

An Analysis of Mergers in the Presence of Renewable Energy Integration Uncertainty

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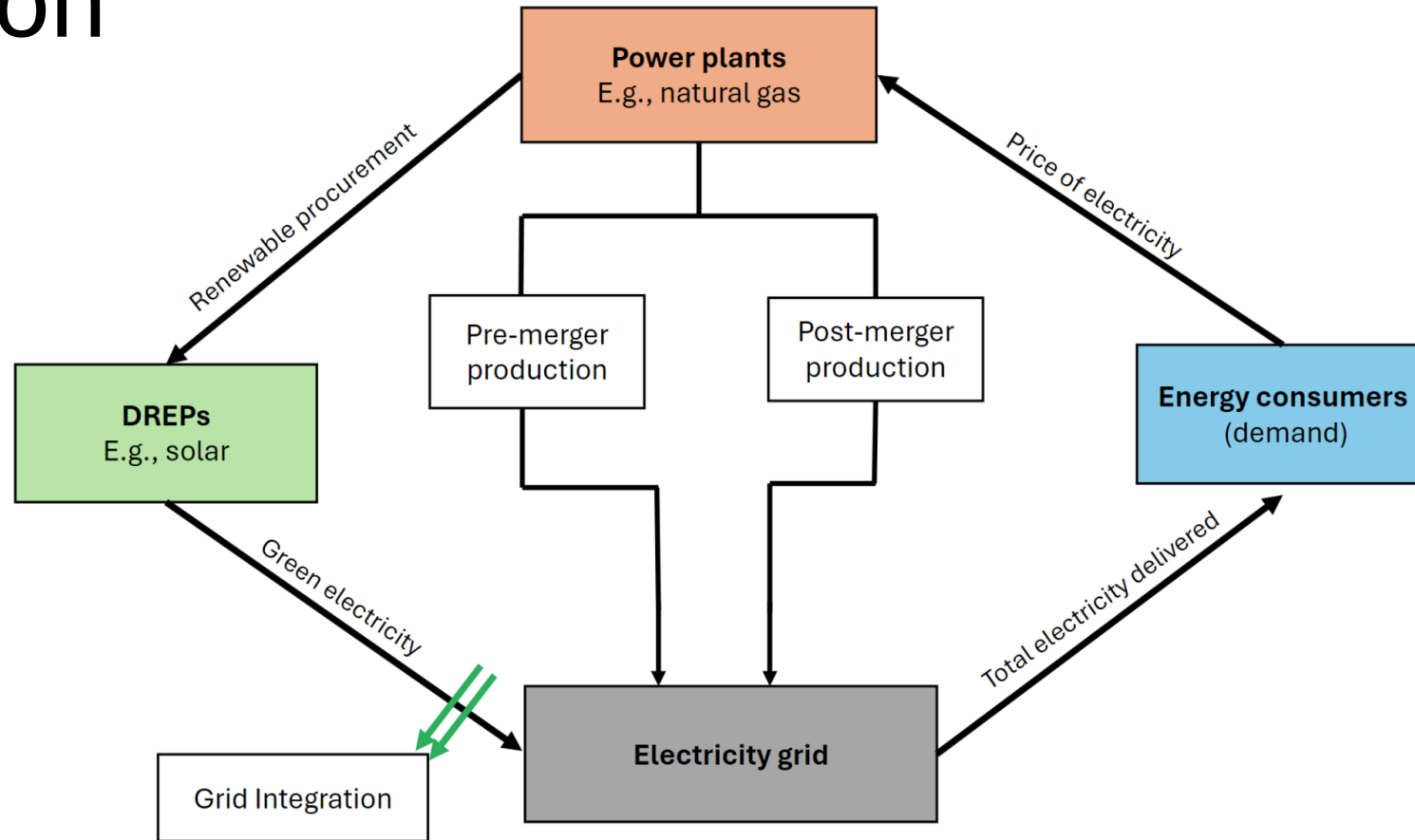
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Motivation



How does the presence of uncertainty about grid integration costs affect the incentives for energy producers to merge?

Analytical Approach

- Characterize pre-merger equilibrium (with and without uncertainty)
- Characterize post-merger equilibrium (with and without uncertainty)
- Define profitability of merger (with and without uncertainty)
- Comparative statics on merger profitability with respect to integration costs.

Summary of Results

1. Without uncertainty (grid integration costs)- a large enough merger helps offset these costs.
2. With Uncertainty (grid integration costs) - merger still helps offset these costs.

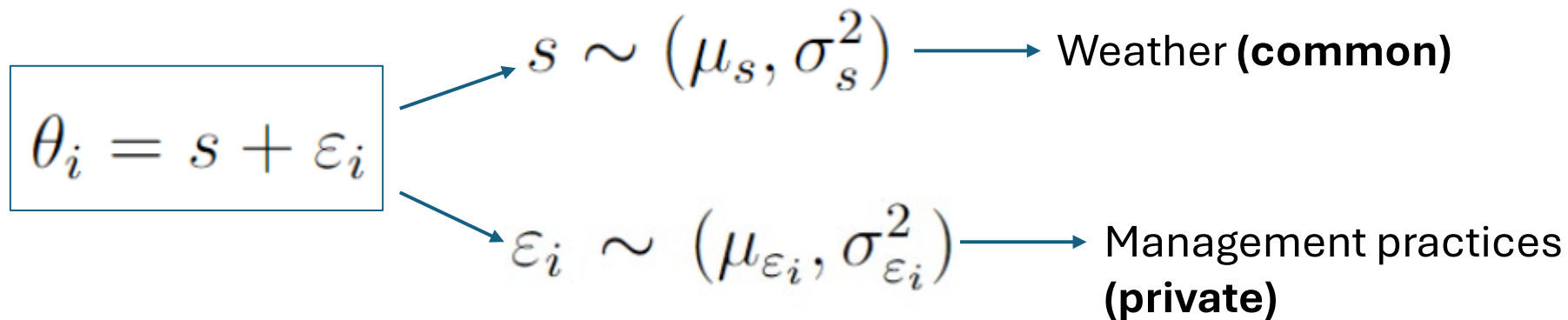
But it also depends on

- a) size of average grid integration costs-GIC- (high or low);
 - b) quality of information available to the newly formed merged entity; and
 - c) size of merger.
 - d) oligopolistic interdependence
3. Incentive to merge for a wider range of GIC, if size of merger is large enough and/or quality of information is high enough.
 4. No incentive to merge for too high average GIC (merger can't offset these costs), or if the quality of information is too low.

Model Building Blocks

Grid integration costs

$$\text{Max}_{x_i} E[\pi_i | \theta_i] = \text{Max}_{x_i} E[p_i x_i - (c_{f_i} x_i + c_{r_i} q^r + \theta_i x_i q^r) - t(\phi_i x_i - q^r) | \theta_i]$$



$$\text{COV}[\varepsilon_i, \varepsilon_j] = 0$$

Quality of information: $\frac{\sigma_{\varepsilon}^2}{\sigma_s^2}$

Bayesian Nash Equilibrium

$$x_i(\theta_i) = \alpha_i \theta_i + \eta_i, \quad \forall i = 1, \dots, n.$$

$$x_i^m(\theta_i) = \alpha_i^m \theta_i + \eta_i^m, \quad \forall i = 1, \dots, n.$$

Hence, pre-merger $E[\tilde{\pi}_i]$ And post-merger $E[\tilde{\pi}_i^m]$

Then,

$$\Delta^u = mE[\tilde{\pi}^m] - mE[\tilde{\pi}]$$

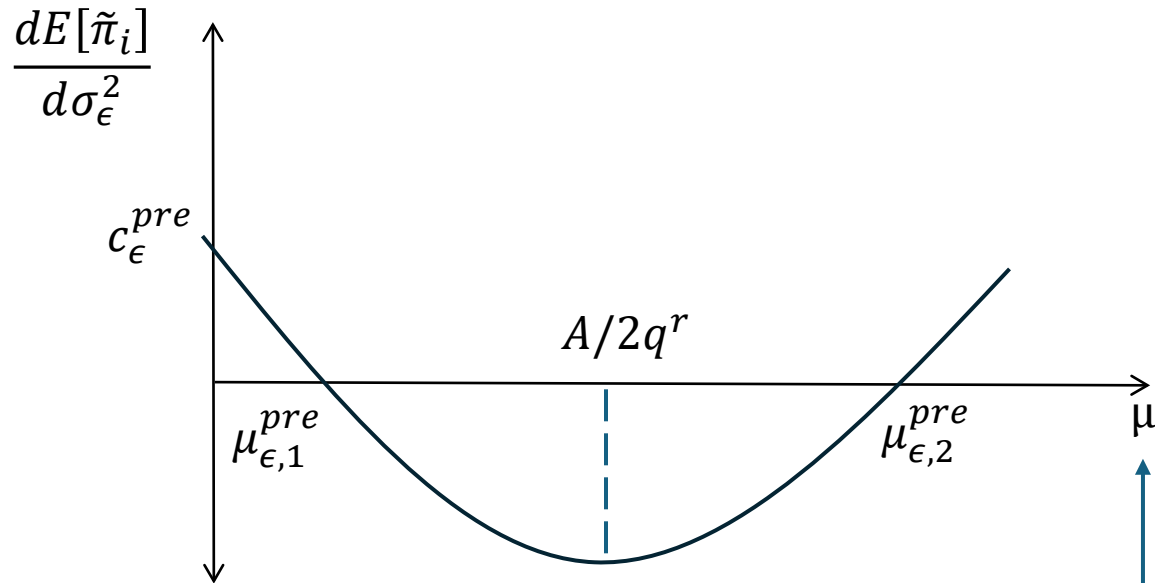
Then, analyze $d\Delta^u$

$$dE[\tilde{\pi}] = [\mu^2 a_\epsilon^{pre} + \mu b_\epsilon^{pre} + c_\epsilon^{pre}] d\sigma_\epsilon^2 + [\mu^2 a_s^{pre} + \mu b_s^{pre} + c_s^{pre}] d\sigma_s^2$$

$$dE[\tilde{\pi}^m] = [\mu^2 a_\epsilon^{post} + \mu b_\epsilon^{post} + c_\epsilon^{post}] d\sigma_\epsilon^2 + [\mu^2 a_s^{post} + \mu b_s^{post} + c_s^{post}] d\sigma_s^2$$

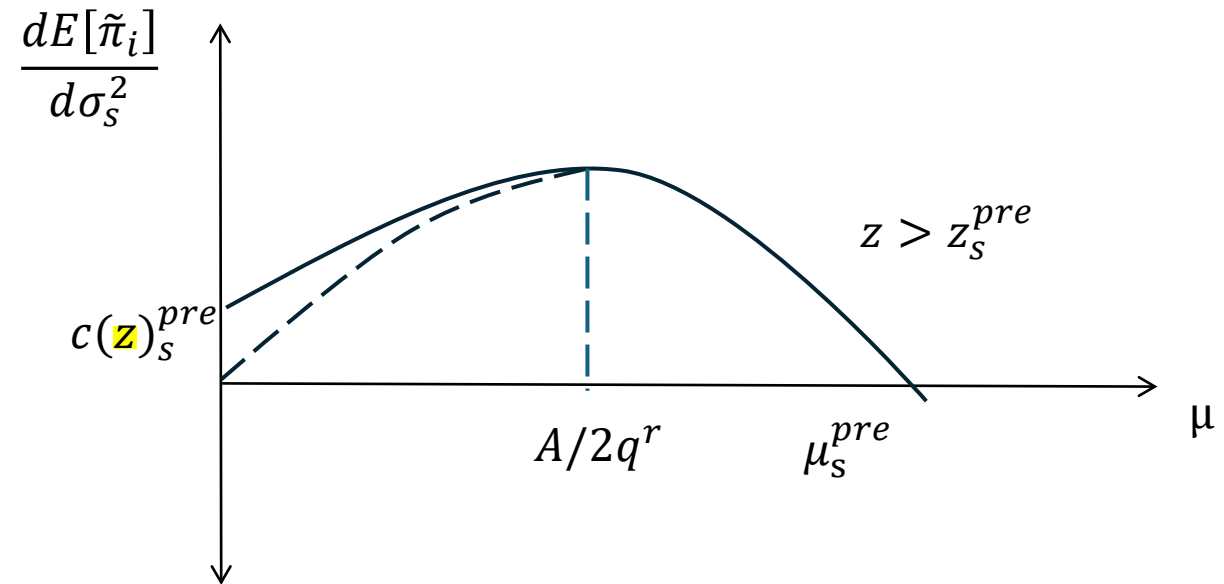
Pre-Merger Market: Results

Private shock, $d\sigma_\epsilon^2 > 0$



Avg. Grid
Integration
Costs

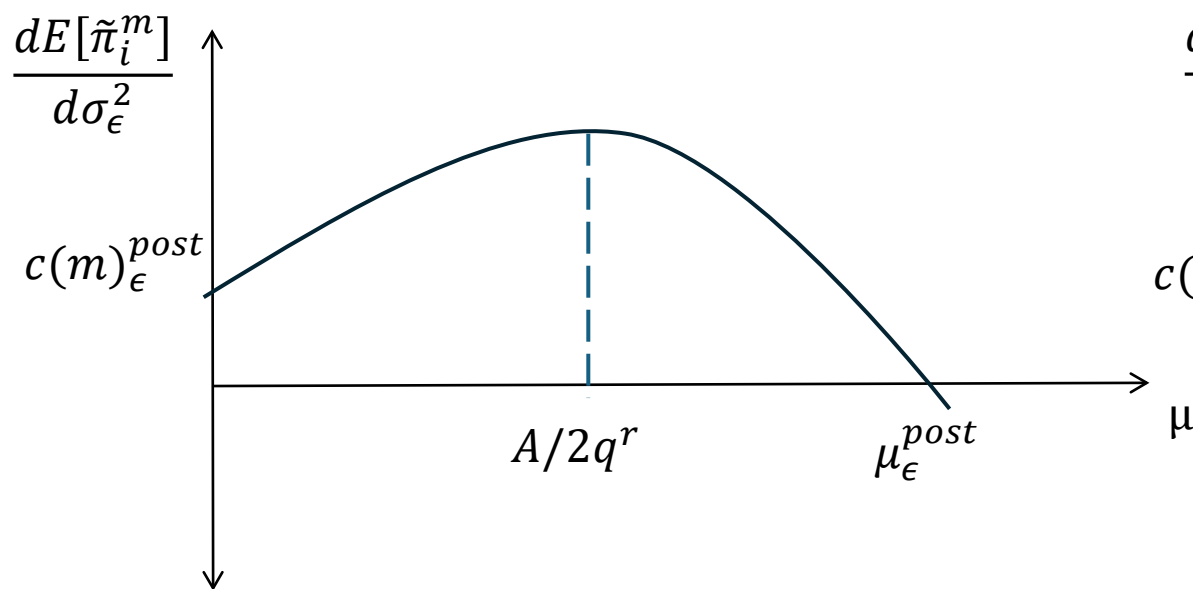
Common shock, $d\sigma_s^2 > 0$



$$z = \frac{1}{1 + \frac{\sigma_\epsilon^2}{\sigma_s^2}}$$

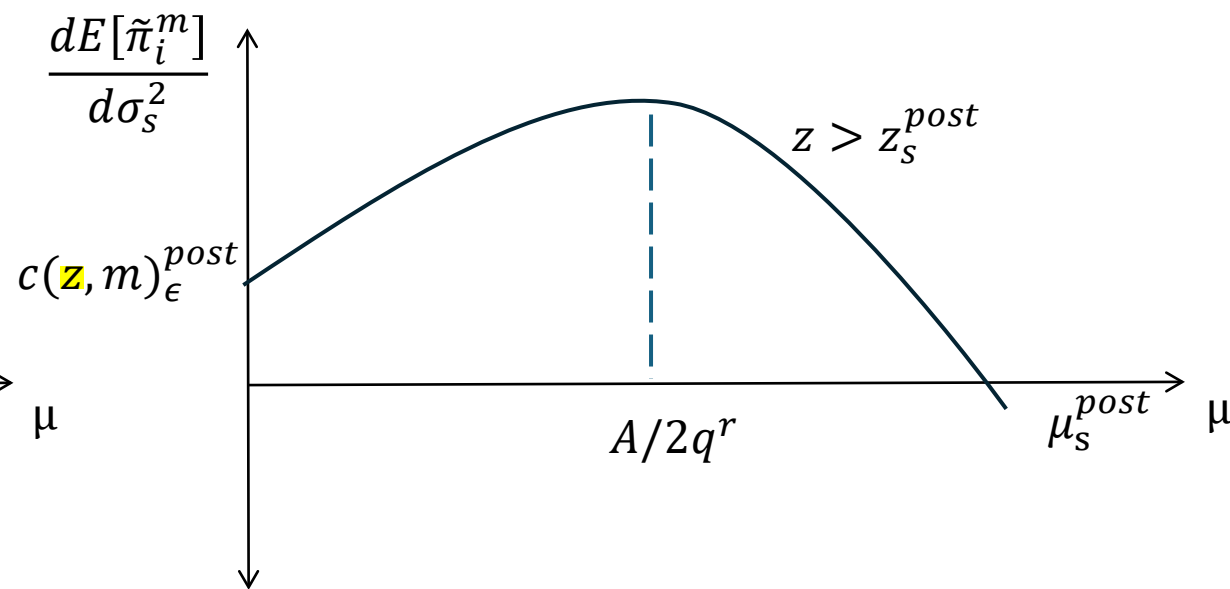
Post-Merger Market: Results

Private shock



m : size of merger

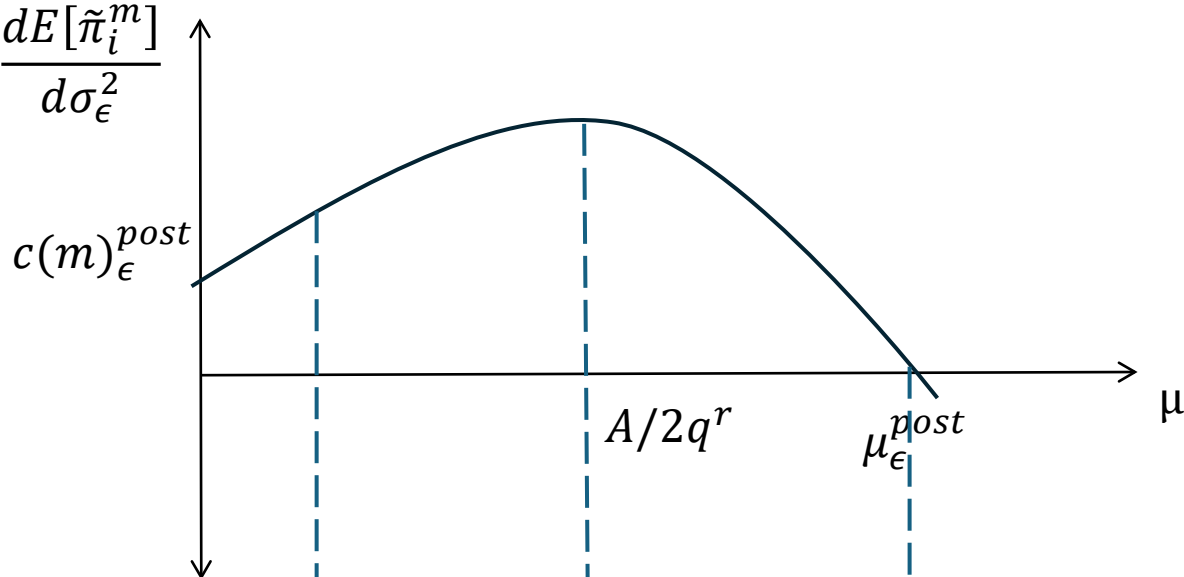
Common shock



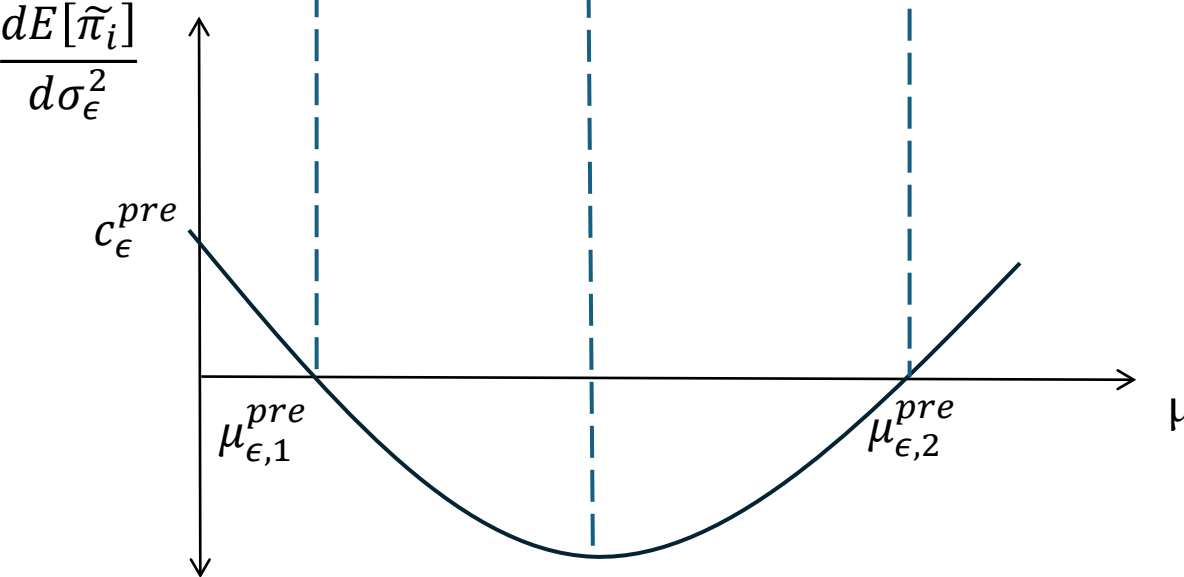
Profitability of Merger (private shock)

$$\Delta^u = mE[\tilde{\pi}^m] - mE[\tilde{\pi}]$$

Post-Merger

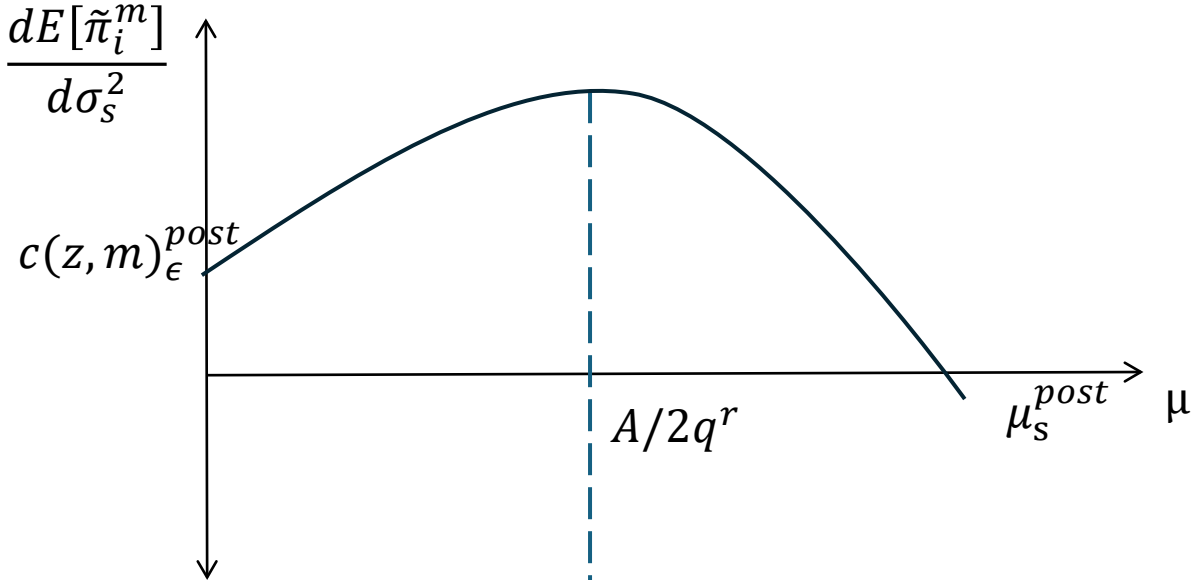


Pre-Merger

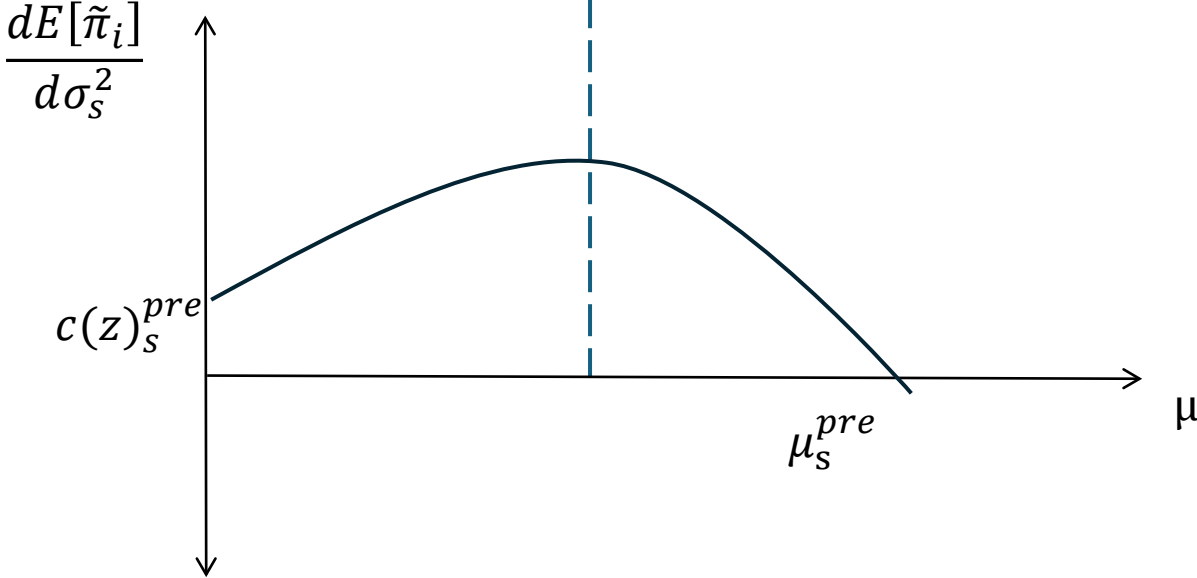


Profitability of Merger (common shock)

Post-Merger
 $z > z_s^{post}$



Pre-Merger
 $z > z_s^{pre}$



Conclusion

- We consider the presence of DREPs.
- Analyze effects of grid integration costs on merger profitability.
- Incentives to merge depend on
 - average integration costs,
 - Quality of information,
 - Size of the merger
 - Oligopolistic interdependence.
- Clear incentives to merge to absorb private shock.
- But incentives under common shock are less clear-cut (depends on quality of information).
- Results help us understand strategic decisions by firms in the energy market.
- Regulators: consider competition (as firms merge), but also grid capacity constraints (as DREPs increase production).

Information structure

$$x_i(\theta_i) = \alpha_i \theta_i + \eta_i, \quad \forall i = 1, \dots, n.$$

$$E[x_i | \theta_j] = \alpha_i E[\theta_i | \theta_j] + \eta_i = \alpha_i (z_j \theta_j + \lambda_j) + \eta_i$$

$$E[\theta_i | \theta_j] = z_j \theta_j + \lambda_j$$

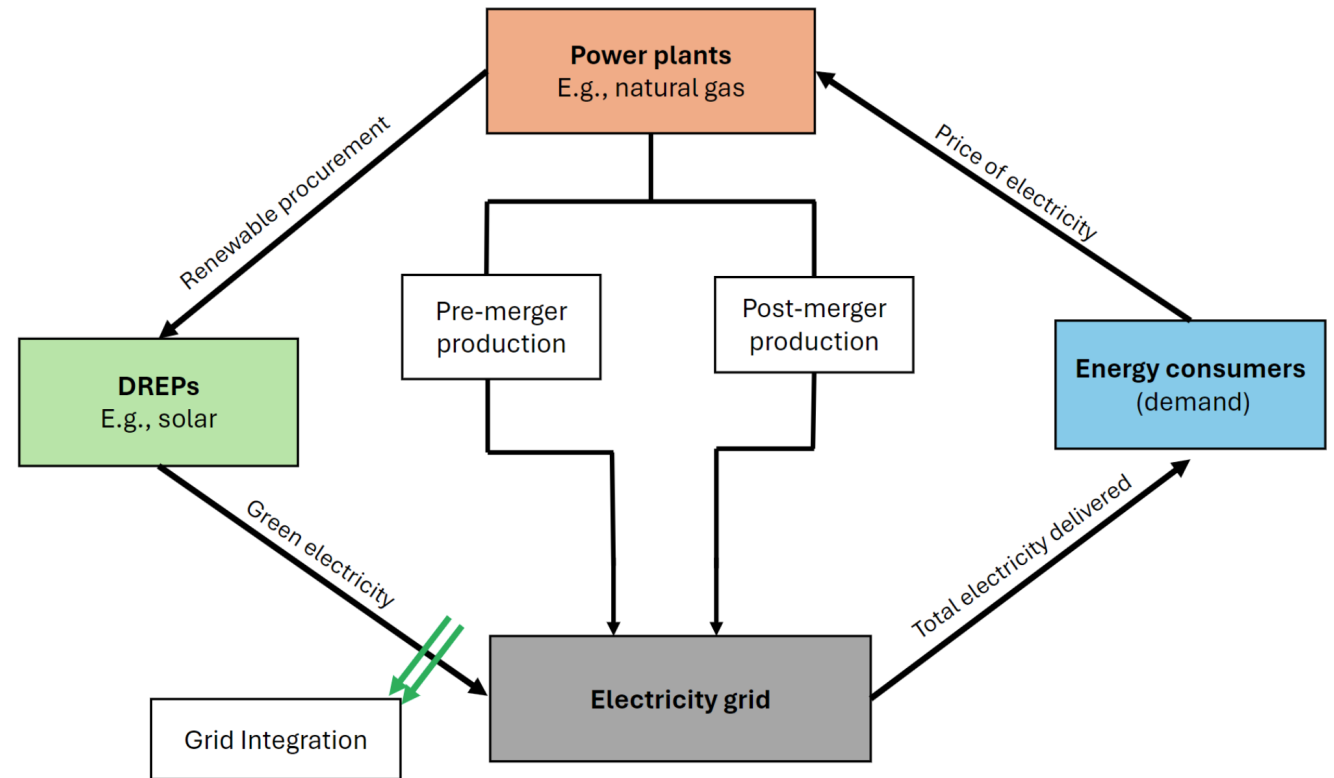
\Rightarrow

$$z = \frac{1}{1 + \frac{\sigma_\epsilon^2}{\sigma_s^2}}$$

Motivation

- Renewable energy production by DREPs has increased.
- DREP capacity expected to rise.
- Energy produced by DREP is sent back to the grid.

- But there is uncertainty about DREPs (grid integration costs).



How does the presence of uncertainty about grid integration costs affect the incentives for energy producers to merge?