Relaxing Competition Through Speculation - Committing to a Negative Supply Slope

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Toulouse, 15 June 2011

Introduction

- Trade of commodity derivatives is widespread
  - Firms manage risks
  - Market aggregate information
- Derivatives could be used as a commitment device by firms
  - By speculating firms might affect outcome of the product market
  - Will commodity derivatives markets be beneficial for competition?
- We test the competitive effect of speculation
  - We do not restrict the model to Cournot and Bertrand strategies, but allow for general supply functions
    (as in Klemperer & Meyer 1989, Green & Newbery, 1992)

What we find

1. Firms will use financial derivatives to commit to a **downward sloping** supply function
   - Produce more when prices are low
   - The residual demand function of competitors becomes less elastic
   - Competitors will set higher prices
   - This is therefore profitable
   - As demand uncertainty increases, less likely to bid a downward sloping function
2. Firms can **speculate** to commit to a downward sloping supply function
   - Sell forward contracts to commit to produce a lot
   - Buy call options with high strike price = right to buy back output when prices are high

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- **Intuition**
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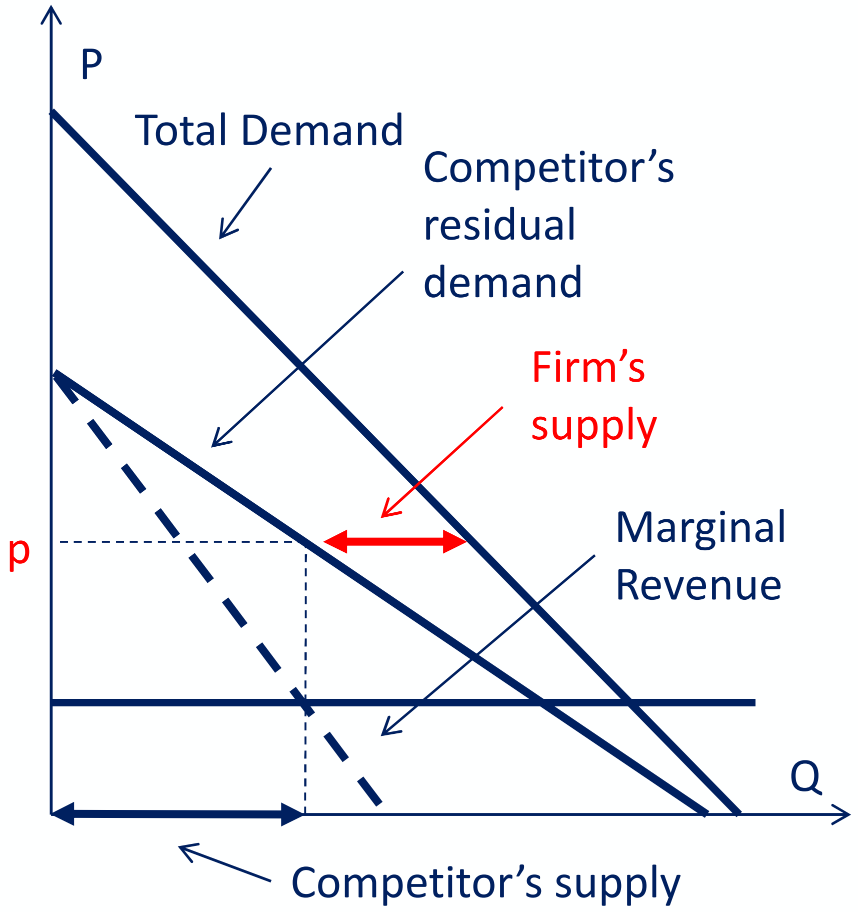
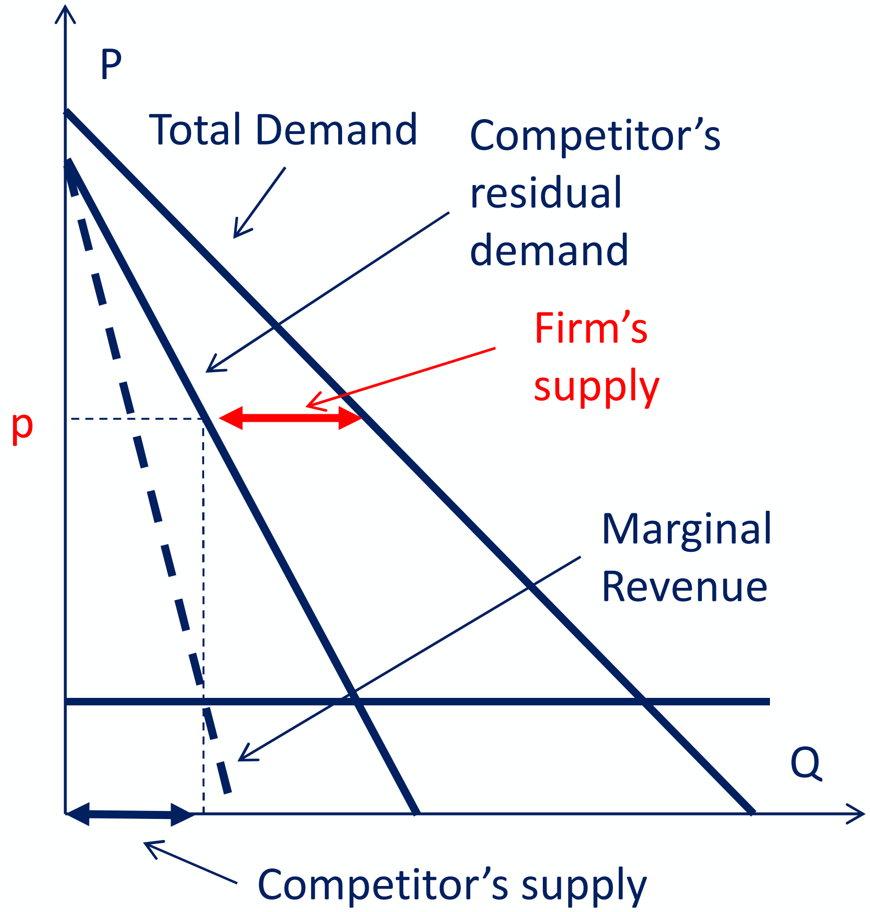
Why do firms commit?

A. Upward sloping supply function



B. Downward sloping supply function

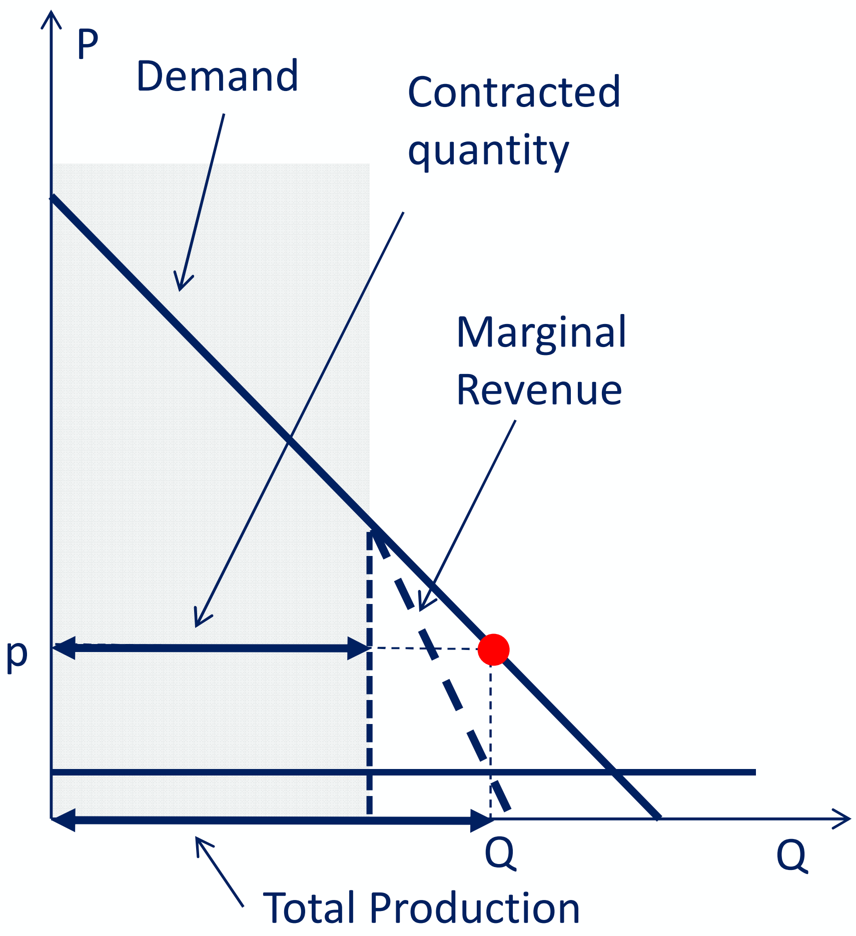


Firm sells same amount at higher price

Why do firms commit?

- Our results has parallels with results in delegation games
  - Shareholders decide whether managers use Betrand or Cournot strategies
  - Playing Cournot is a dominant strategy (Singh and Vives, 1984)
  - Unless demand is very uncertain (Reisinger and Ressner, 2009)

How do firms commit?

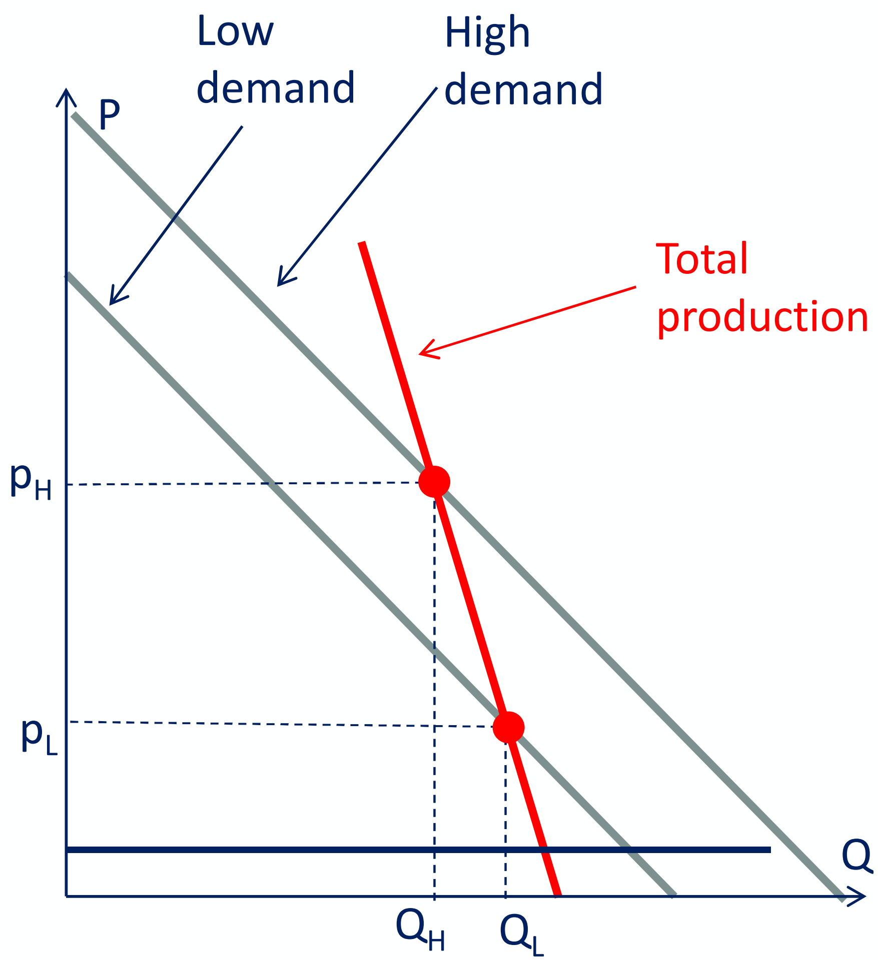


- With forward contracts a firm can commit to produce more in equilibrium

  E.g. Wolak 2000, Bushnell et al. 2008

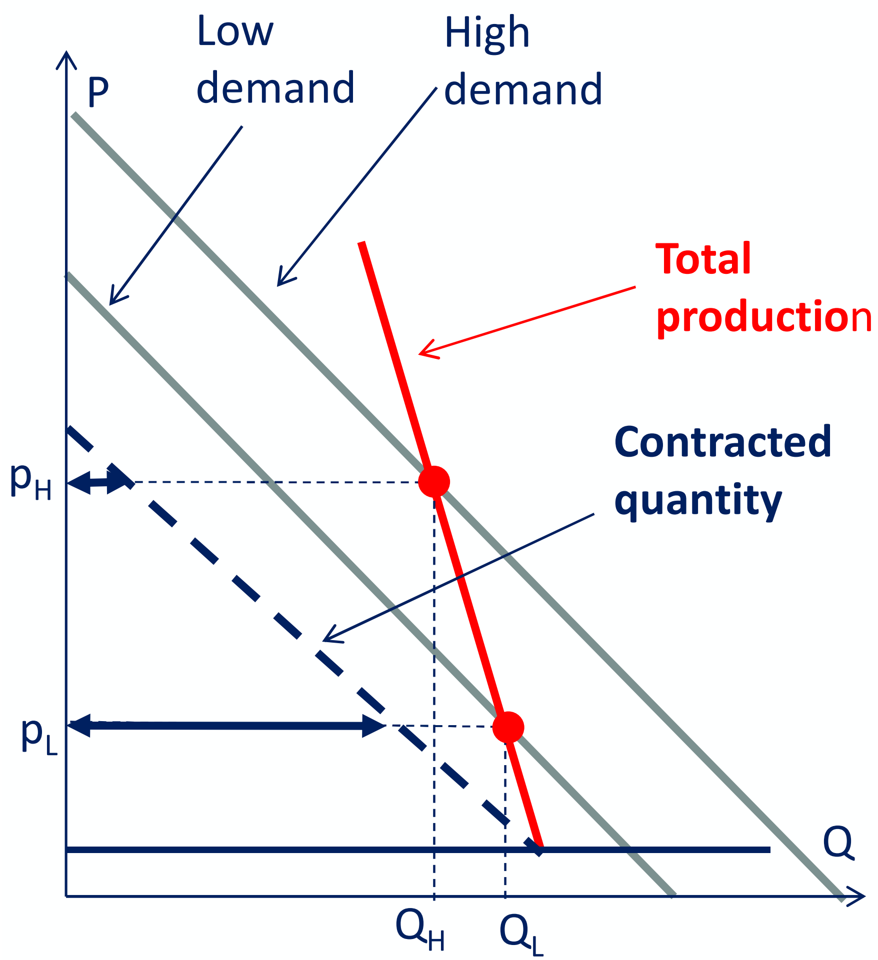
- Mechanism
  - Contract quantity is sunk
  - Firms maximize profit on the remainder of demand
  - Price is lower
  - Production is higher

How do firms commit?



- How to commit to a downward sloping supply function?
- When **price is low**, we would like to commit to be aggressive, **sell a lot forward**
- When **price is high**, we would like to commit not to be aggressive, **sell little forward**

How do firms commit?



- Make **contract position a function of the price**
  - Large for low prices
  - Small for high price
- Can be achieved by
  - selling forward contracts
  - buying call options
- Buying a call option gives the right to buy back quantity if spot price is high
- "Bear call Spread"

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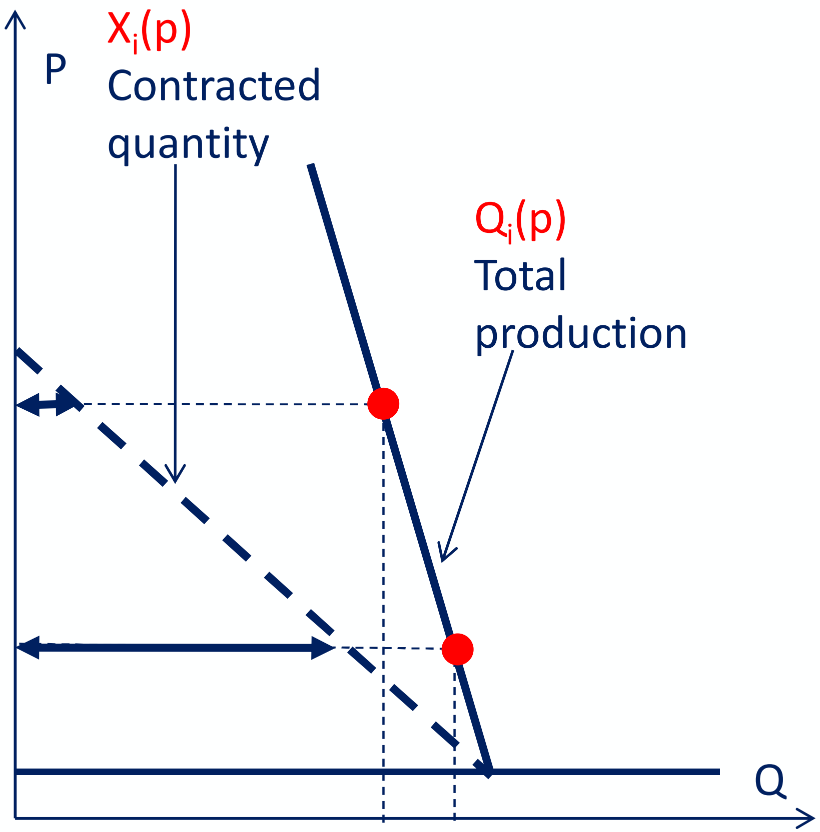
Set up

Two stage oligopoly

1. Firms simultaneously sell a portfolio of contracts to consumers
2. Firms bid simultaneously a supply function in the spot market

- Assumptions
  - Consumers arbitrage perfectly between spot and contract market
  - Demand is stochastic and is realized after firms bid in the spot market
  - Firms observe each other's contract positions after stage 1
  - Firms have no production costs, no capacity constraints
- Extension of Allaz & Vila (1993), Chao & Wilson (2005)

Set up



Firm *i's strategies*

1. Firm *i* sells contracts $X_i(p)$
2. Firm *i* decides how much it sells in spot market $Q_i(p) - X_i(p)$

Equilibrium prices

1. No arbitrage condition
2. Market clearing

$$\sum_i Q_i(p) = D(p) + \varepsilon$$

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2nd Stage: Spot Market Equilibrium

- We show that SFE equilibria are ex-post optimal, as in Klemperer & Meyer, 1989
- For each shock firm *i* chooses a point where its marginal revenue in the spot market is equal to marginal cost (=0).

2nd Stage Equilibrium

$$\forall i: \qquad \underbrace{p \cdot \left(\frac{\partial Q_{-i}(p)}{\partial p} - \frac{\partial D(p)}{\partial p} \right)}_{\text{Slope of the residual demand function}} = \underbrace{Q_i(p) - X_i(p)}_{\text{Net sales in the spot market}}$$

Slope of the residual demand function

Net sales in the spot market

1st Stage: Contracting Equilibrium

- Firm 1 maximizes expected profit

$$\max_{X_1(p)} \int_0^{\overline{p}} p \cdot Q_1(p) \cdot dF(\varepsilon(p))$$

- Subject to the 2nd stage Nash equilibrium

$$\begin{cases} \dfrac{\partial Q_1(p)}{\partial p} = \dfrac{\partial D(p)}{\partial p} + \dfrac{Q_2(p) - X_2(p)}{p} \\ \dfrac{\partial Q_2(p)}{\partial p} = \dfrac{\partial D(p)}{\partial p} + \dfrac{Q_1(p) - X_1(p)}{p} \\ D(p) + \varepsilon(p) = Q_1(p) + Q_2(p) \end{cases}$$

Klemperer Meyer Equations (first two equations)

Market Equilibrium (third equation)

- For each firm we have an optimal control problem with state variables Q_1, Q_2, and ε

1st stage equilibrium

- If the inverse hazard rates are not to steep, $\frac{d}{d\varepsilon}\left(\frac{1-F(\varepsilon)}{f(\varepsilon)}\right) \leq 1$

  then the Nash equilibrium is symmetric and given by: *

1st Stage equilibrium

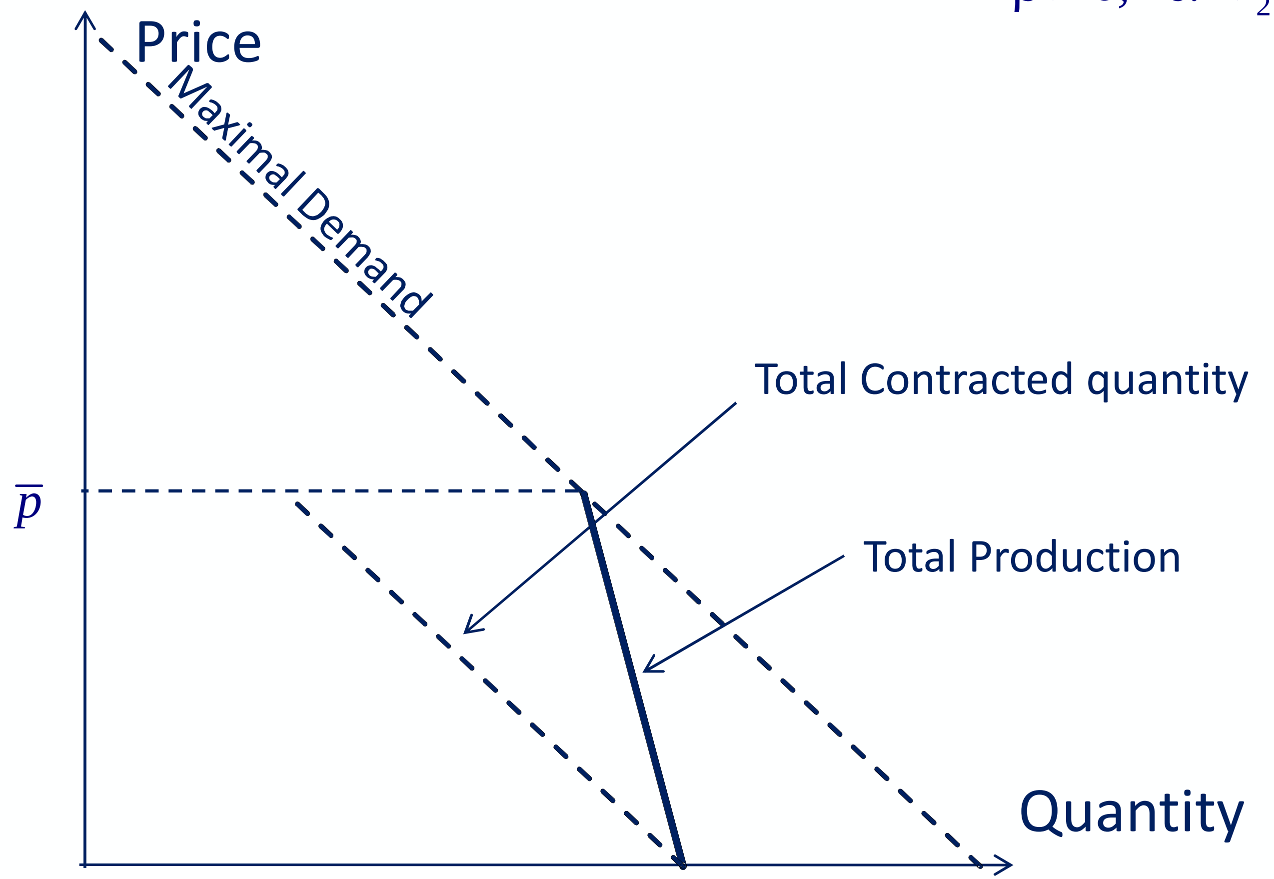
$$\begin{cases} \dfrac{1-F(\varepsilon(p))}{f(\varepsilon(p))} = Q + p\dfrac{dQ(p)}{p} & \text{Optimality Condition} \\ \dfrac{dQ(p)}{dp} = \dfrac{dD(p)}{dp} + \dfrac{Q(p)-X(p)}{p} & \text{Klemperer Meyer Equation} \\ D(p) + \varepsilon(p) = 2Q(p) & \text{Market Equilibrium} \end{cases}$$

*) 2 x partial integration + elimination of constraints → point-wise optimize optimization

Example with Analytical solution

- Linear demand
- 2nd order Pareto distributed demand shocks $\frac{1-F(\varepsilon)}{f(\varepsilon)} = \alpha\varepsilon + \beta$

$$\beta > 0, \quad \alpha < \tfrac{1}{2}$$



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Conclusion

- **Anti-competitive effect of speculation** financial markets
  - Firms speculate in order to adjust the slope of their supply function and to soften competition
  - Price might even be above the monopoly price!
  - Effect is largest when the number of firms is large and demand uncertainty is small
  - Close to delivery, demand uncertainty is small and options are more likely to be abused
  - Regulate risk taking by firms
- In practice we expect the bidding strategy to be less pronounced as this **strategy is risky**
- Results for **other commitment devices** are likely to be similar.
  - Cf. Zöttl (2010), strategic firms invest mainly in base-load, but not in peak capacity to commit to steep bid functions.