

# **The forward premium in electricity markets**

**An experimental study:  
Why and How**

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- Allaz & Vila (JET, 1992)  
“Cournot competition, forward markets and efficiency”
- Van Koten & Ortman (EER, 2013):  
“Structural versus Behavioral Remedies in the Deregulation of Electricity Markets: An Experimental Investigation”

- Bessembinder and Lemmon (2002)

- the forward price is generally an unbiased estimator of the future

$$P_F = (P_S + c)e^{(r-y)t}$$

- Electricity is (mostly) not storable
- the electricity forward wholesale price can be modeled as the result of hedging pressures by the sellers (producers) and buyers (retailers) of electricity.

$$P_F = E(P_S) - \frac{N_P}{(N_P + N_R)} \frac{A}{ca^x} \left[ c\bar{P}_R \text{Cov}(P_S^x, P_S) - \text{Cov}(P_S^{x+1}, P_S) \right]$$

$$P_F = E(P_S) - \alpha \text{Var}(P_S) + \gamma \text{Skew}(P_S)$$

$$\alpha < 0, \quad \alpha = \frac{N_P(x+1)}{(N_P + N_R)ca^x} \left[ E(P_S)^x - P_R E(P_S)^{x-1} \right]$$

$$\gamma > 0, \quad \gamma = \frac{N_P(x+1)}{2(N_P + N_R)ca^x} \left[ x E(P_S)^{x-1} - (x-1)P_R E(P_S)^{x-2} \right]$$

- Electricity prices are correlated with demand
- Profits of retailers:
  - decreasing in price
  - increasing in demand
- Low price variance:
  - the profit-increasing effect of higher demand dominates the profit-decreasing effect of a higher electricity price.
  - lower price of forwards (negative premium)
- High price variance (spikes):
  - the profit-decreasing effect of a higher electricity price dominates the profit-increasing effect of higher demand.
  - higher price of forwards (positive premium).

- Hypothesis 1: The equilibrium forward premium decreases in the anticipated variance of wholesale prices, *ceteris paribus*.
- Hypothesis 2: The equilibrium forward premium increases in the anticipated skewness of wholesale prices, *ceteris paribus*.

- testing these first two hypotheses:
- Selection of empirical articles:
  - Longstaff and Wang (2004), Karakatsani and Bunn (2005), Diko, Lawford and Limpens (2006), Hadsell and Shawky (2006), Douglas and Popova (2008), Lucia and Torro (2008), Weron (2008), Daskalakis and Markellos (2009), Redl, Haas, Huber and Böhm (2009), Botterud, Furio and Meneu (2010), Kristiansen and Ilic (2010; Haugom and Ullrich, (2012), Bun and Chen (2013), Handika and Trück (2013), Redl and Bunn (2013), Weron and Zator (2013), Zator (2013).



# Results support theory?

- Fully support:
  - Longstaff and Wang (2004), Diko, Lawford and Limpens (2006), Hadsell and Shawky (2006), Douglas and Popova (2008)
- Partially support:
  - Lucia and Torro (2008), Redl et al.(2009), Botterud et al.(2010), and Furio and Meneu (2010)
- Contradict:
  - Bunn and Chen (2012), Haugom and Ullrich (2012), Handika and Trück (2013), Redl and Bunn (2013), and Weron and Zator (2013)

# Contradictory findings perhaps not surprising

$$P_F = \text{E}(P_S) - \alpha \text{Var}(P_S) + \gamma \text{Skew}(P_S)$$

1. Expected spot price cannot be observed
  - Predict by a model?
    - Risk of model misspecification
  - Historic measurements of realized ex-post value?
    - Risk of being incorrect

# Contradictory findings perhaps not surprising

$$P_F = E(P_S) - \alpha \text{Var}(P_S) + \gamma \text{Skew}(P_S)$$

2. Variance and Skewness as perceived by market participants cannot be observed
  - Missing variable bias  $P_S$ 
    - Proxy by realized spot price
    - Add “nuisance variables” that may explain the difference

# Contradictory findings perhaps not surprising

$$P_F = E(P_S) - \alpha \text{Var}(P_S) + \gamma \text{Skew}(P_S)$$

## 3. Determined simultaneously

- Independent variables are generally correlated  $P_S$
- Then also correlated with the error terms
  - (Redl et al., 2009; Zator, 2013)

- Nice theory, but basically untestable

**The new state-of-the-art LEE Laboratory in Prague ([www.vse-lee.cz](http://www.vse-lee.cz))**



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Given distribution of demand

1. Forward market  
– Trade forwards

2. Demand realization drawn  
– communicated to both

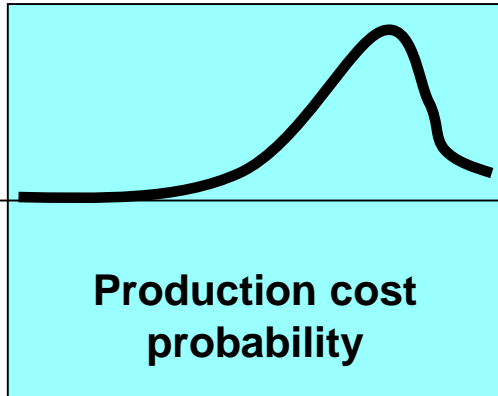
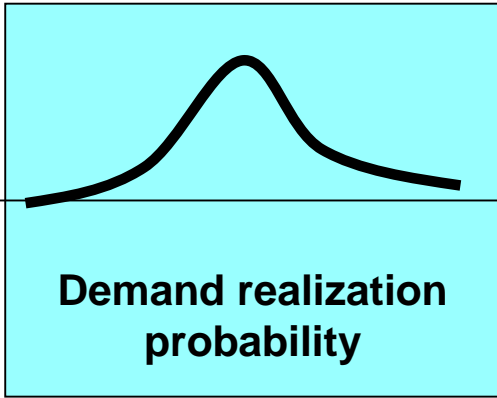
3. Spot market  
– Trade units



In your group are (including you), 2 sellers and 2 buyers

# Round 1, STAGE A

Time left 59s



Offer

- 40
- 20
- 18

Ask

- 16
- 15
- 15
- 10

Offer

- all
- 10
- 5
- 1

**Submit**

**Warning: there are 20 sec left and you are still 2 units short. You will have to buy them for ...?**

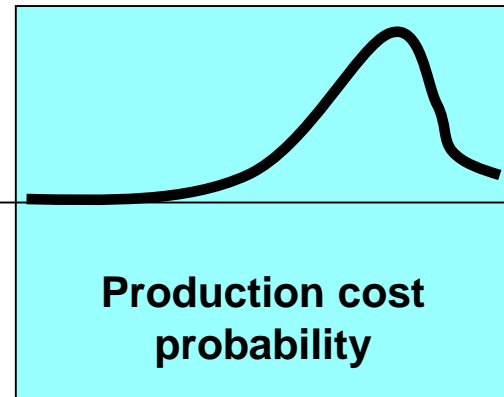
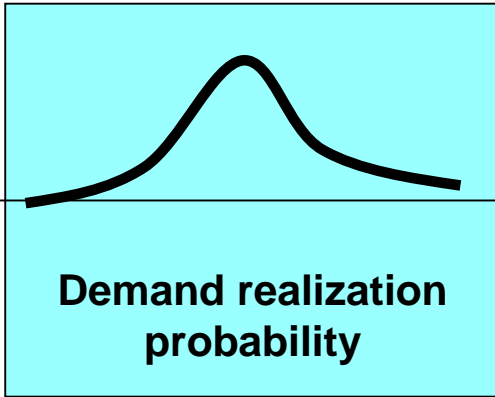
## History

Round	Stage	Demand realization Stage B	Units Bought	Average Buying price	Selling price	Revenue	Costs	Profit	Cumm. Profit
1	A	...	5	9.6			58		
	B	15	10	10	12	180	100	76	76

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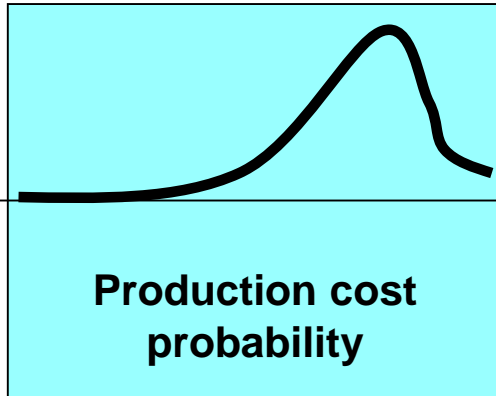
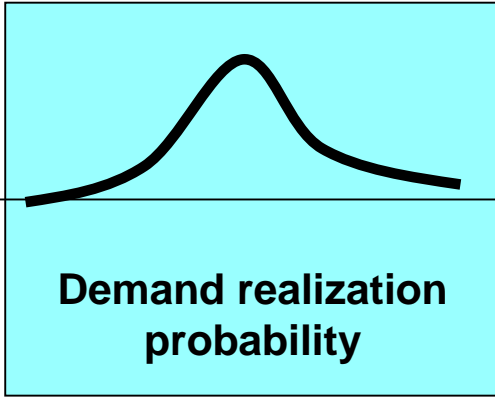
3. Spot market  
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<p>Given distribution of demand</p>	<ol style="list-style-type: none"> <li>1. distribution of demand only knowledge of retailer or also of producer?</li> <li>2. show producers and retailers a price distribution?</li> </ol>
<ol style="list-style-type: none"> <li>1. Forward market <ul style="list-style-type: none"> <li>– Trade forwards</li> </ul> </li> </ol>	<ol style="list-style-type: none"> <li>3. Trade by double auction? (Unit for unit? Supply functions? tâtonnement?)</li> <li>4. After market closes, show prices and traded quantities to both?</li> </ol>
<ol style="list-style-type: none"> <li>2. Demand realization drawn <ul style="list-style-type: none"> <li>– communicated to both</li> </ul> </li> </ol>	<ol style="list-style-type: none"> <li>5. Should the demand realization be private knowledge to retailers?</li> <li>6. Should the demand realization be private knowledge to retailers?</li> </ol>
<ol style="list-style-type: none"> <li>3. Spot market <ul style="list-style-type: none"> <li>– Trade units</li> </ul> </li> </ol>	<ol style="list-style-type: none"> <li>7. What if a retailer is short? (out-of balance fine?)</li> </ol>

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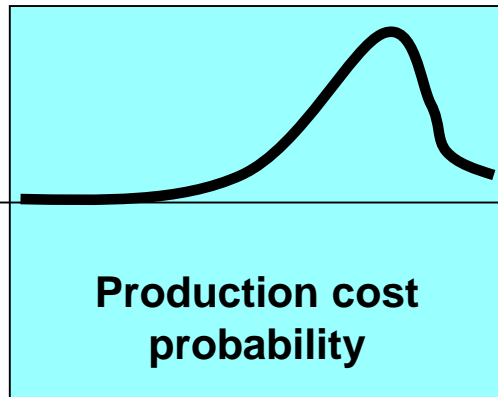
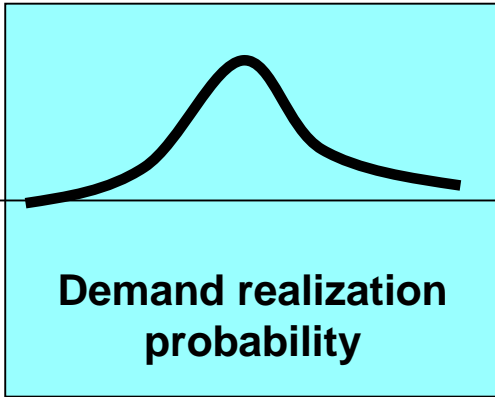
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