

When Market Competition Benefits Firms

Junichiro Ishida, Toshihiro Matsumura, Noriaki Matsushima

Osaka University, University of Tokyo, Kobe University

September 27, 2008

- Regulatory agencies keep an eye on behaviors such as collusion, entry deterrence, predation, horizontal mergers, exclusions. All of these are by and large an attempt to reduce the degree of market competition.

- Regulatory agencies keep an eye on behaviors such as collusion, entry deterrence, predation, horizontal mergers, exclusions. All of these are by and large an attempt to reduce the degree of market competition.
- Besides the belief that competition enhances efficiency, what is implicit is that firms gain by reducing the degree of market competition, often at the expense of consumers.

- Regulatory agencies keep an eye on behaviors such as collusion, entry deterrence, predation, horizontal mergers, exclusions. All of these are by and large an attempt to reduce the degree of market competition.
- Besides the belief that competition enhances efficiency, what is implicit is that firms gain by reducing the degree of market competition, often at the expense of consumers.
- In fact, a conventional wisdom in economics suggests that more intense competition, measured in almost any way, reduces firm profit, e.g., n -firm Cournot models.

- However, casual observations often suggest otherwise: firms on occasion engage in behaviors that appear to help, rather than harm, competitors.

- However, casual observations often suggest otherwise: firms on occasion engage in behaviors that appear to help, rather than harm, competitors.
- One of the most compelling examples is provided by Ford at the beginning of the 20th century.

- However, casual observations often suggest otherwise: firms on occasion engage in behaviors that appear to help, rather than harm, competitors.
- One of the most compelling examples is provided by Ford at the beginning of the 20th century.
- Here, we revisit a fundamental question of market competition: do market competition always harm firms?

The rough sketch of the model

- There are n firms in the market: one dominant firm and $n - 1$ fringe firms.

The rough sketch of the model

- There are n firms in the market: one dominant firm and $n - 1$ fringe firms.
- Standard Cournot model with endogenous cost reduction.
 - 1. Strategic (noncooperative) cost-reducing R&D activities.
 - 2. Cournot competition.

Main results

- The dominant firm's profit can be increasing in n , whereas the fringe firm's is always decreasing.

Main results

- The dominant firm's profit can be increasing in n , whereas the fringe firm's is always decreasing.
- The dominant firm's R&D can be increasing in n , whereas the fringe firm's is always decreasing.

Main results

- The dominant firm's profit can be increasing in n , whereas the fringe firm's is always decreasing.
- The dominant firm's R&D can be increasing in n , whereas the fringe firm's is always decreasing.
- The total R&D can be the inverse U-shaped.

The first stage

- Each firm i , $i = 1, 2, \dots, n$, determines how much to invest in cost reduction x_i , which lowers its marginal cost down to $(z_i - x_i)$.

The first stage

- Each firm i , $i = 1, 2, \dots, n$, determines how much to invest in cost reduction x_i , which lowers its marginal cost down to $(z_i - x_i)$.
 - z_i signifies the *ex ante* productive efficiency.

The first stage

- Each firm i , $i = 1, 2, \dots, n$, determines how much to invest in cost reduction x_i , which lowers its marginal cost down to $(z_i - x_i)$.
 - z_i signifies the *ex ante* productive efficiency.
 - $z_1 < z_f := z_i$ for $i = 2, 3, \dots, n$.

The first stage

- Each firm i , $i = 1, 2, \dots, n$, determines how much to invest in cost reduction x_i , which lowers its marginal cost down to $(z_i - x_i)$.
 - z_i signifies the *ex ante* productive efficiency.
 - $z_1 < z_f := z_i$ for $i = 2, 3, \dots, n$.
 - Firm 1 is the dominant firm and the others are fringe.

The first stage

- Each firm i , $i = 1, 2, \dots, n$, determines how much to invest in cost reduction x_i , which lowers its marginal cost down to $(z_i - x_i)$.
 - z_i signifies the *ex ante* productive efficiency.
 - $z_1 < z_f := z_i$ for $i = 2, 3, \dots, n$.
 - Firm 1 is the dominant firm and the others are fringe.
- The cost of R&D is $I(x_i)$, which satisfies the usual properties.

The second stage

- Upon observing x_i for all i , the firms engage in (typical) Cournot competition.

The second stage

- Upon observing x_i for all i , the firms engage in (typical) Cournot competition.
- Inverse demand: $1 - Q$ where Q is the total quantity supplied.

The second stage

- Upon observing x_i for all i , the firms engage in (typical) Cournot competition.
- Inverse demand: $1 - Q$ where Q is the total quantity supplied.
- Each firm chooses q_i so as to maximize its own profit.

The second stage

- Upon observing x_i for all i , the firms engage in (typical) Cournot competition.
- Inverse demand: $1 - Q$ where Q is the total quantity supplied.
- Each firm chooses q_i so as to maximize its own profit.

Gains from R&D investments

- The first-order condition is

$$\underbrace{q_i^E + (p^E - c_i - q_i^E) \frac{\partial q_i^E}{\partial x_i}}_{\text{non-strategic gain}} - \underbrace{\sum_{j \neq i}^n \frac{\partial q_j^E}{\partial x_i} q_i^E}_{\text{strategic gain}} = I'(x_i).$$

Gains from R&D investments

- The first-order condition is

$$\underbrace{q_i^E + (p^E - c_i - q_i^E) \frac{\partial q_i^E}{\partial x_i}}_{\text{non-strategic gain}} - \underbrace{\sum_{j \neq i}^n \frac{\partial q_j^E}{\partial x_i} q_i^E}_{\text{strategic gain}} = I'(x_i).$$

- The question eventually boils down to how the marginal gain of the investment is affected by the number of firms n .

The case of the dominant firm

- Since $\partial q_i^E / \partial x_i = n / (n + 1)$ and $\partial q_f^E / \partial x_i = -1 / (n + 1)$, the marginal gain for the dominant firm is reduced to

$$\frac{\partial \pi_1^E}{\partial x_1} = \underbrace{\frac{q_1^E + n(p^E - c_1)}{n + 1}}_{\text{non-strategic gain}} + \underbrace{\frac{(n - 1)q_1^E}{n + 1}}_{\text{strategic gain}}.$$

The case of the dominant firm

- Since $\partial q_i^E / \partial x_i = n / (n + 1)$ and $\partial q_f^E / \partial x_i = -1 / (n + 1)$, the marginal gain for the dominant firm is reduced to

$$\frac{\partial \pi_1^E}{\partial x_1} = \underbrace{\frac{q_1^E + n(p^E - c_1)}{n + 1}}_{\text{non-strategic gain}} + \underbrace{\frac{(n - 1)q_1^E}{n + 1}}_{\text{strategic gain}}.$$

- Substituting the equilibrium price, we obtain

$$\frac{\partial^2 \pi_1^E}{\partial x_1 \partial n} = \frac{-2(n - 1)(1 - c_f) + 4n(c_f - c_1)}{(n + 1)^3}.$$

The case of the dominant firm

- Since $\partial q_i^E / \partial x_i = n / (n + 1)$ and $\partial q_f^E / \partial x_i = -1 / (n + 1)$, the marginal gain for the dominant firm is reduced to

$$\frac{\partial \pi_1^E}{\partial x_1} = \underbrace{\frac{q_1^E + n(p^E - c_1)}{n + 1}}_{\text{non-strategic gain}} + \underbrace{\frac{(n - 1)q_1^E}{n + 1}}_{\text{strategic gain}}.$$

- Substituting the equilibrium price, we obtain

$$\frac{\partial^2 \pi_1^E}{\partial x_1 \partial n} = \frac{-2(n - 1)(1 - c_f) + 4n(c_f - c_1)}{(n + 1)^3}.$$

- Competition may benefit the dominant firm when the dispersion in the *ex post* marginal costs is sufficiently large.

The case of the fringe firms

- By the same token, the marginal cost for a fringe firm is

$$\frac{\partial \pi_f^E}{\partial x_f} = \underbrace{\frac{q_f^E + n(p^E - c_f)}{n+1}}_{\text{non-strategic gain}} + \underbrace{\frac{(n-1)q_f^E}{n+1}}_{\text{strategic gain}}.$$

The case of the fringe firms

- By the same token, the marginal cost for a fringe firm is

$$\frac{\partial \pi_f^E}{\partial x_f} = \underbrace{\frac{q_f^E + n(p^E - c_f)}{n+1}}_{\text{non-strategic gain}} + \underbrace{\frac{(n-1)q_f^E}{n+1}}_{\text{strategic gain}}.$$

- Substituting the equilibrium price, we obtain

$$\frac{\partial \pi_f^E}{\partial x_f} = \frac{n(1 - q_1^E - (n-2)q_f^E - c_f)}{n+1} = \frac{2n(1 + c_1 - 2c_f)}{(n+1)^2}.$$

The case of the fringe firms

- By the same token, the marginal cost for a fringe firm is

$$\frac{\partial \pi_f^E}{\partial x_f} = \underbrace{\frac{q_f^E + n(p^E - c_f)}{n+1}}_{\text{non-strategic gain}} + \underbrace{\frac{(n-1)q_f^E}{n+1}}_{\text{strategic gain}}.$$

- Substituting the equilibrium price, we obtain

$$\frac{\partial \pi_f^E}{\partial x_f} = \frac{n(1 - q_1^E - (n-2)q_f^E - c_f)}{n+1} = \frac{2n(1 + c_1 - 2c_f)}{(n+1)^2}.$$

- Competition always reduces the fringe firm's profit.

What can we learn so far?

- Two observations can be made:

What can we learn so far?

- Two observations can be made:
 - Observation 1: The dominant firm's investment may (or may not) increase with n .

What can we learn so far?

- Two observations can be made:
 - Observation 1: The dominant firm's investment may (or may not) increase with n .
 - Observation 2: Each fringe firm's investment always decreases with n .

What can we learn so far?

- Two observations can be made:
 - Observation 1: The dominant firm's investment may (or may not) increase with n .
 - Observation 2: Each fringe firm's investment always decreases with n .
- As a consequence, the dispersion in the *ex post* marginal costs may widen. Intense competition *per se* may benefit firms with advanced technologies.

Competition stimulates the investment by the rich

- We have thus far stated results in terms of the *ex post* marginal costs, but similar results can be obtained in terms of the *ex ante* marginal costs as well.

Competition stimulates the investment by the rich

- We have thus far stated results in terms of the *ex post* marginal costs, but similar results can be obtained in terms of the *ex ante* marginal costs as well.
- To obtain sharper predictions, we consider a more tightly specified version of the model described thus far. Let $I(x) = \gamma x^2$.

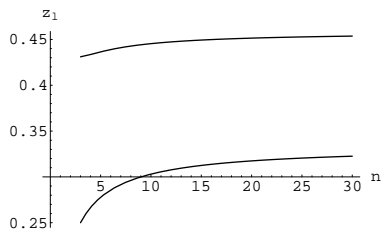
Competition stimulates the investment by the rich

- We have thus far stated results in terms of the *ex post* marginal costs, but similar results can be obtained in terms of the *ex ante* marginal costs as well.
- To obtain sharper predictions, we consider a more tightly specified version of the model described thus far. Let $I(x) = \gamma x^2$.

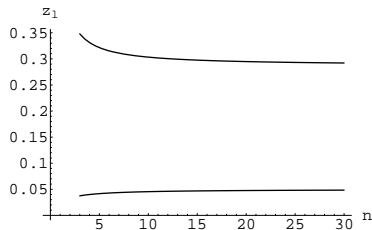
Proposition

For any $n > 1$ and $\gamma \geq 1$, (i) there exists some nonempty interval $Z^x \equiv (\underline{z}_1, z_1^x)$ such that x_1^E is increasing in n if and only if $z_1 \in Z^x$; (ii) x_f^E is decreasing in n .

When investments increase with n



$(\gamma = 3/2)$



$(\gamma = 10)$

Figure 1: The range of z_1 ($\partial x_1 / \partial n > 0$, $z_f = 0.5$).

Competition makes the rich get richer

- Intense market competition widens the dispersion in the *ex post* marginal costs when $z_1 \in Z^x$. This may benefit the dominant firm.

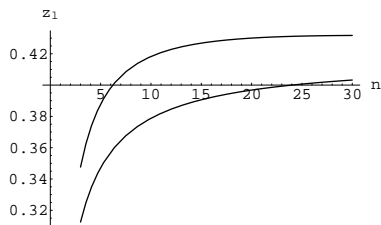
Competition makes the rich get richer

- Intense market competition widens the dispersion in the *ex post* marginal costs when $z_1 \in Z^x$. This may benefit the dominant firm.

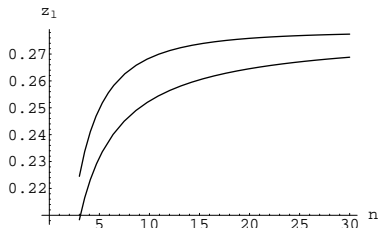
Proposition

For any $n > 1$ and $\gamma \geq 1$, (i) there exists some nonempty interval $Z^P \equiv (\underline{z}_1, z_1^P)$ such that Π_1^E is increasing in n if and only if $z_1 \in Z^P$; (ii) Π_f^E is decreasing in n .

When profits increase with n



($\gamma = 6/5$)



($\gamma = 9/5$)

Figure 2: The range of z_1 ($\partial \Pi_1 / \partial n > 0$, $z_f = 0.5$).

- Roughly, two forces are at work in this type of environment.

- Roughly, two forces are at work in this type of environment.
 - Non-strategic effect: A direct benefit from a unit cost reduction, which depends on the firm's own production level.

- Roughly, two forces are at work in this type of environment.
 - Non-strategic effect: A direct benefit from a unit cost reduction, which depends on the firm's own production level.
 - Strategic effect: An increase in R&D lowers other firms' production. An increase in the number of rivals enhances this incentive.

- Roughly, two forces are at work in this type of environment.
 - Non-strategic effect: A direct benefit from a unit cost reduction, which depends on the firm's own production level.
 - Strategic effect: An increase in R&D lowers other firms' production. An increase in the number of rivals enhances this incentive.
- When the strategic effect dominates the nonstrategic effect, an increase in the number of firms increases firm profit. In symmetric oligopoly, the strategic effect is always dominated.

- There are several works which show that an increase in the number of firms may increase profit.

- There are several works which show that an increase in the number of firms may increase profit.
 - Ashiya (2000, IJIO): strategic market preemption.

- There are several works which show that an increase in the number of firms may increase profit.
 - Ashiya (2000, IJIO): strategic market preemption.
 - Naylor (2002, EL): an increase in the number of downstream firms shifts bargaining power in favor of them.

- The present paper is more closely related to Coughlan and Soberman (2005, IJRM), Chen and Riordan (2007, EJ), Ishibashi and Matsushima (2008, MS).

- The present paper is more closely related to Coughlan and Soberman (2005, IJRM), Chen and Riordan (2007, EJ), Ishibashi and Matsushima (2008, MS).
- In these studies, market entry works as a commitment device to soften market competition.

- The present paper is more closely related to Coughlan and Soberman (2005, IJRM), Chen and Riordan (2007, EJ), Ishibashi and Matsushima (2008, MS).
- In these studies, market entry works as a commitment device to soften market competition.
- The market actually becomes less competition as the number of firms increases.

How novel is our result?

- We claim that this is the first result to show that an individual firm may benefit directly from more intense market competition *per se*.

How novel is our result?

- We claim that this is the first result to show that an individual firm may benefit directly from more intense market competition *per se*.
- Empirically testable?: in our model, the equilibrium price is decreasing in n while, in theirs, it is increasing (meaning that the market becomes less competitive).

How novel is our result?

- We claim that this is the first result to show that an individual firm may benefit directly from more intense market competition *per se*.
- Empirically testable?: in our model, the equilibrium price is decreasing in n while, in theirs, it is increasing (meaning that the market becomes less competitive).
- It provides dominant firms a reason to help, rather than harm, competitors. Implications?

The Ford story: background

- At the beginning of the 20th century, Ford was the dominant automobile producer which had attained an unprecedented level of efficiency with radically new technologies.

The Ford story: background

- At the beginning of the 20th century, Ford was the dominant automobile producer which had attained an unprecedented level of efficiency with radically new technologies.
- Ford's share of all automobile production grew from 9.4% in 1908 to 48% in 1914. In its main field, i.e., the cheap car field, its share was 98%.

The Ford story: background

- At the beginning of the 20th century, Ford was the dominant automobile producer which had attained an unprecedented level of efficiency with radically new technologies.
- Ford's share of all automobile production grew from 9.4% in 1908 to 48% in 1914. In its main field, i.e., the cheap car field, its share was 98%.
- These figures are astonishing, given that the industry was not as concentrated as it is today.

The Ford story: competitive edges

- The source of Ford's competitive edges was undoubtedly its productive efficiency, made possible by several innovations and inventions such as the moving assembly line system and Henry Ford's scientific management (so-called Fordism).

The Ford story: competitive edges

- The source of Ford's competitive edges was undoubtedly its productive efficiency, made possible by several innovations and inventions such as the moving assembly line system and Henry Ford's scientific management (so-called Fordism).
- In 1914, Ford, only with 13,000 employees, manufactured 260,720 while all of the others, with 66,350, manufactured mere 286,770.

The Ford story: open knowledge disclosure

- Ford's dominance in the industry was evident. Surprisingly, though, Ford had no intention of hiding its secrets.

The Ford story: open knowledge disclosure

- Ford's dominance in the industry was evident. Surprisingly, though, Ford had no intention of hiding its secrets.

Engineers came from all over America and Europe to study this achievement in efficiently standardized and specialized production. Nothing was concealed. Indeed, Henry Ford and his associates this year cooperated with the editors of Engineering in laying before the world, in the technically detailed and richly illustrated pages of Arnold and Faurote's Ford Methods and the Ford Shops, ... (Nevins, 1954)

- Ford could have driven more competitors out of the market by keeping its “secrets” to themselves more carefully.

- Ford could have driven more competitors out of the market by keeping its “secrets” to themselves more carefully.
- Why did Ford choose not to follow this path and instead give away its critical knowledge so generously?

- Ford could have driven more competitors out of the market by keeping its “secrets” to themselves more carefully.
- Why did Ford choose not to follow this path and instead give away its critical knowledge so generously?
- Is there any sensible reason to help, rather than harm, competitors in the market?

- The Ford story is not an isolated event. Even in this day and age, there are instances where firms freely disclose its critical knowledge.

Open knowledge disclosure

- The Ford story is not an isolated event. Even in this day and age, there are instances where firms freely disclose its critical knowledge.
- The practice is often referred to as open knowledge disclosure where know-how is disclosed via channels such as publications, seminar presentations, or more informal communication.

Open knowledge disclosure

- The Ford story is not an isolated event. Even in this day and age, there are instances where firms freely disclose its critical knowledge.
- The practice is often referred to as open knowledge disclosure where know-how is disclosed via channels such as publications, seminar presentations, or more informal communication.
- Our model provides a (partial) explanation for this practice.

- Whether market competition stimulates innovation is an old issue.

Competition-innovation: theory

- Whether market competition stimulates innovation is an old issue.
- Intuition goes both ways. Competition may or may not stimulate investments.

Competition-innovation: theory

- Whether market competition stimulates innovation is an old issue.
- Intuition goes both ways. Competition may or may not stimulate investments.
- In standard oligopoly models, it depends on the way competition is measured.

- There are many methodological difficulties because market structure itself is an endogenous variable. Sophisticated econometric methods must be employed to tackle this issue.

- There are many methodological difficulties because market structure itself is an endogenous variable. Sophisticated econometric methods must be employed to tackle this issue.
- Old evidence by and large indicate a positive relationship between competition and innovation, c.f., Nickell (1996, JPE), Blundell, Griffith and Van Reenen (1999, RES).

- There are many methodological difficulties because market structure itself is an endogenous variable. Sophisticated econometric methods must be employed to tackle this issue.
- Old evidence by and large indicate a positive relationship between competition and innovation, c.f., Nickell (1996, JPE), Blundell, Griffith and Van Reenen (1999, RES).
- More recent evidence suggests that the relationship is non-monotonic and inverted U-shape, c.f., Aghion et al. (2005, QJE).

- There are many methodological difficulties because market structure itself is an endogenous variable. Sophisticated econometric methods must be employed to tackle this issue.
- Old evidence by and large indicate a positive relationship between competition and innovation, c.f., Nickell (1996, JPE), Blundell, Griffith and Van Reenen (1999, RES).
- More recent evidence suggests that the relationship is non-monotonic and inverted U-shape, c.f., Aghion et al. (2005, QJE).

What our model has to say

- Our model predicts no clear relationship between the aggregate rate of innovation (total R&D) and the number of firms.

What our model has to say

- Our model predicts no clear relationship between the aggregate rate of innovation (total R&D) and the number of firms.
- Anything goes, including the inverted U-shape.

What our model has to say

- Our model predicts no clear relationship between the aggregate rate of innovation (total R&D) and the number of firms.
- Anything goes, including the inverted U-shape.
- This much is certain: the distribution of firm productivity matters. We focus only on one particular industry structure. There may be more to add if we consider a more general distribution.

What our model has to say

- Our model predicts no clear relationship between the aggregate rate of innovation (total R&D) and the number of firms.
- Anything goes, including the inverted U-shape.
- This much is certain: the distribution of firm productivity matters. We focus only on one particular industry structure. There may be more to add if we consider a more general distribution.

- Again, no clear relationship between social welfare and the number of firms.

- Again, no clear relationship between social welfare and the number of firms.
- Our framework basically builds on Lahiri and Ono (1988), extended to incorporate R&D investments.

- Again, no clear relationship between social welfare and the number of firms.
- Our framework basically builds on Lahiri and Ono (1988), extended to incorporate R&D investments.
- A version of the excess entry theorem may fail to hold in our setup.

- Again, no clear relationship between social welfare and the number of firms.
- Our framework basically builds on Lahiri and Ono (1988), extended to incorporate R&D investments.
- A version of the excess entry theorem may fail to hold in our setup.
- Further implications need to be explored.

- Contrary to the conventional wisdom, an increase in the number of firms can increase investment and firm profit.

Conclusion

- Contrary to the conventional wisdom, an increase in the number of firms can increase investment and firm profit.
- The key is *ex ante* productivity differentials.

Conclusion

- Contrary to the conventional wisdom, an increase in the number of firms can increase investment and firm profit.
- The key is *ex ante* productivity differentials.
- Market competition makes a dominant firm even more dominant. Fringe firms are welcome!