

Vertical Integration and Market Power

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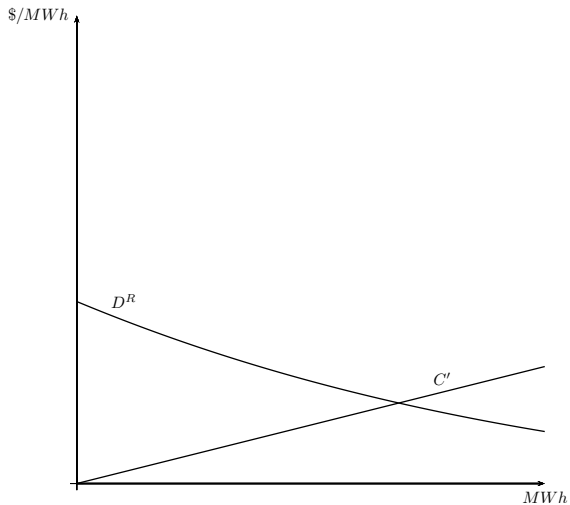
2016 EPOC Winter Workshop

Outline

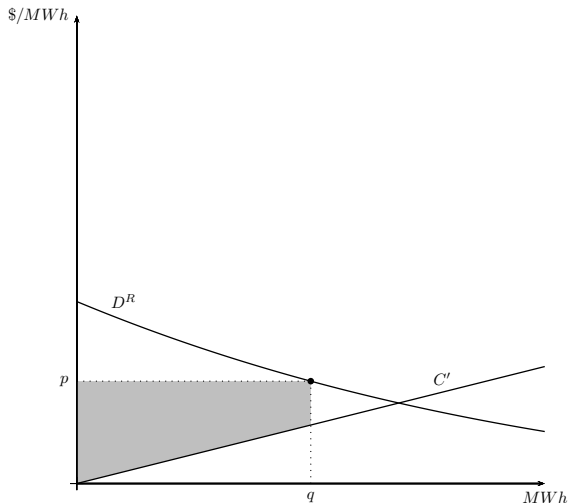
- 1 SFE and contracting
 - Optimal offer stacks
 - Contracts for Differences

- 2 Vertical Integration
 - Correlation between Retail and Aggregate Demand
 - Example
 - Effects on third parties

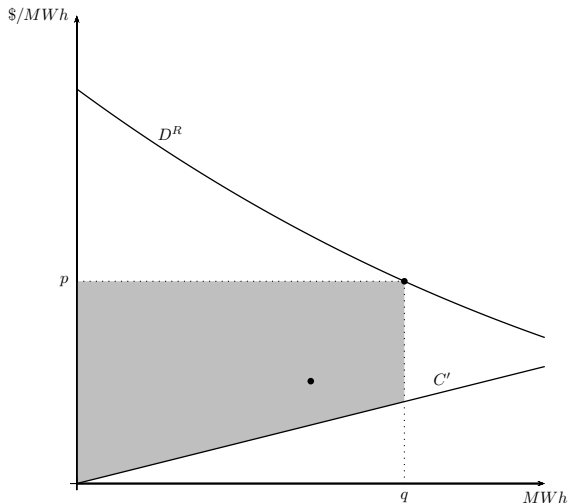
The Generator's Problem



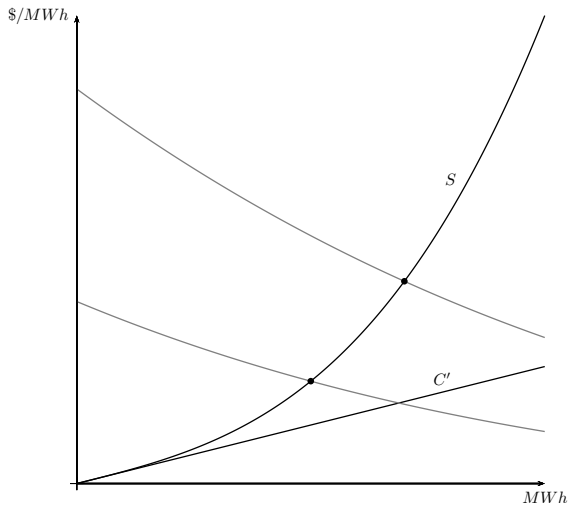
The Generator's Problem



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The Generator's Problem



Optimality conditions

Without contracts:

For each possible residual demand curve D_R ,

$$\max_{q,p} \mathbb{E}[pq - C(q)]$$

subject to $q = D_R(p)$.

Optimality condition

$$\frac{q}{p - C'(q)} = D'_R.$$

Contract obligations x can be contracts for differences or fixed-price variable-volume.

Optimality conditions

With contracts:

For each possible residual demand curve D_R ,

$$\max_{q,p} \mathbb{E}[pq - C(q) - px]$$

subject to $q = D_R(p)$.

Optimality condition

$$\frac{q - \mathbb{E}[x|q,p]}{p - C'(q)} = D'_R.$$

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Optimality conditions

With contracts:

For each possible residual demand curve D_R ,

$$\begin{aligned} \max_{q,p} \mathbb{E}[pq - C(q) - px] \\ \text{subject to } q = D_R(p). \end{aligned}$$

Optimality condition

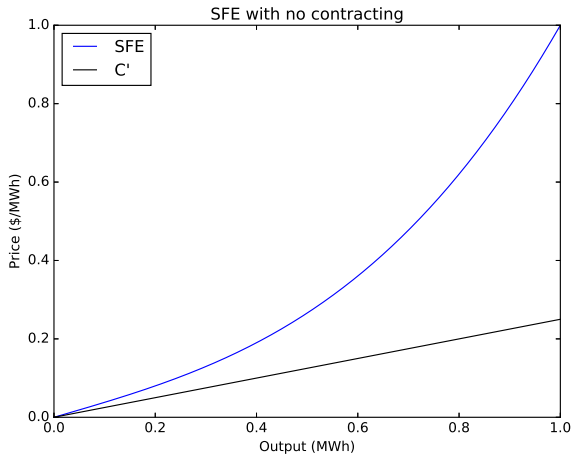
$$\frac{q - \mathbb{E}[x|q,p]}{p - C'(q)} = D'_R.$$

Contract obligations x can be contracts for differences or fixed-price variable-volume.

Supply-Function Equilibrium

- All generators make profit-maximising offers, given other offers.
- We model the spot market; contract positions exogenous.
- Solve a differential equation to find the symmetric 4-player SFE.

SFE without Hedging



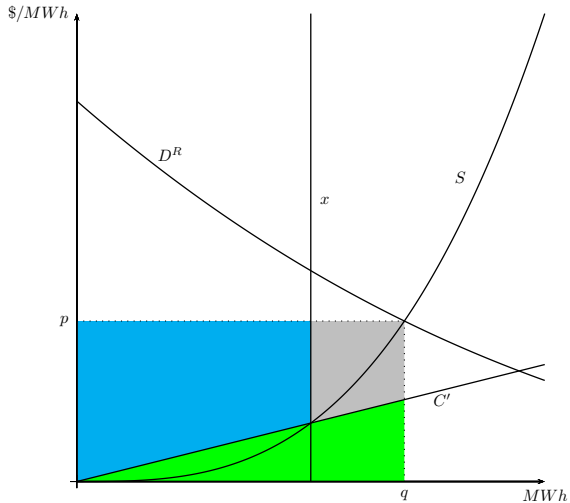
Contracts for Differences

- Contract for Differences (CfD) pay difference between strike price and spot price
- Generators sell them to retailers, industrials as forward sales
- Obligation does not depend on market price or demand levels

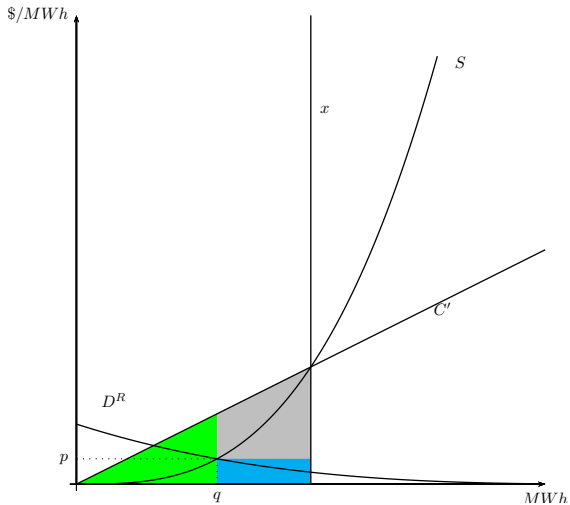
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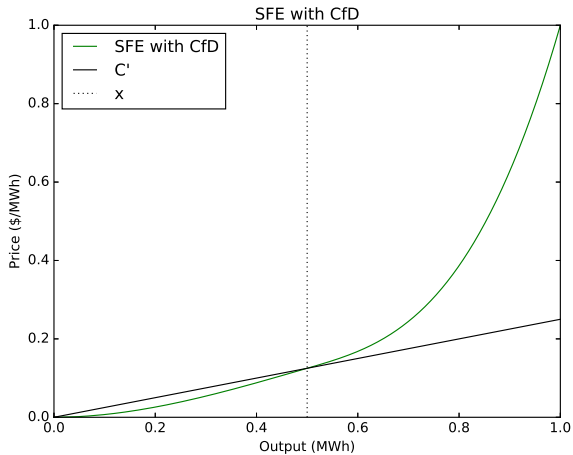
SFE with CfD



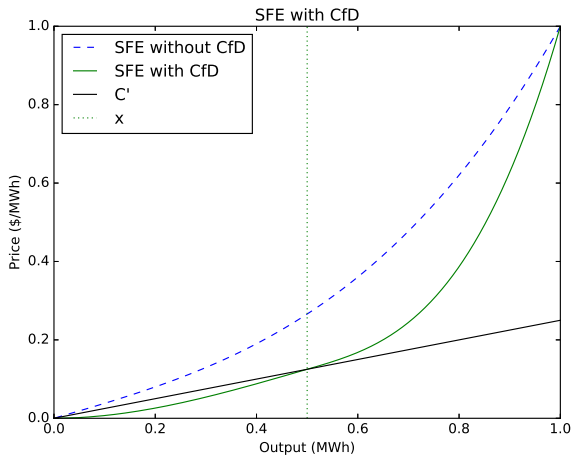
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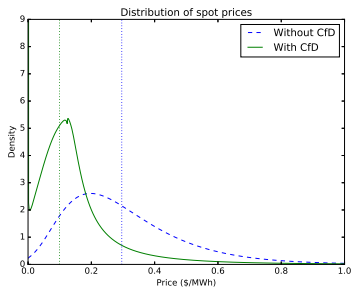
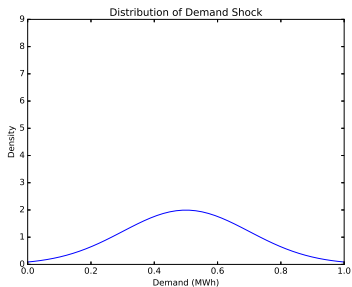
SFE with CfD



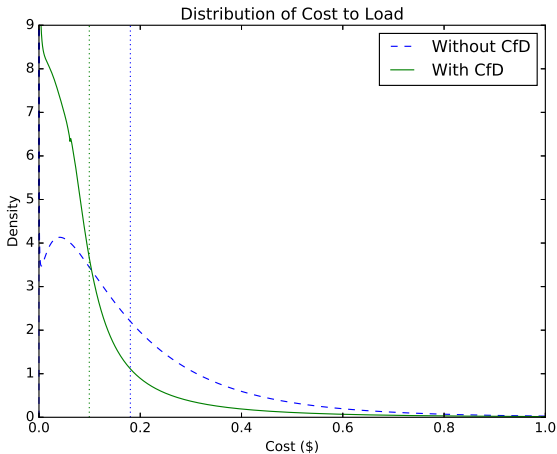
SFE with CfD



Contracting Changes Prices



Contracting Changes Prices



Contracting changes prices

- Purchasers of CfD compare futures prices with expected spot prices
- But; buying CfD changes generators' incentives in spot market, which changes spot price distribution
- Market-power premium for forward sales, as well as risk premium

Vertical Integration

- Retailers sell to consumers on fixed-price variable-volume basis
- Generators that integrate with retailers must also buy energy to cover retail commitment
- Sometimes generators will be net purchasers of energy
- This affects their incentives in offering to wholesale market
- There will be correlation between the retail load and the wholesale price

Vertical Integration

- Four gentailers, each with
 - 25% generation market share
 - 20% retail market share
 - linear marginal cost of generation

What if There is No Correlation?

Result:

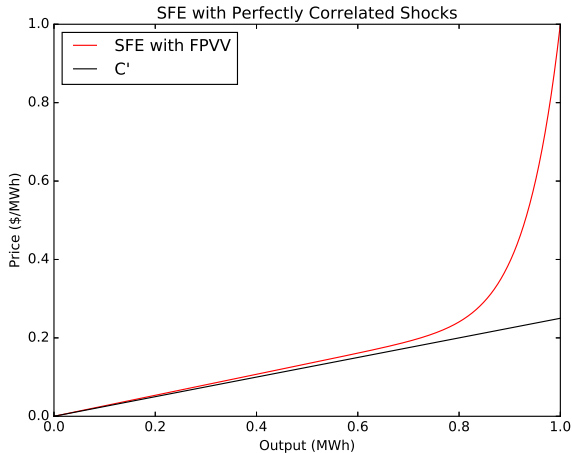
If (and only if) retail load and aggregate demand are independent, then vertical integration is equivalent to selling CfD for expected retail load

This is not the case in real-world markets!

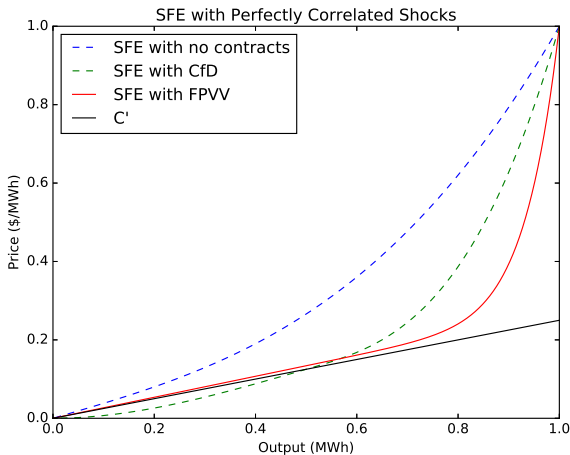
Perfect Correlation

- Retail obligation follows generation proportionally
- Generators only reap a fraction of the market-power rents (difference between generation and retail market share)

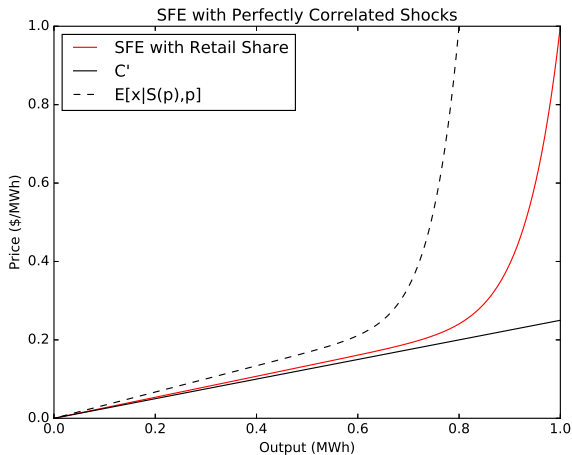
Perfect Correlation



Perfect Correlation



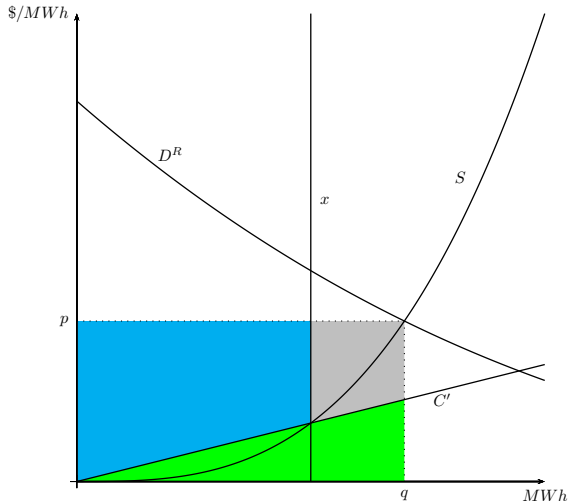
Perfect Correlation



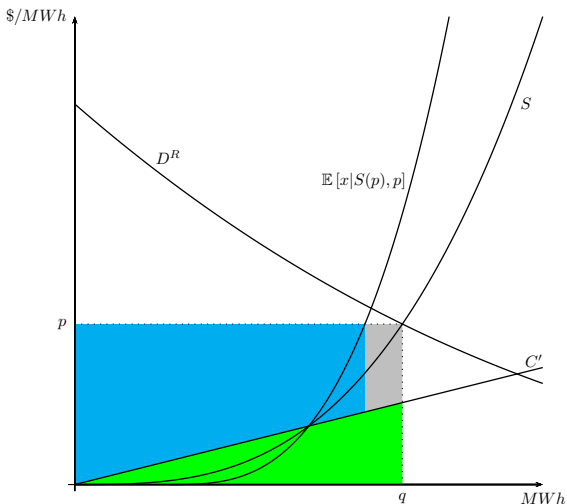
Imperfect Correlation

- Aggregate demand is sum of retail and industrial demands
- Sum of independent or positively correlated random variables will be positively correlated with the summands
- Fixed and variable components of expected retail obligation

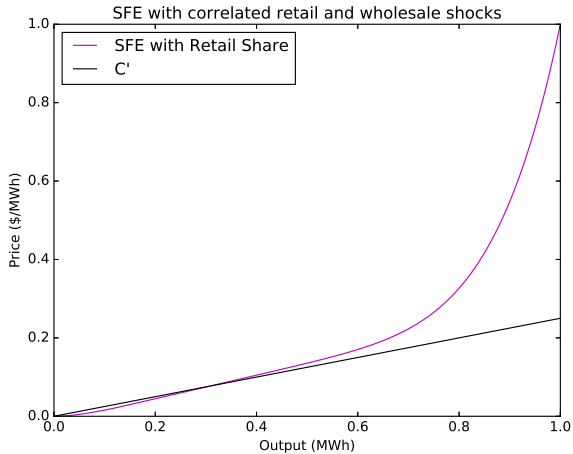
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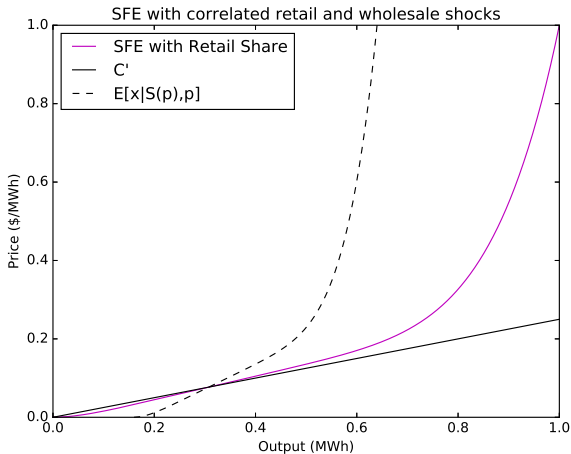
SFE with Vertical Integration



Imperfect Correlation



Imperfect Correlation



Example

Assumptions

- Four symmetric generators with linear marginal cost
- Four retailers with perfectly correlated retail demand
- Independent industrial demand/wind shock
- Industrials buy on spot
- Last unit of generation capacity offered at price cap

Scenarios

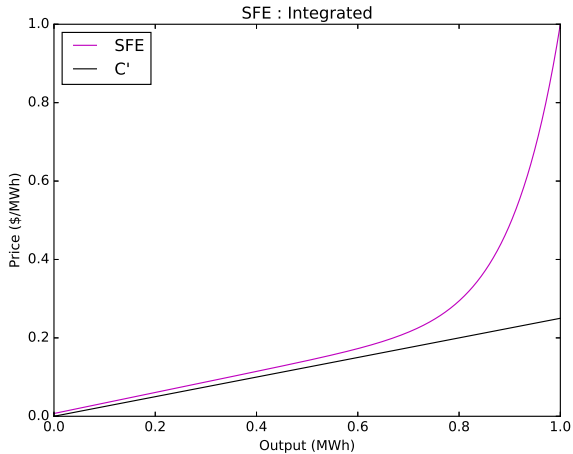
Vertical integration

- Four generators own four retailers
- Gentailers serve retail customers at fixed price, variable volume

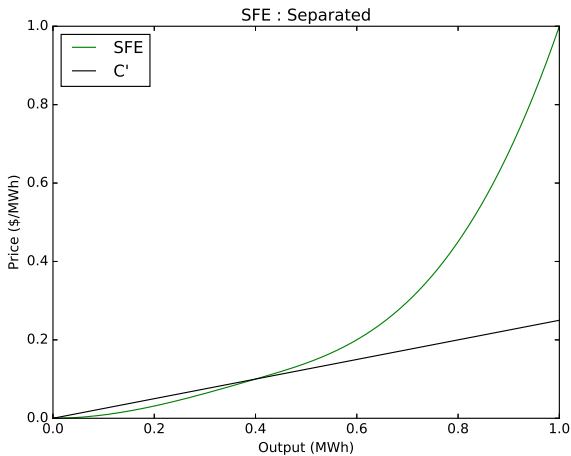
Vertical separation

- Generators sell CfD to retailers
- Retailers buy supplementary energy on spot

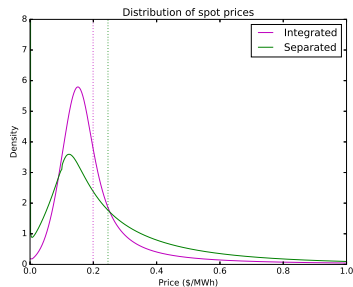
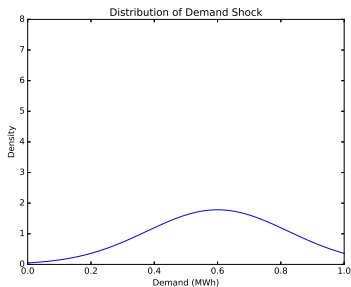
Equilibrium



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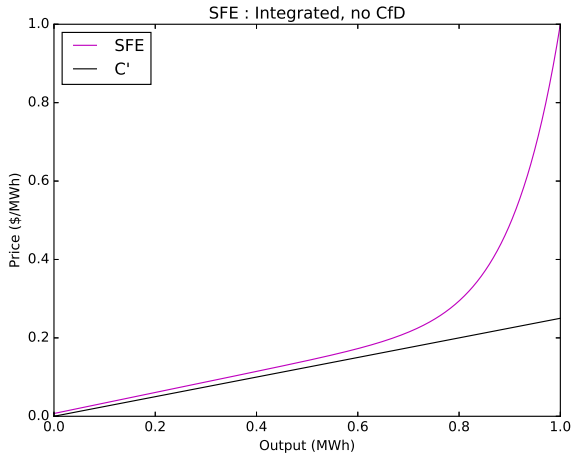
Price Distributions



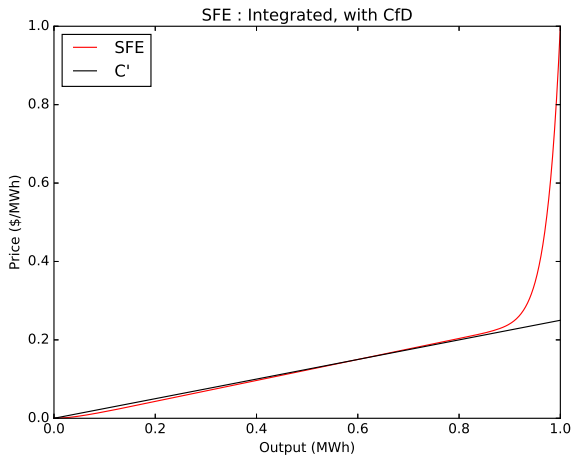
If Industrials Buy CfD

- Industrials will want to cover some of their load with CfD
- This will (also) move spot price distribution
- Suppose that instead of buying all on spot, industrials buy CfD to cover expected load

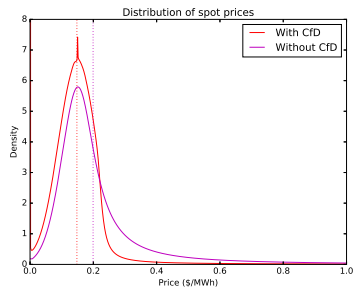
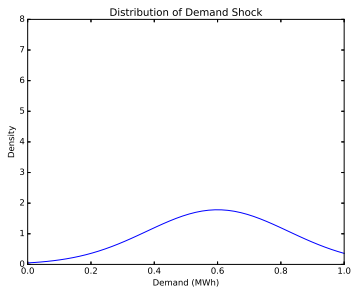
Industrials Buy all on Spot



Industrials Buy CfD



Price Distributions



Summary

- Trading in contracts changes the distribution of spot prices.
- Vertical Integration and forward selling are *not* strategically equivalent
- Third parties benefit from generators integrating with retailers.
- Further questions
 - What is the premium between futures and spot prices, in equilibrium?
 - What does this mean for longer term market conditions?

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