The Effect of Horizontal Mergers, When Firms Compete in Investments and Prices

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Motivation

- Recent lobbying by mobile companies: consolidation necessary to invest in infrastructure.
    - Currently, too little profits; merger increases profits by giving firms the money they need to invest.
- Interest extends beyond telecom industry:
    - Role of investment and innovation relevant in recent merger proposals in pharma and agro-chemical industry (e.g., Dow-Dupont).

Literature

- Gap in theoretical literature on effects of horizontal mergers on prices *and* investments.
  - Challenge: merger creates market asymmetry – firm with larger product portfolio.
  - Also: not easy to deal with n differentiated goods and two (price, investment) variables each – equilibrium characterization, existence, uniqueness.

- Existing (large) literature: change in competition (e.g., among many, Vives, 2008; Lopez and Vives, 2016):
  - Different from a merger, as it captures a symmetric change in both competition and appropriability.
  - (Ambiguous results)

- Exception: Mermelstein, Nocke, Satterthwaite, and Whinston (2015). But different question: role of scale economies in dynamic model with merger to monopoly.

This paper

- We establish the effects of a merger in a model with differentiated firms competing on prices and investments.
  - Results for $n > 2$ rely on methodologies borrowed from aggregative game theory.
  - (We first transform the two-variable firms' problem into a one-variable problem.)

- Leading scenario: simultaneous choices, symmetric goods, cost-reducing investment and efficiency gains. We show robustness to:
  - Asymmetric products.
  - Quality-improving investment.
  - Sequential choices.
  - Involuntary spillovers.

- We also look at NSAs (Network Sharing Agreements) or RJVs (Research Joint Ventures): investment decisions taken cooperatively, price decisions are not.

Results

1. Absent efficiency gains:
   - Merger *unambiguously* reduces total investment and consumer surplus (the latter is proved for all demands which satisfy IIA property, but also holds in parametric analysis of models that fail to satisfy IIA).
2. With efficiency gains:
   - The merger raises consumer surplus only if efficiency gains are substantial $\rightarrow$ it exists an efficiencies' value λ_{CS} that yields a consumer-surplus-neutral merger.
   - There exists a value $\lambda_X < \lambda_{CS}$ that yields the same investment levels as the benchmark $\rightarrow$ an increase in investment is necessary but not sufficient for merger to raise CS.

Model

- Consider n symmetric single-product firms simultaneously choosing prices and cost-reducing investments.
- Firm i's problem in the benchmark (no merger):

$$\max_{p_i, x_i} \tilde{\pi}_i = (p_i - c(x_i))q_i(p) - F(x_i),$$

where p is the vector of firms' prices.

- If firms i and k merge, they solve

$$\max_{p_i, p_k, x_i, x_k} \tilde{\pi}_{i,k} = \tilde{\pi}_i + \tilde{\pi}_k + \lambda G(x_i, x_k),$$

where λ captures the importance of efficiency gains.

A merger between firms i and k

- The merged firms will (in red: difference wrt benchmark):

$$
\begin{aligned}
\max_{p_i, p_k, x_i, x_k} \tilde{\pi}_{i,k} &= (p_i - c(x_i))q_i(p_i, \bar{p}_{-i}) - F(x_i) \\
&\quad + (p_k - c(x_k))q_k(p_k, \bar{p}_{-k}) - F(x_k) \\
&\quad + \lambda G(x_i, x_k), \qquad i \neq k.
\end{aligned}
$$

- The FOCs wrt p_i and x_i are (for p_k, x_k are symmetric):

$$
\begin{aligned}
\partial_{p_i}\tilde{\pi}_{i,k} &= q_i(p_i, \bar{p}_{-i}) + \partial_{p_i} q_i(p_i, \bar{p}_{-i})(p_i - c(x_i)) \\
&\quad + \partial_{p_i} q_k(p_k, \bar{p}_{-k})(p_k - c(x_k)) = 0, \\
\partial_{x_i}\tilde{\pi}_{i,k} &= -\partial_{x_i} c(x_i) q_i(p_i, \bar{p}_{-i}) - F'(x_i) + \lambda \partial_{x_i} G(x_i, x_k) = 0.
\end{aligned}
$$

- Consider $\lambda = 0$. Insiders will raise prices. This reduces quantity and (see FOC wrt x_i) reduces investments; hence, higher costs and in turn higher prices...

Merger to monopoly: results

- Absent efficiencies, the merger increases prices and reduces investments.
  - Standard mechanism: each merging firm internalizes the impact of higher sales on merging party's revenues
  - ...and lower sales will also negatively affect investment incentives
- When efficiencies are accounted for:
  - For low value of such gains, the merger will lead to lower investments and higher prices.
  - For intermediate levels of efficiencies, the merger increases investments but this is insufficient to prevent an increase in prices.
  - Only for high levels of efficiency gains, will the merger be beneficial.

Merger in n-firm industry

- With outsiders to the merger, effects become complex:
  - If insiders' prices increase $\rightarrow$ outsiders sell more, and hence they invest more, tending to lower outsider prices...
  - What is the final effect on outsiders' prices? Could outsiders' (possibly) lower prices and (certainly) higher investments lead to higher total investments and CS?
  - Existence and uniqueness conditions not trivial.

- We proceed in two steps, which aim at reducing the dimensionality of the problem:
  - We want to rely on aggregative game theory, where a firm's payoff depends only on its own action $a_i(p_i) \equiv a_i$ and on the sum of all firms' actions, the aggregate $A = \sum_{j=1}^{n} a_j$.
  - But first we need to rewrite the firm's payoff as a function of one action only, rather than two.

From 2 to 1 variable per firm (benchmark)

- Maximization of $\tilde{\pi}_i$ requires solving a multi-dimensional problem (p_i and x_i). But write FOC wrt x_i as:

$$
\begin{aligned}
\partial_{x_i}\tilde{\pi}_i = \partial_{x_i}\tilde{\pi}_{i,k} &= -c'(x_i)q_i(p) - F'(x_i) = 0 \\
\iff q_i(p) &= -\frac{F'(x_i)}{c'(x_i)} \\
\iff x_i &= \chi(q_i(p))
\end{aligned}
$$

  where $\chi(\cdot)$ gives a unique value of x_i for any given p (assume: $c'(x_i) \leq 0$, $c''(x_i) \geq 0$, $F'(x_i) \geq 0$, $F''(x_i) \geq 0$).

- Now, firm i's problem is a standard pricing game:

$$
\max_{p_i} \quad \pi_i = (p_i - c(\chi(q_i(p)))q_i(p) - F(\chi(q_i(p)))
$$
$$
\text{subject to } x_i = \chi(q_i(p)).
$$

- Analogous transformation holds for the merged firms.

Each firm's payoff from n to 2 actions

- We can now use aggregative game theory (Anderson et al. 2015; Nocke & Schutz, 2017; Anderson & Peitz, 2015).
- We focus on the following class of quasi-linear indirect utility functions:

$$V(\bar{p}) = \sum_{i \in n} h(p_i) + \Psi\left(\sum_{i \in n} \psi(p_i)\right).$$

- By Roy's identity, ensuing demand function is

$$q_i(p_i, \bar{p}_{-i}) = -h'(p_i) - \psi'(p_i)\Psi'\left(\sum_{j \in n} \psi(p_j)\right),$$

and has aggregative formulation (Nocke & Schutz, 2017).

Each firm's payoff from n to 2 actions

- Then, set $a_i = \psi(p_i)$, so that $q_i = q_i(A, a_i)$ and $\pi = \pi_i(A, a_i)$ (for the merged entity, $\pi_{i,k} = \pi_i(A, a_i) + \pi_k(A, a_k)$).
- Examples of demand functions with aggregative formulation: Shubik-Levitan linear demand, logit, CES.

Logit example

- Consider a logit demand:

$$q_i(p) = \frac{\exp\{s - p_i\}}{\sum_{j=1}^{n} \exp\{s - p_j\}} \iff q_i(A, a_i) = \frac{a_i}{A},$$

  by setting $a_i = \exp\{s - p_i\}$ and $A = \sum_{j=1}^{n} a_j$.

- Given that $p_i = s - \log(a_i)$, firm i solves:

$$\max_{a_i} \quad \pi_i = (s - \log(a_i) - c(\chi(a_i/A)))\frac{a_i}{A} - F(\chi(a_i/A))$$

  under $x_i = \chi(a_i/A)$.

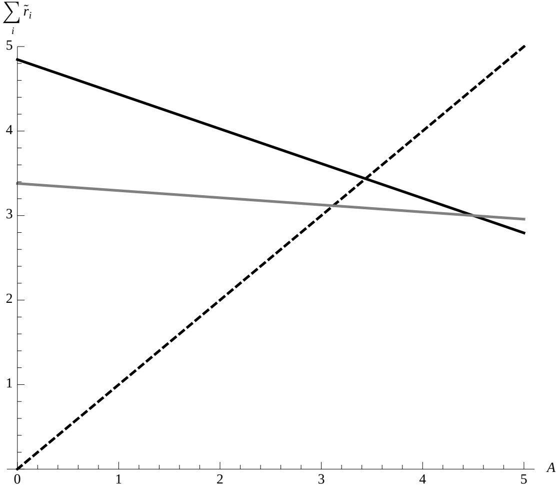
- Next, construct the *inclusive* reaction function $a_i = \tilde{r}_i(A)$.

Equilibrium analysis

- After such reaction function is derived, equilibrium is defined by a simple problem:

$$\sum_{i=1}^{n} \tilde{r}_i(A) = A$$

- Note: by construction, a_i, thus $\tilde{r}_i$, decreases in own price. Then, a lower a_i means a higher price.
- We then derive firms inclusive reaction functions in the benchmark and after the merger.



$$q_i = \frac{(\alpha - p_i)[1 + (n-1)\gamma] - \gamma \sum_{j=1}^{n} (\alpha - p_j)}{(1-\gamma)[1+(n-1)\gamma]},\ c(x_i) = c - x_i,\ F(x_i) = x_i^2/2$$

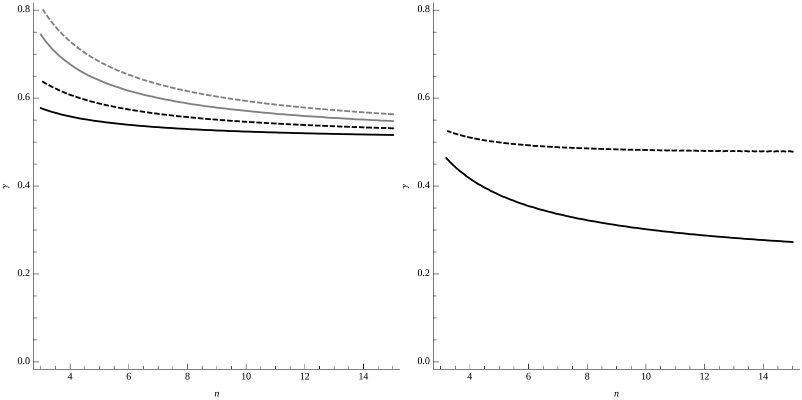
Merger with n firms: results

1. If consumer welfare depends on the aggregate, but not on its composition, the merger reduces consumer surplus.
   - This property is satisfied by those demand functions that satisfy the IIA property (e.g., logit and CES)
   - It does not hold for Shubik-Levitan demand functions.
   - (But we show in parametric models that the merger harms CS and W.)

2. If industry quantity increases in the aggregate A, the merger implies a fall in total output and investment.
   - Among others, this property is satisfied by the logit and Shubik-Levitan demand functions.
   - Results also holds for CES when all prices rise with the merger.

3. (With efficiency gains, same qualitative results as in merger to monopoly.)

CS with linear demand



Quality increasing

- We show the robustness of these results to two classes of models with quality-increasing investments:
  1. Quality adjusted models (e.g., Sutton, 1998; Symeonidis, 2003), in which consumer's utility depends on $x_i q_i$:

     $$U(x_i q_i, ..., x_n q_n) \to x_i q_i = D_i(z), \text{where } z_i = p_i / x_i.$$
     $$\text{Profit: } (p_i - c_i) q_i = (z_i - c_i / x_i) D_i(z).$$

  2. Models (e.g., Shubik-Levitan, Haeckner, 2000; quality version of logit model) in which quantity depends on hedonic price $h_i = p_i - f(x_i)$, with $f' \geq 0$:

     $$(p_i - c) q_i(h) = (h_i - (c - f(x_i)) q_i(h).$$

- The Shaked-Sutton model also gives rise the same results: total investments and CS decrease (but W may increase).

Robustness analysis

1. Asymmetric goods:
   - CS: same conclusions as with symmetric goods.
   - Investments: same results under stronger assumption on investment function (namely, $\chi(\cdot)$ is linear in q_i).

2. Sequential moves: firms know investments when they set prices.
   - Due to commitment effects, we cannot rely on aggregate game formulation.
   - Same qualitative results as in main model with Shubik-Levitan demand and Salop when considering a 3-to-2 firms merger.

3. Involuntary spillovers: investment on good i generates economies for good j production.
   - As with efficiency gains, larger spillovers make the merger procompetitive.

NSA/RJV

- Insiders choose investments to maximize joint profits, but prices to maximize individual profits.
- Efficiency gains also arise in a NSA/RJV.
- For $n \geq 2$, NSA performs (weakly) better than the benchmark for any level of efficiency gains.
- It is also better than any CS-reducing merger, whereas we cannot rank NSA with CS-increasing mergers.
- We find NSA always dominates the merger in parametric analysis with Shubik-Levitan and Salop.

Summary

- In an oligopoly model with differentiated products we establish the effects of a merger on investments and prices.
- Specifically, we find the following:
  1. Under fairly general conditions, the merger yields lower investments and consumer surplus.
  2. With intermediate efficiency gains, the merger can raise investments (but not CS); with higher efficiencies, also consumer surplus.
  3. A NSA is preferable to the merger.
- Implication: merging parties need to substantiate efficiency claims, claims that consolidation leads to higher investment do not seem credible.

Possible extension to other frameworks

- Corporate finance framework
  - One can write a model where the merger relaxes financial constraints and allows for projects that otherwise would not be carried out
  - Study the trade-off between this effect and those underlined in this paper?
  - (NB.: in a real case, the firms should substantiate the financial constraints claims.)