Relaxing Competition Through Speculation - Committing to a Negative Supply Slope

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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
- Introduction
- Intuition
- Model
- Analysis
- Conclusion
Why do firms commit?

A. Upward sloping supply function

- Total Demand
- Competitor’s residual demand
- Firm’s supply
- Marginal Revenue

B. Downward sloping supply function

- Total Demand
- Competitor’s residual demand
- Firm’s supply
- Marginal Revenue

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

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).

\[ \forall i: \quad p \cdot \left( \frac{\partial Q_{-i}(p)}{\partial p} - \frac{\partial D(p)}{\partial p} \right) = Q_i(p) - X_i(p) \]

- Slope of the residual demand function
- Net sales in the spot market
1st Stage: Contracting Equilibrium

- Firm 1 maximizes expected profit

\[ \max_{X_1(p)} \int_0^p p \cdot Q_1(p) \cdot dF(\epsilon(p)) \]

- Subject to the 2nd stage Nash equilibrium

\[
\begin{align*}
\frac{\partial Q_1(p)}{\partial p} &= \frac{\partial D(p)}{\partial p} + \frac{Q_2(p) - X_2(p)}{p} \\
\frac{\partial Q_2(p)}{\partial p} &= \frac{\partial D(p)}{\partial p} + \frac{Q_1(p) - X_1(p)}{p} \\
D(p) + \epsilon(p) &= Q_1(p) + Q_2(p)
\end{align*}
\]

Klemperer Meyer Equations

Market Equilibrium

- For each firm we have an optimal control problem with state variables \( Q_1, Q_2, \) and \( \epsilon \)
If the inverse hazard rates are not too steep, \( \frac{d}{d\varepsilon} \left( \frac{1-F(\varepsilon)}{f(\varepsilon)} \right) \leq 1 \)

then the Nash equilibrium is symmetric and given by: *

\[
\begin{align*}
\frac{1-F(\varepsilon(p))}{f(\varepsilon(p))} &= Q + p \frac{dQ(p)}{p} \\
\frac{dQ(p)}{dp} &= \frac{dD(p)}{dp} + \frac{Q(p) - X(p)}{p} \\
D(p) + \varepsilon(p) &= 2Q(p)
\end{align*}
\]

*) 2 x partial integration + elimination of constraints \( \rightarrow \) point-wise optimize optimization
Example with Analytical solution

- Linear demand
- 2$^{nd}$ order Pareto distributed demand shocks
  \[ \frac{1-F(\varepsilon)}{f(\varepsilon)} = \alpha \varepsilon + \beta \]
  \[ \beta > 0, \; \alpha < \frac{1}{2} \]
Introduction

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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.