *Mo* and *NMo* is ambigous

Results - collusion

- Result I: Under both arrangements, entry increases as the discount factor increases.
- Result II: As the discount factor tends to one, the quantity made available under *Mo* exceeds the quantity made available under *NMo*. Total surplus under *Mo* is higher.
    - Capacity under *NMo* is a "threat" to deviate from the monopoly output. Under *Mo*, this collusive tool cannot be exploited.

Conclusion

- Important to understand what the objective is. Improving competition has different implications from improving consumer surplus/ welfare.
  - *Mo* provision provides incentives for underinvestment be it competitive or monopoly setting
  - Does under investment necessarily translate into lower transmission, and subsequently, lower welfare? Not clear
  - Given the ambiguity in theory such question becomes empirical in nature
- If collusion is possible and cannot be regulated, then we can see that the the *Mo* provision is better than *NMo*. Under competitive settings, though, the answer is not so straightforward.
- These results have implications beyond electricity transmission. For example, oil pipeline network would also find these results pertinent.
- What next: What happens when generators themselves invest in transmission capacity?