Transmission Rights and Market Power on Electric Power Networks

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Introduction

• How the holding of transmission rights affects the behavior of generators and consumers with market power (a simple 2-node electricity model)

• Financial transmission rights v.s. Physical transmission rights
2-node Electricity Model

G1: C1 = C1(q1) Cheapgen

G2: C2 = C2(q2) Deargen

D(p2) = q1 + q2 > K

Transmission link K
Benchmark: C.E.

\[ p_1^* = C_1'(K) \quad \text{Nodal price at N} \]

\[ p_2^* = C_2'(D(p_2^*) - K) > p_1^* \quad \text{Nodal price at S} \]

\[ q_1 = K \quad \text{The flow constraint is binding} \]

\[ D(p_2^*) = q_1 + q_2 = K + q_2 \quad \text{Supply equals demand} \]

Congestion Rents = \( (p_2^* - p_1^*) K \) \rightarrow ISO
Financial Transmission Rights

- FTRs give the holders a proportionate share of the congestion rents when $K$ is binding:
  
  Market value of FTRs: $\eta = p_2 - p_1$

- $K$ rights issued and total payments to rights holders: $(p_2 - p_1)K$

- C.E.:
  
  $p_1^* = C_1'(K)$  
  $p_2^* = C_2'(D(p_2^*) - K) > p_1^*$

  $\eta^* = p_2^* - p_1^*$
Physical Transmission Rights

• Generators in node N must have physical rights to schedule their generation according to their bilateral contracts with consumers in node S.

• Market value of physical rights: $\eta = p_2 - p_1$

• C.E.: $p_1^* = C_1'(K) \quad p_2^* = C_2'(D(p_2^*) - K) > p_1^*$

$$D(p_2^*) = q_1 + q_2 = K + q_2 \quad \eta^* = p_2^* - p_1^*$$
Summary so far

• Equivalence of financial and physical rights when the energy and rights markets are perfectly competitive.

• Equivalence to the no-rights C.E.
Market Power at S: no-rights benchmark

• G1 behaves competitively:

\[ p_1 = C_1'(K) = p_1^* \quad q_1 = K \]

• G2 has market power:

\[ p_2^m = \arg\max (p_2[D(p_2) - K] - C_2(D(p_2) - K)) \]

\[ p_2^m > p_2^* \quad \text{and} \quad q_2^m < q_2^* \]
FTRs and Market Power

• Assume that G2 holds a fraction $\alpha \in [0,1]$ of the K FTRs. Congestion Rents: $F(p_2) = (p_2 - p^*_1)K$

• G2’s problem:
  \[
  \max_{p_2}\{G(p_2) + \alpha(F(p_2))\} \\
  = \max_{p_2}\{p_2[D(p_2) - K] - C_2(D(p_2) - K) + \alpha[p_2 - C_1'(K)]K\}
  \]

  Comparative static: $\frac{\partial p_2(\alpha)}{\partial \alpha} > 0$

When $\alpha=1$, G2 maximizes its profit as if it had a monopoly over the entire demand function.
Physical Rights and Market Power

• Basic difference between physical and financial rights: it may be profitable to withhold physical rights.
• The rights G1 acquire effectively define the capacity of the link.
• Withholding of rights from G1 could result in production inefficiency.
Withholding of Physical Rights

• Consider the case that G2 initially owns all the physical rights.
• Commitment: G2 imports power $q_1 \leq K$ from G2 and sells $q_1 + q_2$ to consumers in S.
• G2’s problem:

$$\max \{ p_2 [D(p_2) - q_1] - C_2 (D(p_2) - q_1) + [p_2 - C_1'(q_1)] q_1 \}$$
Withholding Physical Rights, Cont’d

• G2 is a “gatekeeper” for production in N when it controls all the physical rights.

\[ q_1 = K \quad \text{or} \]

\[ q_1 < K \quad \text{and} \quad C_2'(D(p_2) - q_1) = C_1'(q_1) + q_1C_1''(q_1) \]

• When \( q_1 < K \), \( p_2 \) will be higher than no-generator-market-power case.
Conclusion

• If G2 has market power, its holding financial rights enhances that market power.
• Holding physical rights can both enhance the market power of G2 and lead it to inefficiently restrict imports from G1 by withholding some physical rights from the rights market.