

Market power premia in forward electricity prices

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Forward and spot markets

Forward premia

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Our model

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Locational marginal pricing

- Prices vary by node in the grid
- Uniform price at each node

Properties (Hogan, 2016)

- Efficient (but for market power)
- Non-discriminatory
- Allows open access to transmission

Forward market is derivative of spot

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All physical delivery must be traded through spot market

Only derivatives are traded forward

– contracts whose payout is conditional on spot prices

Bulk of forward trading is contracts for difference

Forward can mean a little forward or very forward, e.g.:

PJM/MISO/NYISO, etc:

Day-ahead/hourly

NZ:

Quarterly CfD/Half-hourly spot

Problem: there seem to be larger differences between forward and spot prices than risk-aversion can account for.

In

- California (Borenstein et al., 2008, Oren et al., 2014)
- PJM (Longstaff & Wang, 2004)
- New England (Hadsell, 2008)
- New York (Saravia, 2003)
- MISO (Birge, Hortaçsu et al., 2014)
- Nordpool (Lazarczyk, 2016)
- and even New Zealand (Bevin-McCrimmon, Diaz-Rainey, & Sise, 2016)

The problem with forward premia

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They are a symptom of inefficiency

They show that markets are not competitive

Issues in US of manipulating forward market to increase value of transmission rights

Risk premium

Buy now to insure against disaster

Purpose of forward contracting is to hedge risk, so prices must be determined by risk attitudes

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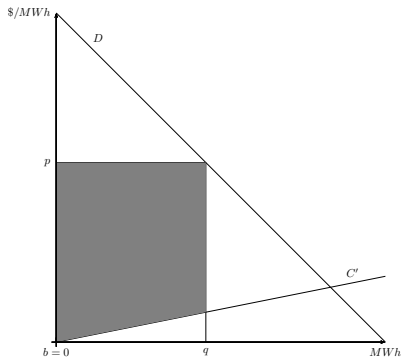
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Price discrimination

Generators use rounds of forward trading to bite into consumer surplus



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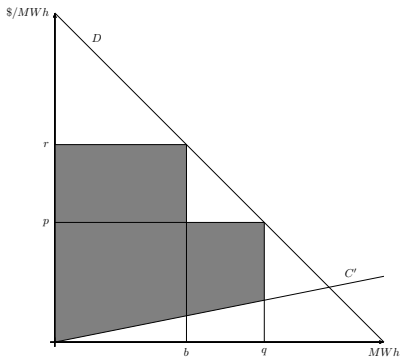
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Introducing speculators

Under competitive assumptions, risk-neutral speculators should reduce risk premia by taking on risk.

If we think forward premia come from price discrimination, then speculators can again help prices to equalise.

In risk-neutral setting, equality between forward and (expected) spot prices gets imposed as a constraint (e.g. Allaz & Vila, 1993)

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How does market power propagate from spot, back to forward market?

Agents hold a portfolio at spot market time.

Spot market incentives are a function of this forward position.

Forward prices are prices that would induce agents to change their portfolio.

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Variables

| | |
|---------------------------------|-----|
| Spot price | p |
| Forward price | r |
| Physical production/consumption | q |
| Forward sales | b |

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- Large generators compete in Cournot game
- Demand curve minus non-strategic fringe supply
- Generators consider CfD obligations when optimising offers

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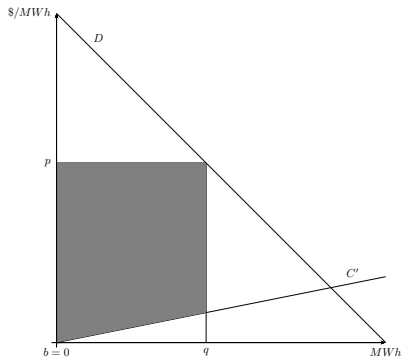
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Generator Spot Strategy

Output increases with CfD written, while price decreases.



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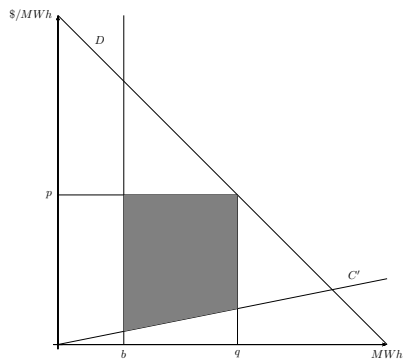
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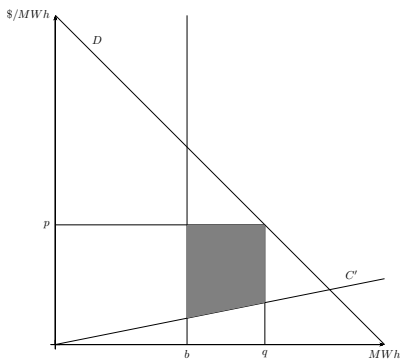
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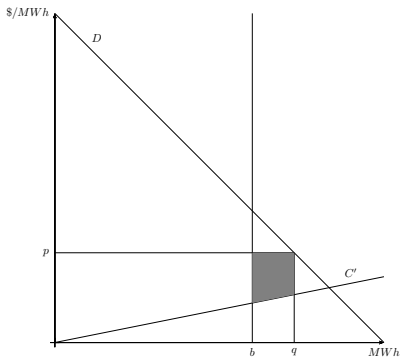
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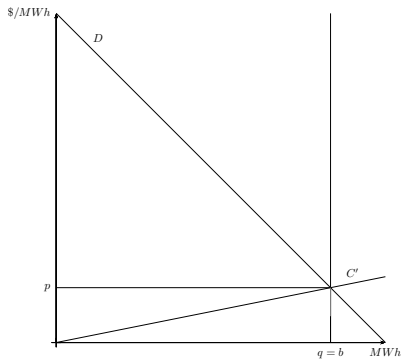
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Important properties

- More forward sales means lower spot prices
- Selling forward allows generators to increase market share

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Assumptions:

- No speculators
- Consumers buy CfD from generators
- Spot market is Cournot (sub-)game between generators
- Spot market outcomes are a function of forward position
- Market participants trade contracts to shift forward position

Consumer Objective

Consumer has a fixed load q .

Minimize cost

$$\min_b [qp + b(r - p)]$$

Spot price is a function of forward position

$$\frac{dp}{db} < 0$$

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Consumer Objective

Forward price is the price that sets marginal cost to zero

$$\frac{d}{db} [qp + b(r - p)] = (q - b) \frac{dp}{db} + r - p = 0$$

So

$$r = p - (q - b) \frac{dp}{db}$$

We know that $\frac{dp}{db} < 0$, and assume $q - b > 0$, so

$$r > p.$$

Premium is the reduced cost of the un-contracted demand.

Generator Objective

Maximize profit

$$\max_{b_1} [pq_1 + b(r - p)]$$

Spot price is a function of forward position

$$p(b) \text{ with } \frac{dp}{db} < 0.$$

Spot output is function of spot price (Demand curve)

$$q_1 + q_2 = D(p).$$

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Generator Objective

Maximize profit

$$\frac{d}{db_1} [(p - c) q_1 + b(r - p)] = 0$$
$$\frac{dp}{db_1} (q_1 - b_1) + (p - c) \frac{dq_1}{db_1} - p + r = 0$$

Increase in market share trumps drop in price

$$\frac{dp}{db} (q - b) + (p - c) \frac{dq}{db} > 0$$

So

$$r < p.$$

Generators will willingly sell forward at the expected spot price
(Allaz & Vila effect)

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What will be the forward price?

Assuming incomplete cover, consumers will have a higher marginal value for CfD than generators.

If generators have market power in forward trading as well, price will be closer to consumers' valuation, i.e. above spot price.

Possible interactions with risk hedging?

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Competitive equilibrium

If forward market is competitive (big if), it will clear when marginal values r are equal.

$$(q - b) \frac{dp}{db} = \frac{dp}{db} (q - b) + (p - c) \frac{dq}{db}$$

Gives competitive prices on spot

$$p = c,$$

all sales are forward sales

$$q = b,$$

and zero premium on forward sales

$$r = p.$$

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Introduce speculators

If speculators can buy low and sell high they will create market forces that will eliminate the forward premium.

Or so we hope.

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Speculator's incentives

A speculator has written b_s CfD.

Their cost

$$\Omega = b_s(r - p)$$

At minimum, $\frac{d\Omega}{db_s} = 0$, so

$$r = p + b_s \frac{dp}{db}$$

If they trade CfD with consumers: $\frac{dp}{db} = 0$

$$r = p$$

How much will consumers pay them? Just the spot price. No gain from trade.

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A speculator has written b_s CfD.

Their cost

$$\Omega = b_s(r - p)$$

At minimum, $\frac{d\Omega}{db_s} = 0$, so

$$r = p + b_s \frac{dp}{db}$$

If they trade CfD with generators $\frac{dp}{db_g} = -\frac{dp}{db_g} > 0$

$$r = p + b_s \frac{dp}{db_s} > p$$

At what price will the generators trade?

$$r_g = p - \frac{dp}{db_g} (q - b_g) + (p - c) \frac{dq}{db_g}$$

Speculators

Speculators who write CfD will want to buy them back from generators to reduce the spot price, since this reduces their liability.

In competitive equilibrium of forward market, speculators hold nothing.

Otherwise they are just middlemen, perhaps able to appropriate some market power rents for themselves.

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Differentiated products

From consumer's perspective, CfD backed by generators and CfD backed by speculators are different products.

Buying from generator not only covers you for high prices, but reduces likelihood of those high prices.

They will have different prices.

Modest efficiency gains from having a slightly different security in the market.

But how do you know who will end up with the other side of your CfD when the spot market clears?

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Sufficient conditions for existence of premium

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Assumptions:

- Not all demand gets covered by CfD
- When consumer buys CfD, some is covered by a generator
- Generators have spot market power

Conclusion

- Spot market outcomes depend on the forward positions of oligopolists
- Who is counterparty to your contract for differences may be important
- All else being equal, a CfD bought from a generator is worth more than one bought from a speculator
- The forward premium is the price of market power

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Next steps

Make sure that the model works for more formal forward markets, like day-ahead dispatch

Think of how to fix forward market so that speculators are more helpful

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Speculator's incentives

Now suppose $b_s < 0$. Speculator has bought CfD.

Their cost

$$\Omega = b_s(r - p)$$

At minimum, $\frac{d\Omega}{db_s} = 0$, so

$$r = p + b_s \frac{dp}{db}$$

If they trade CfD with generators $\frac{dp}{db_g} = -\frac{dp}{db_s} > 0$

$$r = p + b_s \frac{dp}{db_s} < p$$

At what price will the generators trade?

$$r_g = p - \frac{dp}{db_g} (q - b_g) + (p - c) \frac{dq}{db_g}$$

Purchasing choice

- Buy now at forward price
- Buy later at spot price

Risk – spot price could be higher than forward

Information – buying forward reveals my private information about demand

Market power – buying forward affects incentives of oligopolists

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Possible connections between forward purchases and spot prices

Information – by buying more forward I reveal that demand is high, so spot price will be high

Protection – by buying forward I reduce incentives for oligopolists to mark up, so price will be low

Which is more likely in electricity?

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