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

Federico Boffa\textsuperscript{1} \hspace{1cm} Viswanath Pingali\textsuperscript{2} \hspace{1cm} Francesca Sala\textsuperscript{3}

\textsuperscript{1}University of Macerata \\
\textsuperscript{2}Indian Institute of Management Ahmedabad \\
\textsuperscript{3}UK Competition Commission

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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.
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.
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 Hauteclercque 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: \( R_i(q_I, q_E) = \eta(q_I + q_E)q_i \),
  
  - The main source of revenue for investors is price difference between the two nodes.
  - Sufficiently large transmission network implies no price difference.
Sequential entry is key

1. I chooses transmission capacity $k_I$
   - Sunk capacity costs $rk_I$

2. $E$ decides whether or not to enter
   - Fixed setup cost $F$

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

Output marginal cost
- $0$ up to capacity $r$
- $0$ 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 output 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.
Case $r < \alpha \beta / 5$

\[ Mo \Rightarrow \Delta W > 0 \]
\[ Mo \Rightarrow \Delta W > 0, \quad Mo \Rightarrow \Delta W < 0 \]
\[ Mo \Rightarrow \Delta W < 0 \quad \text{if } r > r \]
\[ Mo \Rightarrow \Delta W < 0 \quad \text{if } r < r \]
\[ Mo \Rightarrow \Delta W > 0 \]
Time-varying demand

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

\[ P_1 = \alpha \beta - \beta_1 Q_1 \]
\[ P_2 = \alpha \beta - \beta_2 Q_2 \]
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

\[ MB = 2\alpha\beta/\beta^2 \]

\[ MB = \alpha^2(\beta^2 - \beta_1) \]

\[ r_1 = -2\alpha^2\beta_1 \]

\[ r_2 = \alpha^2(\beta^2 - 2\beta_1) \]

\[ r_3 = \alpha\beta/\beta_1 \]
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 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 ambiguous.
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?