Oligopoly Theory (5)
Price Competition and Endogenous Competition Structure in Mixed Oligoplies

Aim of this lecture

(1) To understand the reason why welfare-maximizing behavior may harm welfare

(2) To understand the ideas of partial privatization approach and optimal degree of privatization.
Outline of the Fifth Lecture

5-1 Welfare-Maximizing Price in a Differentiated Product Duopoly.
5-2 Endogenous Competition Structure in Mixed Duopolies.
5-3 Endogenous Competition Structure in Mixed Oligopolies.
5-4 Endogenous Competition Structure with Production Subsidies.
5-5 Price Competition in Mixed Duopolies in Homogeneous Product Markets.
Welfare-maximizing pricing given the private rival’s price

Suppose that firms produce differentiated substitutable products.

Quantity Competition
Given the rival’s output, the public firm whose objective is welfare chooses its output so as to realize $p=c'$.

Price competition
Given the rival’s price, the public firm whose objective is welfare chooses its output so as to $p(\geq\leq)c'$. 
Partial privatization and optimal pricing of the public firm.

$R_0(\theta, p_1)$ is increasing in $\theta$ (the degree of privatization) under moderate conditions. → The public firm is more aggressive than the private firm because it cares about CS.

An increase in $\theta$ raises $p_0$ and then raises $p_1$. When $\theta=0$, an increase in $p_0$ does not affect $W$ (envelope theorem) and an increase in $p_1$ reduces $W$. When $\theta>0$, both reduce $W$.

⇒ The optimal $\theta=0$. 

Oligopoly Theory
In private oligopolies, under moderate conditions, price competition yields tougher competition (lower equilibrium price and smaller firms’ profits) and greater welfare.
Price vs Quantity in Private Duopoly

Under price competition
A decrease in $p_1$ raises $q_1$ directly.
A decrease in $p_1$ reduces $q_2$, which indirectly raises the revenue of firm 1.

Under quantity competition
An increase in $q_1$ reduces $p_1$ directly.
A decrease in $q_1$ reduces $p_2$, which indirectly reduces the revenue of firm 2, but not that of firm 1.

$\Rightarrow$ Price competition leads to more aggressive behavior of private firms.
Price vs Quantity in Mixed Duopoly

Under price competition, the public firm sets the price that is higher than its marginal cost.
Under quantity competition, the public firm sets the quantity such that the price is equal to its marginal cost.
⇒ The public firm is more aggressive under quantity competition than the price competition.

The private firm is more aggressive under quantity competition than the quantity competition.

The market share of the public firm is smaller under price competition than under quantity competition.
Price vs Quantity in Mixed Duopoly

Under quantity competition, the public firm's output is larger than the private firms' and a small amount of production substitution from the public firm to the private firm improves welfare.

A change of from quantity competition to price competition yield production substitution from the public firm to the private firm, which may improve welfare.
A lesser aggressive behavior of the public firm increases the profit of private firms.
Ghosh and Mitra (2010)

\[ p_1 = \alpha - \beta q_1 - \beta \delta q_2 \quad p_2 = \alpha - \beta q_2 - \beta \delta q_1 \quad \delta \in (0,1) \]

\( \delta \) represents the degree of product differentiation. Constant marginal costs.

Price competition yields greater welfare and larger profit of the private firm.

Price competition is less tough than quantity competition in a mixed duopoly. Nevertheless, price competition yields greater welfare.
Singh and Vives (1984)

Duopoly Model, profit-maximizers.

Demand
\[ p_1 = \alpha - \beta q_1 - \beta \delta q_2 \quad p_2 = \alpha - \beta q_2 - \beta \delta q_1 \quad \delta \in (0,1) \]
\( \delta \) represents the degree of product differentiation.

Costs
Marginal cost is constant. Firm i’s marginal cost is \( m_i \)
Time Line

In the first stage, each firm chooses price contract or quantity contract.

In the second stage, after observing the rival’s choice of the previous stage, each firm chooses price or quantity, according to the first stage choice.
Results

If the products are substitutable, choosing quantity contract is a dominant strategy.

⇒ Cournot appears in the unique equilibrium.

Many works such that Tanaka (2001a,b) and Tasnadi (2006) showed that their results are quite robust.
Matsumura and Ogawa (2010)

Linear symmetric demand system with product differentiation. Constant marginal costs. The same formulation of Ghosh and Mitra (2010).


Choosing price competition is a dominant strategy for both firms. ⇒ Bertrand competition.
Matsumura and Ogawa (2010)

For the private firm, choosing the price makes the public firm less aggressive, which increases the private firm's profit. This is because a more aggressive behavior of the public firm reduces (does not affect) the private rival's output when the private rival commit to the price (quantity).

For the public firm, choosing the price makes the private firm more aggressive, which improves welfare. This is because a more aggressive behavior of the private firm reduces (does not affect) the public rival's output when the public firm commit to the price (quantity).
CSR

Payoff: \( U_i = \theta_i W + (1 - \theta_i) \pi_i \)

(We obtain similar results in the case with \( U_i = \theta_i CS + (1 - \theta_i) \pi_i \))

In the first stage, each firm chooses price contract or quantity contract.

In the second stage, after observing the rival’s choice of the previous stage, each firm chooses price or quantity, according to the first stage choice.

We assume that four fixed contract games, p-p (Bertrand), q-q (Cournot), p-q, and q-p games, have interior solutions.
Results

If $\theta_1 = \theta_2$ and $m_1 = m_2$, then choosing the quantity contract is a dominant strategy unless $\theta = \delta$.

$\Rightarrow$ Regardless of $\theta := \theta_1 = \theta_2$, Cournot competition appears in equilibrium (and the equilibrium is unique unless $\theta = \delta$).

Results

If $\theta_1 > \delta > \theta_2$ and $m_1 = m_2$, then firm 1, choosing the price contract is a dominant strategy. Bertrand appear in equilibrium if objectives are asymmetry.

A generalized result of Matsumura and Ogawa (2012)

Not welfare-concerned objectives but asymmetry of objectives matter.
Results

delta=0.2

Bertrand

others

Cournot
Results

delta=0.4

Bertrand

others

Cournot
Results

delta=0.6

Bertrand

others

Cournot
Results

delta=0.8

Bertrand

others

Cournot
Homogeneous Product Markets in Private and Mixed Duopolies With Supply Obligation

Henceforth, I assume that both firms have the same cost function and the marginal cost is increasing.
Bertrand equilibrium with increasing marginal costs in a private duopoly

supply curve derived from the marginal cost curves of two firms
Bertrand equilibrium with increasing marginal costs in a private duopoly

In the equilibrium both firms name $P = P^E$ and obtain the demand $D(P^E)/2$.

Suppose that firm 1 raises its price. → The profit is zero, so it has no incentive for raising its price.

Suppose that firm 1 reduces its price. → It obtains the demand $D(P_1)$. Because $P^E = c_1'(D(P^E)/2)$, the profit is maximized given the price. Because $c'$ is increasing, $P^E D(P^E)/2 - c_1(D(P^E)/2) > P_1 D(P_1) - c_1(D(P_1))$. 
Bertrand equilibrium with increasing marginal costs in a private duopoly

supply curve derived from the marginal cost curves of two firms
Continuum Equilibrium

Both higher and lower prices than the perfectly competitive price can be equilibrium prices.

Define $P^H$ by $P^HD(P^H)/2 - c_1(D(P^H)/2) = P^H - c_1(D(P^H))$.

If $P_1 > P^H$, then $P_1D(P_1)/2 - c_1(D(P_1)/2) < P_1D(P_1) - c_1(D(P_1))$.

Define $P^L$ by $P^LD(P^L)/2 - c_1(D(P^L)/2) = 0$.

If $P_1 > P^L$, then $P_1D(P_1)/2 - c_1(D(P_1)/2) < 0$.

Any price $P \in (P^L, P^H)$ can be an equilibrium price.
Bertrand equilibrium with increasing marginal costs in a private duopoly

supply curve derived from the marginal cost curves of two firms
Bertrand equilibrium in a mixed duopoly when both firms have supply obligation

supply curve derived from the marginal cost curves of two firms
Homogeneous product markets in mixed duopolies when only the public firm has supply obligation
Bertrand equilibrium in a mixed duopoly with supply obligation of the public firm

In the equilibrium both firms name $P = P^E$ and obtain the demand $D(P^E)/2$. Firm 0 has no incentive to change the price because the first best is implemented.

Suppose that firm 1 raises its price. $\rightarrow$ The profit is zero, so it has no incentive for raising its price.

Suppose that firm 1 reduces its price. $\rightarrow$ It obtains the demand $D(P_1)$. Because $P^E = c_1'(D(P_E)/2)$, the profit is maximized given the price. Because $c'$ is increasing, $P^E D(P^E)/2 - c_1(D(P^E)/2) > P_1 D(P_1) - c_1(D(P_1))$. 
Bertrand equilibrium in a mixed duopoly with supply obligation of the public firm

Suppose that in an equilibrium both firms name $P > P^E$ and obtain the demand $D(P)/2$.

Firm 1 (Private firm) has an incentive to reduce its price because $P > MC_1$.

This is because the private firm has no supply obligation.

$\Rightarrow$ The equilibrium price $P > P^E$ does not constitute an equilibrium.
Bertrand equilibrium in a mixed duopoly with supply obligation of the public firm

Suppose that in an equilibrium both firms name \( P < P^E \). and Then firm 1 chooses \( q_1 \) obtain such that \( P = MC_1 \) and the residual demand is supplied by the public firm. Because no supply obligation \( P > MC_0 \) firm 0 has an incentive to raise \( P_0 \) to improve welfare. \( \Rightarrow \) The equilibrium price \( P < P^E \) does not constitute an equilibrium.

\~The equilibrium is unique and efficient.
Bertrand equilibrium in a mixed duopoly with supply obligation of the public firm

MC of each firm

supply curve derived from the marginal cost curves of two firms
Homogeneous product markets in mixed duopolies when no firm has supply obligation
Asymmetric Price

Suppose that \( P_1 > P_0 \).
Suppose that \( q_1 > 0 \).
Under the assumption of efficient rationing, the total output is \( D(P_1) \). Therefore, the welfare is maximized when \( q_1 = q_0 \).
\( \Rightarrow \) Firm 0's optimal output is \( D(P_1)/2 \).

Given this behavior, firm 1 chooses \( P_1 = P^M \) unless the resulting welfare is lower than that with public monopoly.
Equilibrium outcome in a mixed duopoly without supply obligation

Given $P_1 = P^M$, firm 0 has no incentive to set $P_0 > P_1$ because it obviously reduces welfare.

In equilibrium, firm 1 names $P_1 = P^M$, firm 0 names $P_0 \leq P^M$, $q_0 = q_1 = D(P_1)/2$

Bertrand competition yields quite an anti-competitive outcome.