Learning-by-doing in Data Markets

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17th Digital Economics Conference
Toulouse, January 2025

Motivations

Increasing influence of data analytics (and data brokers) on firm's decisions and competition. But

1) The use of data is a two-way process, firms providing some raw data to Brokers which give them back treated.

   Ex : retail industry, banking,…

   ``Data Brokers […] obtain data directly from their merchant and financial service company clients» (FTC report 2014)

2) Brokers tend to be more efficient as they treat more data -> Learning-By-Doing (LDB).

Question: What are the impacts of this learning effect and who really benefits from it?

Main Results

We develop a model with some (1 or 2) data brokers interacting with firms competing downstream and show that

1) More efficiency in the learning process can make the brokers worse off.

2) With competing and heterogenous brokers, less efficient ones can make more profit (and even reach monopoly profit sometimes) than more efficient ones.

Main mechanism: in a (simple) dynamic framework, competing firms may be reluctant to contract with brokers when this may benefit their competitors.

-> key assumption: lack of dynamic commitment of the brokers which opens the door to the «hold-up» of the first firm contracting with them.

Literature

- Learning by doing
  - Arrow (1962)
  - Bajari *et al.* (2019) in the case of Amazon.
  - Cabral and Riordan (1994), Besanko *et al.* (2014).

  We focus on the impact of competition among buyers.

- Sale of information
  - Montes *et al.* (2019)
  - Abrardi *et al.* (2024)

  We add the learning effect (dynamics).

- Commitment issue
  - Coase (1972)
  - Liu *et al.* (2023)

  We explain how bad technology can be a substitute for commitment power.

Model

One or two brokers, two firms, A and B, competing on a Hotelling line:

Firms have access to some data on their closest δ_A and δ_B consumers

The brokers can treat these data allowing firms to price discriminate against these consumers. Otherwise, firms compete *à la* Hotelling for all consumers.

Model

The brokers can treat the data of Firm A and then of Firm B, at costs:

- $c\delta_A$ to treat the data of Firm A
- $c\delta_B$ to treat the data of Firm B if the broker has not treated Firm A's data.

If a broker treated Firm A's data, it lowers its treatment cost for Firm B (LDB effect).

- $c\delta_B(1-\alpha\delta_A)$ is then the broker's cost to treat the data of Firm B, where α measures the strength of the learning effect.

Timing

1. Each broker makes an offer to sell information to Firm A. Firm A accepts or refuses the offers, and this decision is public.
2. Each broker makes an offer to sell information to Firm B. Firm B accepts or refuses this offer, and this decision is public.
3. Firms set a uniform price for consumers on whom they do not have information.
4. If the firms have acquired information on δ_A and δ_B consumers, they then personalize prices for these identified consumers.
5. Consumers choose whether to buy from the firms and which product to buy.

Downstream Competitive Equilibrium

Firms make profits depending on whether they have info on consumers.

There are 3 sub-markets.

1. For the consumers close to FA, FB will propose a standard price whereas FA will adjust its price to every consumer and will serve them all.
2. For the consumers close to FB, FA will propose a standard price whereas FB will adjust its price to every consumer and will serve them all.
3. For the consumers close to the center (i.e. between δ_A and δ_B), both firms will propose the standard price.

Downstream Competitive Equilibrium

We can then derive the firm's equilibrium prices and show that each firm's profit increases in its own information and decreases in the amount of information its competitor owns.

We focus on the case where $\delta_A = \delta_B = \delta$. Then the profits are given by

- $\pi_A = \pi_B = \frac{t}{2}$ if both firms remain uninformed
- $\pi_A = \pi_B = \hat{\pi} = \frac{t}{2} - \delta^2 t$ if both firms buy
- $\overline{\pi} = \frac{t}{2} + \frac{\delta t}{3}\left[2 - \frac{7\delta}{3}\right]$ & $\underline{\pi} = \frac{t}{2} - \frac{\delta t}{3}\left[1 - \frac{\delta}{3}\right]$ if only one firm ($\overline{\pi}$) buys

$$\overline{\pi} > \frac{t}{2} > \hat{\pi} > \underline{\pi}$$

Selling Strategy in a Monopoly Case

The Broker has three options: selling to A only, selling to B only, or selling to both firms.

In the first two cases (exclusive sales), the broker does not benefit from the learning effect.

We will look at its optimal strategy with and without commitment to its future actions.

Selling Strategy in a Monopoly Case with Commitment

When selling to one firm only, the Broker has incentives to sell some information to Firm A only.

Indeed,

- It can then threaten to sell to Firm B if Firm A refuses its offer. and set a price $\overline{\rho} = \overline{\pi} - \underline{\pi}$ extracting the whole differential surplus.

When selling to both firms, each firm will get the same profit $\hat{\pi}$ and the broker can set a price $\underline{\rho} = \hat{\pi} - \underline{\pi}$ to both firms.

When selling to Firm B, the maximal price the broker can set is $\hat{\rho} = \overline{\pi} - t/2$.

Proposition :

1. Selling exclusively to Firm A is optimal for the broker for any α and feasible when the broker can commit.

2. Selling exclusively to Firm B is better for the broker than selling to A and B if

$$\delta \geq \delta_2(\alpha) = \frac{3}{5 - 3\alpha\tilde{c}}\left(\frac{2}{3} - \tilde{c}\right).$$

Selling Strategy in a Monopoly Case without Commitment

Without commitment, the broker may be tempted to contract with Firm B after having contracted with Firm A.

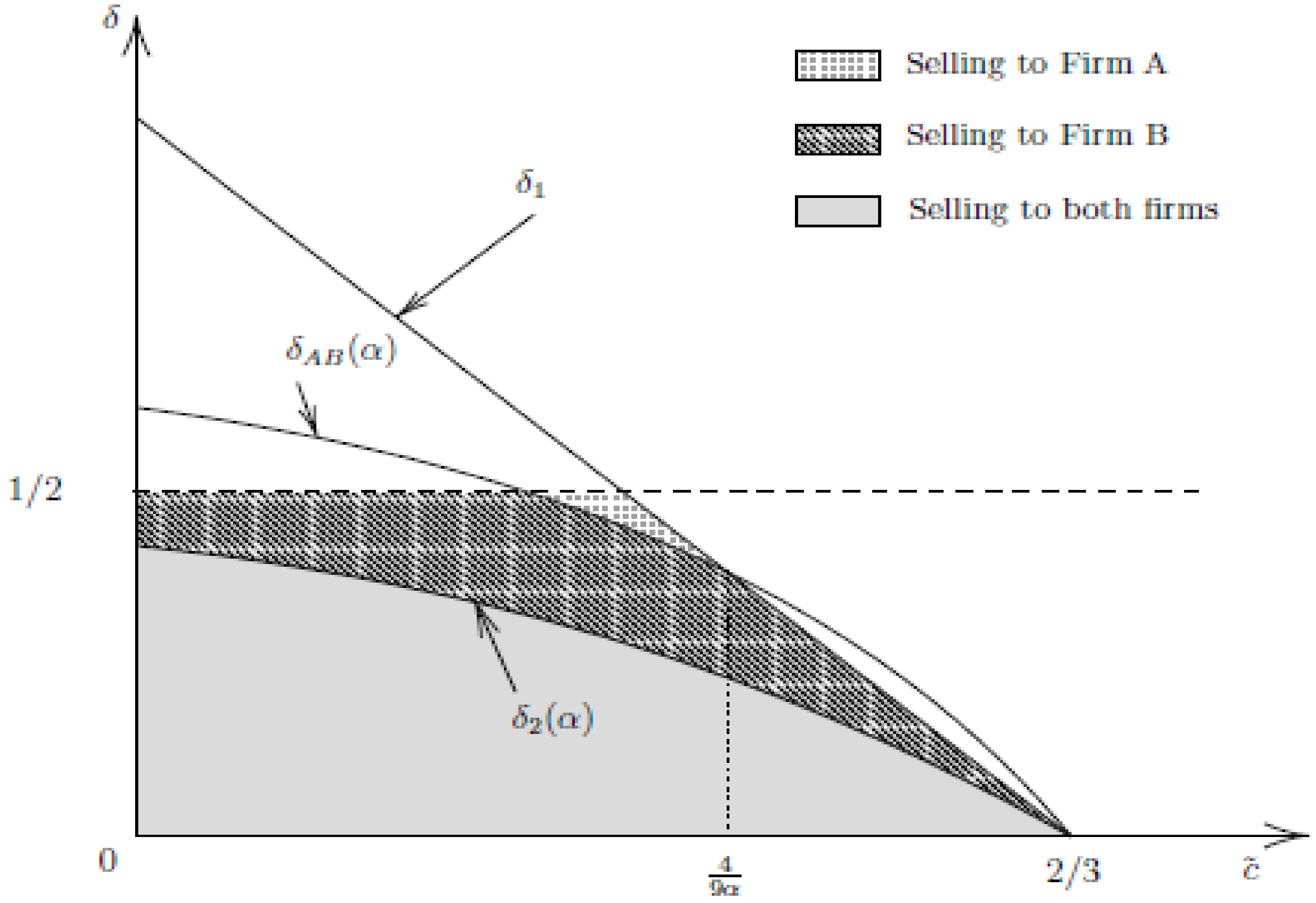
It happens when $\underline{\rho} - c\delta(1 - \alpha\delta) \geq 0 \;\Leftrightarrow \delta \leq \delta_{AB} = \frac{9}{11-9\alpha\tilde{c}}\left(\frac{2}{3} - \tilde{c}\right)$.

So for any $\delta < \delta_{AB}$, the profits of the broker are reduced because of its commitment problem.

Since δ_{AB} increases with α, the more efficient a broker is at learning, the higher the commitment problem.

So without commitmentthe broker can choose to sell either to both firms, or to Firm A or to Firm B.

Optimal Strategy of the Broker without commitment



Comparative Statics w.r.t. δ

- When the amount of data to be treated increases,
  - the value of an exclusive contract also increases ($\overline{\rho} - \hat{\rho}$ increases).
  - The differential treatment cost of 2 firms vs 1 firm increases.

This is why the broker contracts with one (resp. two) firm(s) when δ is large (resp. Small).

- But the increase in the amount of data treated, by increasing the cost, increases the commitment power of the broker.

This is why the broker can contract with Firm A exclusively (and therefore replicates the profit of the commitment case) for high values of δ .

Comparative Statics w.r.t. α

When the learning effect increases, the broker's treatment cost of the second firm decreases.

- This increases the temptation to hold-up Firm A (setting an exclusive price for Firm A but also contacting Firm B), deterring Firm A from contracting with the broker.
    - Since the price paid by Firm A for exclusivity is higher than the price paid by Firm B, this decreases the broker's profit when it contracts with only one firm.
- If the broker contracts with both firms anyway, the decrease in the treatment costs benefits the broker.

Therefore, the brokers' profit is **non-monotonic** with the learning effect, first decreasing and then increasing.

Competing Brokers

We assume that there are two brokers differentiated by their ability to learn, $\underline{\alpha}$ and $\overline{\alpha}$ (with $\overline{\alpha} > \underline{\alpha}$).

There are three possible impacts of competition

1. Downward pressure on prices (for δ small).
2. The efficient broker makes monopoly profits (with larger δ)
3. The inefficient broker makes monopoly profits (with even larger δ)
   - Then the inefficient broker can propose an exclusive contract to Firm A whereas the other broker cannot offer anything credible.

SO THE INEFFICIENT BROKER CAN BENEFIT FROM THIS INEFFICIENCY.

Rmk: with data sharing, competition increases among brokers.

Other Extensions

1. Alternative Timing with Renegotiation

2. Myopic Firms

3. Asymmetric Information on the Learning Effect

4. Strategic choice of Information Sales by the Broker

Conclusions

The presence of learning effects alters both the brokers and the firms' strategies.

1. Brokers can be worse off when they get better at treating data.
2. Firms have incentives to select the less efficient brokers to have their data treated.
3. Allowing brokers to share their data may trigger fiercer competition for data to the benefit of the downstream firms.

Question: how can Brokers commit to a reasonable internal use of data?