Relaxing Competition Through Speculation
-
Committing to a Negative Supply Slope

Pär Holmberg (IFN, EPRG assoc) and Bert Willems (Tilburg)

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Introduction

- Trade of derivative/financial contracts is widespread
  - Firms manage risks
  - Markets aggregate information

- Derivatives could be used as a commitment device
  - By strategically selling and buying derivatives, firms influence spot market outcome
  - Will trade in derivatives benefit competition?

- Previous studies of forward contracts were unconclusive (Allaz & Vila, 1993; Mahenc & Salanié, 2004)
  - We do not restrict the model to Cournot and Bertrand strategies, but allow for general supply functions as in Klemperer & Meyer (1989) and Green & Newbery (1992).
  - We allow firms to choose a portfolio of option contracts with a spectrum of strike prices.
Summary of results

1. Firms commit to **downward sloping** (total) supply functions
   ♦ Produce more when prices are low
   ♦ => Competitors’ residual demand less elastic
   ♦ => Competitors set higher prices in spot market
   ♦ => Firm increases its profit
   ♦ More demand uncertainty => less downward sloping supply

2. Contracts as commitment device
   ♦ Sell forward contracts to commit to produce a lot at low prices
   ♦ Buy portfolio of call options with spectrum of strike prices
     → As spot market increases, reduce production commitment
   ♦ Firms speculate
Introduction

Intuition

Model

Conclusion
Why do firms commit to a negative slope?

A. Upward sloping supply function

B. Downward sloping supply function

Firm sells same amount at higher price
How do contracts influence bidding in spot market?

- **Sell forward contracts** => firm commits to produce more (aggressive commitment)
  

- **Mechanism**
  - Contract quantity is sunk
  - Firms maximize profit on the remainder of demand
  - => Lower price and higher production
How do firms commit to a downward sloping supply?

- Make contract position a function of the price
  - Large for low prices (aggressive commitment)
  - Small for high price (soft commitment)

![Diagram showing a downward sloping supply curve and a contract curve, with annotations explaining the commitment strategies.]
How do firms commit to a downward sloping contracting curve?

- **Sell** $X_0$ forward contracts
- **Buy** $\delta X_1$ call options with strike price $P_1$
- **Buy** $\delta X_2$ call options with strike price $P_2$
- *etc.*
- **If the spot price** = $p$, firm has committed to deliver

$$X(p) = X_0 - \int_0^p \delta X(S)$$

Amount of contracts in the money
Related results for other commitment devices

- Delegation games: Shareholders decide whether managers use Bertrand or Cournot strategies
  - Playing Cournot is a dominant strategy (Singh and Vives, 1984)
  - Unless demand is very uncertain (Reisinger and Ressner, 2009)

- Strategic investment
  - Zöttl (2010), firms invest in base-load, but not in peak capacity to commit to steep supply functions.
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Set up

Two stage oligopoly

1. Firms simultaneously choose a portfolio of physical option contracts with a spectrum of strike prices, $X_i(p)$.
2. Firms simultaneously bid a supply function $Q_i(p) - X_i(p)$ in the spot market

Assumptions

♦ Consumers arbitrage perfectly between spot and contract market
♦ Uncertain demand is realized after firms bid in the spot market
♦ Firms observe each other’s contract positions after stage 1
♦ Firms have no production costs

Results 2\textsuperscript{nd} Stage: Spot Market Equilibrium

- SFE 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).

\[ \forall i : \quad Q_i(p) - X_i(p) - p \cdot \left( \frac{\partial Q_{-i}(p)}{\partial p} - \frac{\partial D(p)}{\partial p} \right) = 0 \]

Net sales in the spot market \quad Slope of the residual demand function

- A monotonic solution of the set of K&M equations is a Nash equilibrium, provided firms bid above marginal cost.
1st Stage: Contracting Equilibrium

- Firm 1 maximizes expected profit

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

- Subject to the 2nd stage Nash equilibrium

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

- For each firm we have an optimal control problem with state variables \(Q_1, Q_2,\) and \(\varepsilon\)
The solution is symmetric and given by:

1\textsuperscript{st} Stage equilibrium

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

- Optimality Condition
- Klemperer Meyer Equation
- Market Equilibrium

If \( \forall \varepsilon: \frac{d}{d\varepsilon} \left( \frac{1 - F(\varepsilon)}{f(\varepsilon)} \right) < \frac{1}{N-1} \) then the solution of those equations are an equilibrium in the first stage.
Will our solution give us a SPNE?

- In a sub-game perfect Nash equilibrium (SPNE), we need to specify how much firms produce out of equilibrium in the second stage, \( (Q^*(X)) \) i.e. if firms do not produce the equilibrium contracting level \( X^* \).

- In our model we rely on a stronger concept than SPNE and require that the a firm can not improve its profit, by changing its contracting position, whatever assumption it makes about the equilibrium that will be played in the second stage.

- Our solution can be implemented as SPNE, but may not be the unique SPNE.
Example with Analytical solution

- Linear demand
- 2\textsuperscript{nd} order Pareto distributed demand shocks $\frac{1-F(\varepsilon)}{f(\varepsilon)} = \alpha \varepsilon + \beta$
- In duopoly, contracting reduces welfare
- Contracting increases volatility

\begin{align*}
\text{Price} & \quad \text{Maximal Demand} \\
\bar{p} & \\
\text{Quantity} & \quad \beta > 0, \quad \alpha < \frac{1}{2}
\end{align*}

Total Production w contracting

Total Production, no contracting

Total Contracted quantity
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**Conclusion**

- **Anti-competitive effect of speculation in financial markets**
  - Firms speculate in order to commit to a negative supply slope and to soften competition
  - Price might even be above the monopoly price. Prisoner’s dilemma
  - More strategic contracting 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

- Downward sloping bids were allowed and observed in Nordpool until October 10, 2007
  - Anecdotal evidence that those bids were linked with contract positions, we do not know whether those firms did this strategically
  - In a marginal power-pool (APX), we only observe the uncontracted production. This part is upward sloping.
Practice

- **Risk aversion?**
  - Risk-aversion will make the effects less pronounced as this strategy is risky (speculative).
  - Contracting will lead to hockey stick bidding (competitive at low prices, withholding at high prices, everywhere upward sloping).
  - Firms will sell contracts for their production by base-load plants, but not by peakers.

- **We do not argue for restricting access to financial markets**
  - Results for other commitment devices with the same flexibility are likely to be similar (contracts with retailers, large industrial users).
  - Liquid and anonymous financial market makes it harder for firms to commit to a contracting portfolio.
  - Contracts provide hedging opportunities (reduce risk, and reduce market power during base-load hours).