Horizontal Mergers in the Presence of Network Externalities

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Oct. 16 @CPRC

Motivation: mergers in digital industry (1)

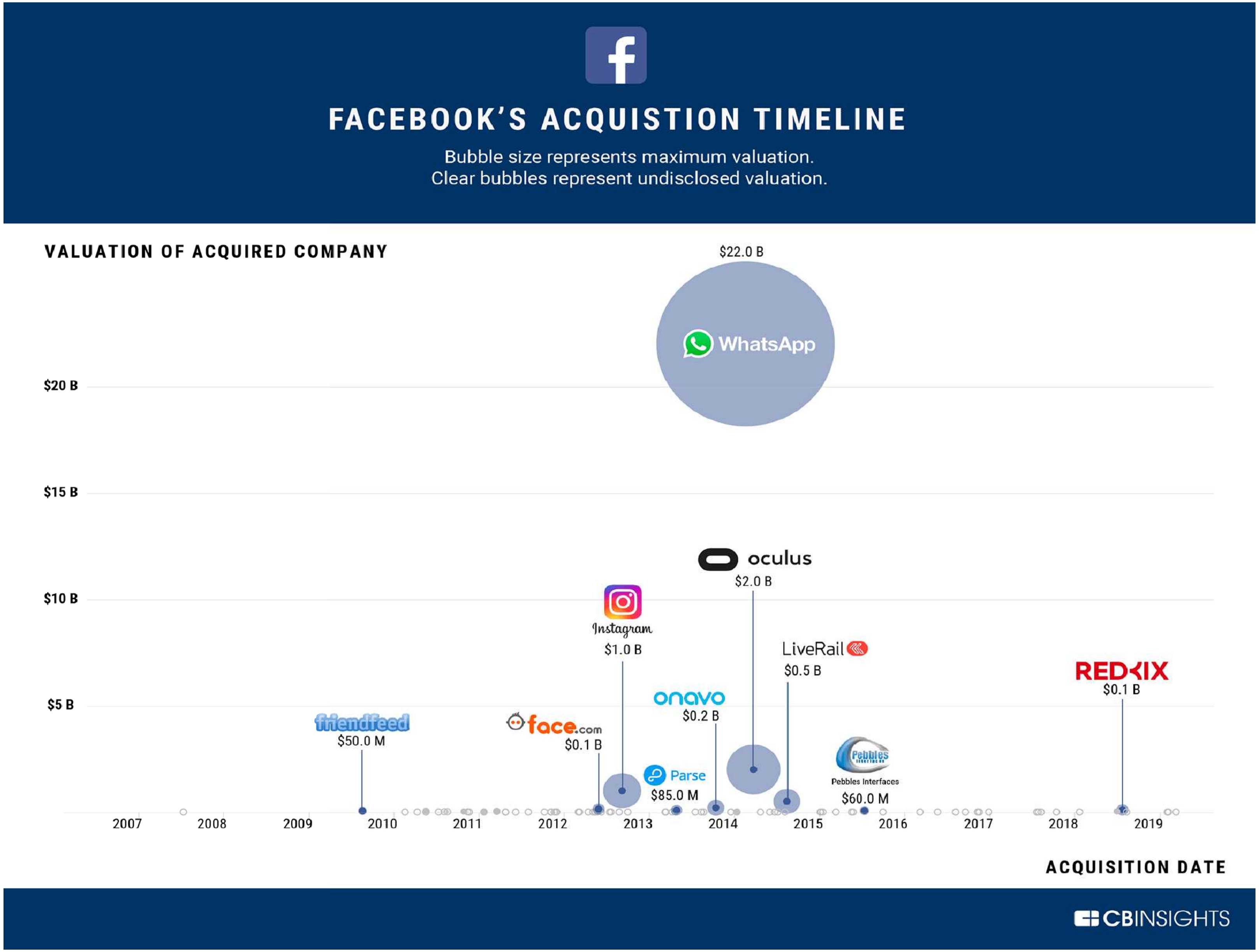
M&A in digital industry: numerous acquisitions by Big Tech.

acquirer	# of acquisitions	Ex. of target
Google (1998-)	214	DoubleClick
Microsoft (1975-)	189	LinkedIn
Apple (1976-)	89	Shazam
Facebook (2004-)	65	WhatsApp

Table: # of acquisitions during 1991-2018 (source: IG)

Motivation: mergers in digital industry (2)

M&A in digital industry: high-stake acquisitions.



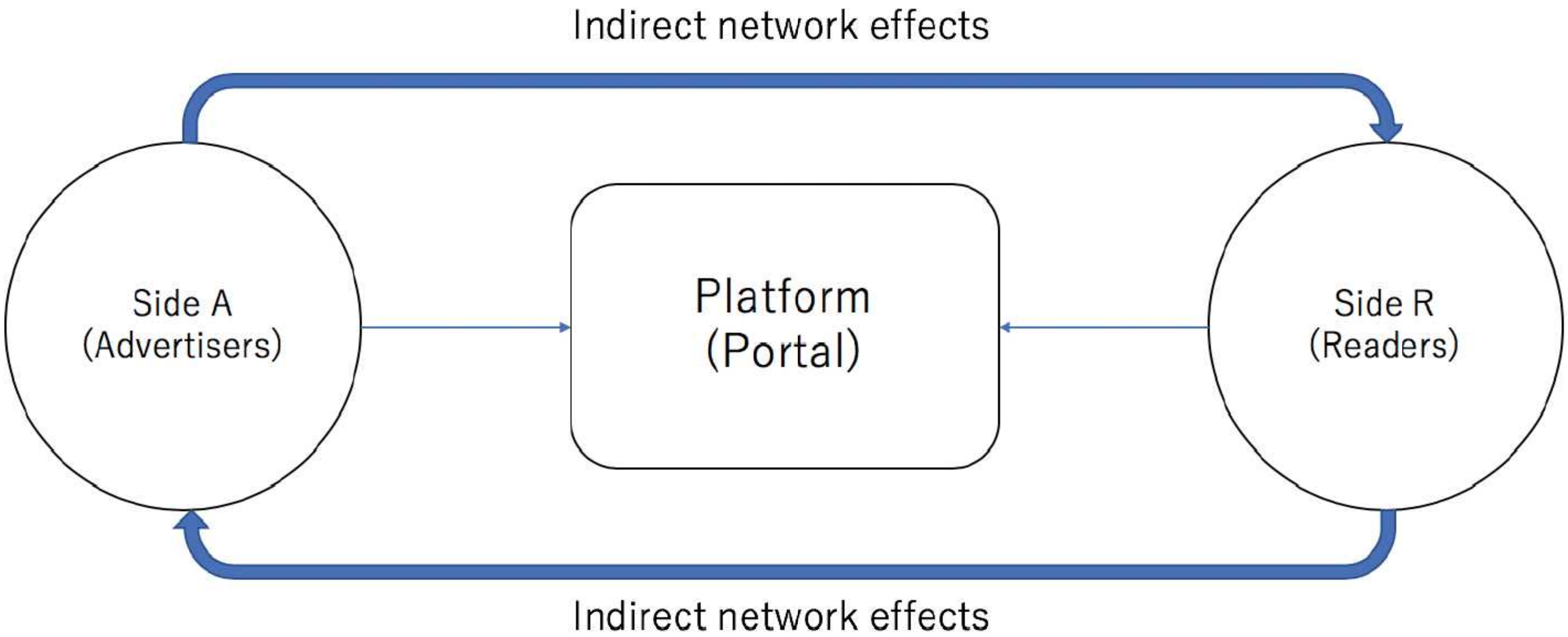
Motivation: mergers in digital industry (3)

Issues on mergers in digital industry (Ocello and Sjödin, CPI)

- Fast-moving nature (innovation)
- Non-monetary-price competition
- Multi-homing
- Data accumulation
- **Network effects**
- **Two- or multi-sidedness**

This study: focus network effects and two-sidedness.

Two-sided markets:

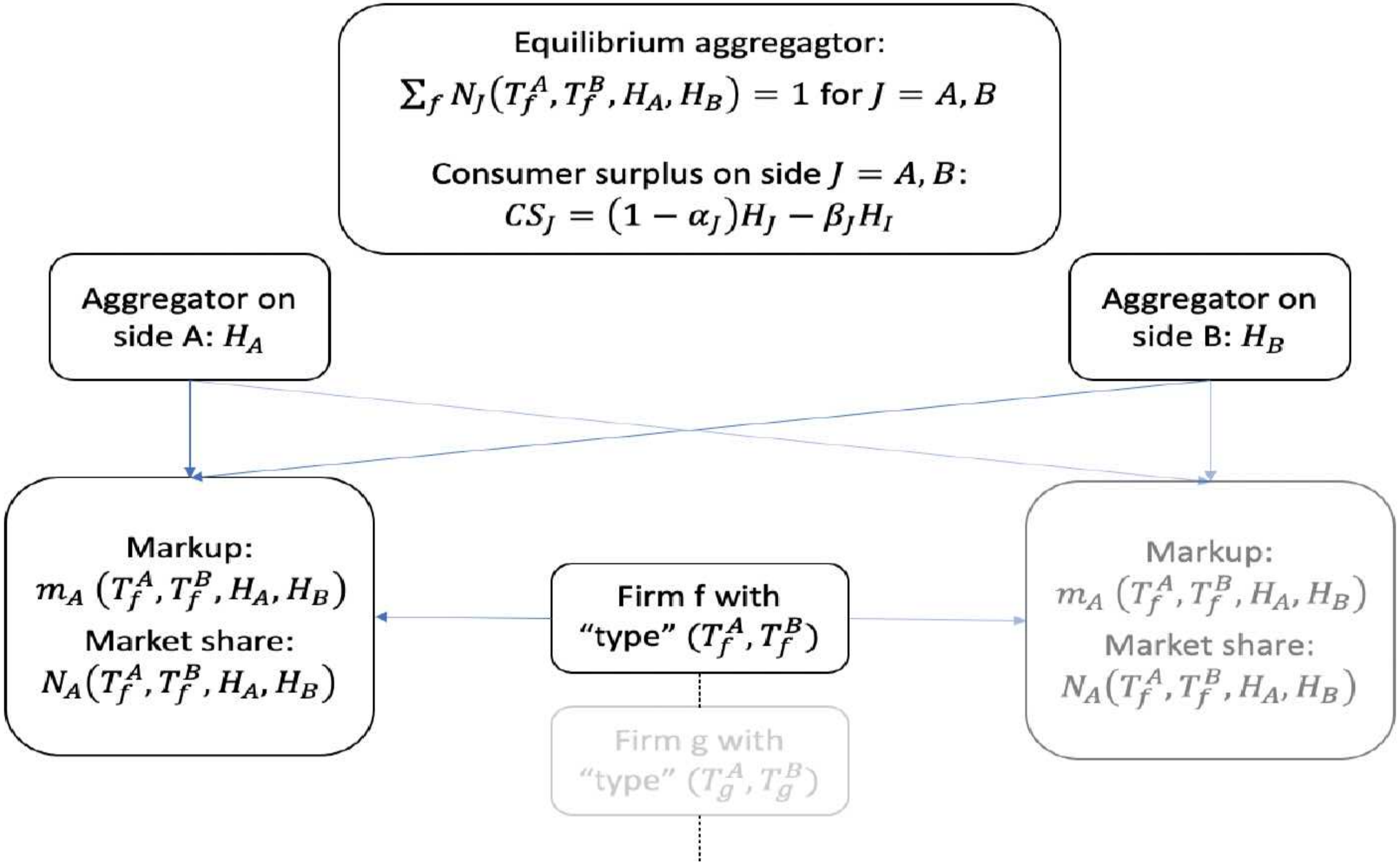


Modelling framework

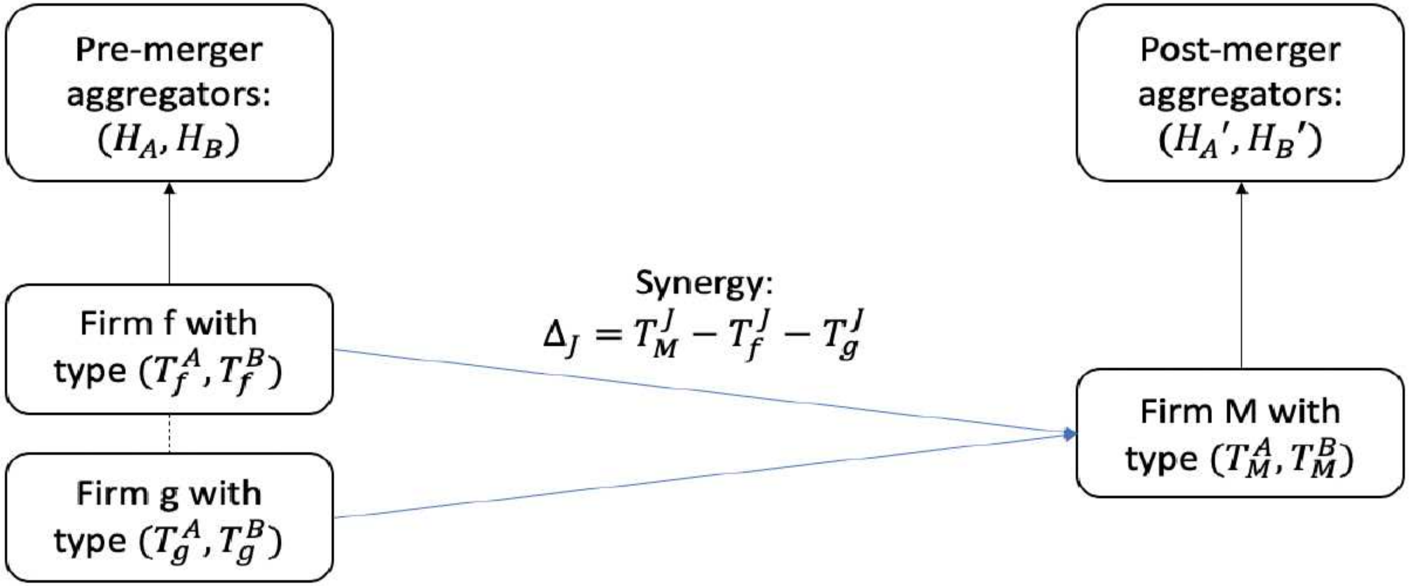
This study tries to offer a tractable framework to analyze mergers with network externalities:

- Use an aggregative-games approach to merger analysis (Nocke and Schutz, 2018a, 2018b)
- Extend their framework to incorporate network externalities.
- Analyze the impacts of network effects and two-sidedness on “scrutiny" merger policy.

Modelling framework



Framework



Pre-merger aggregators: (H_A, H_B)
Post-merger aggregators: (H_A', H_B')
Synergy: $\Delta_J = T_M^J - T_f^J - T_g^J$
Firm f with type (T_f^A, T_f^B)
Firm M with type (T_M^A, T_M^B)
Firm g with type (T_g^A, T_g^B)

Overview of the results

Key tradeoff:

- Impact of network effects:
  - Direct gain from demand-side scale econoies $(+)$
  - Magnifying the increase in market power $(-)$
- Additional impacts of two-sidedness:
  - Change in subsidization incentives $(+)$ $(-)$

Existing studies have offered scarce guidance on which effect dominates, under what condition.

Overview of the results

The presence of network effects makes merger policy more

- **lenient** when merging parties are small or industry is symmetric;
- **stringent** when merging parties are dominant.

In two-sided markets:

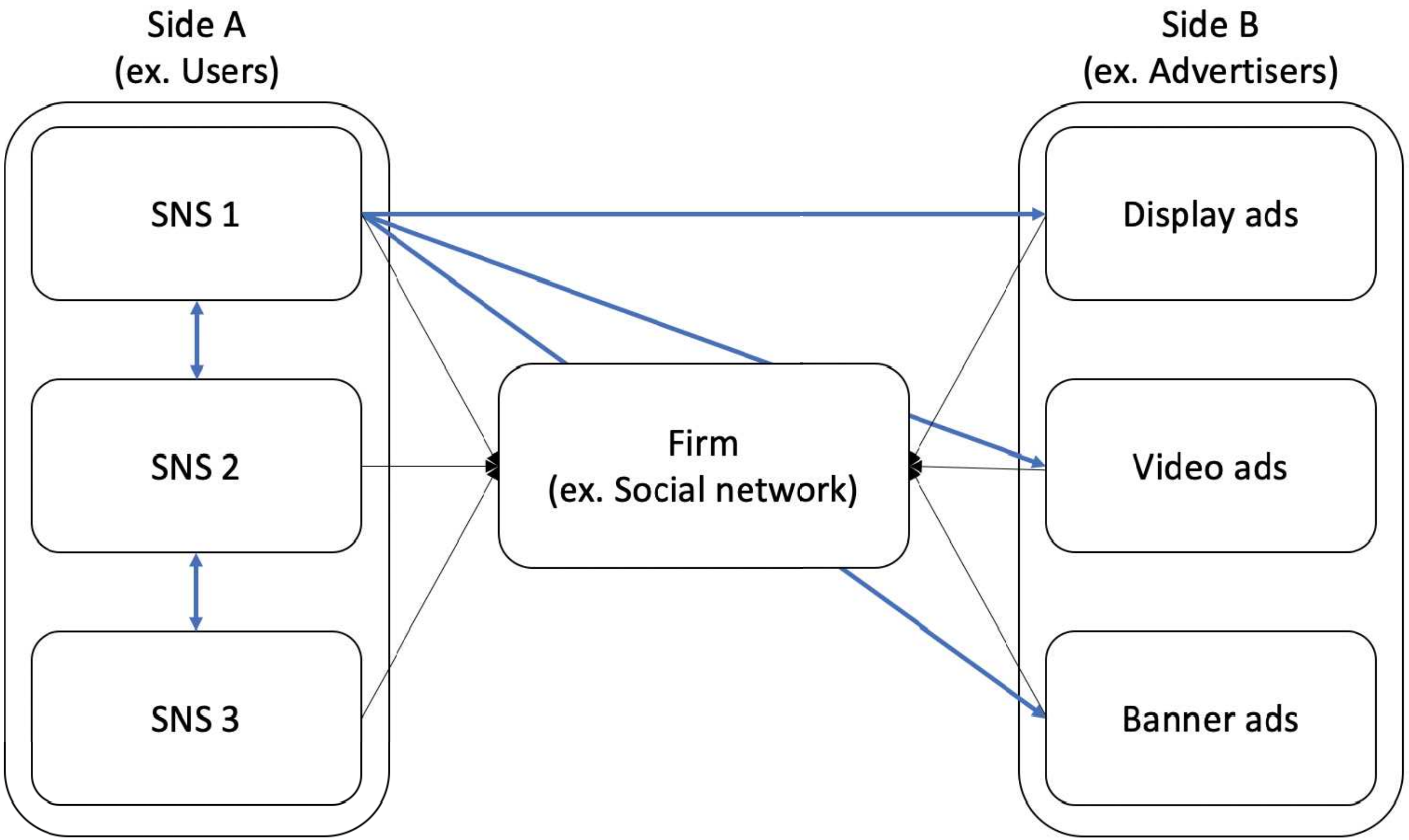
- Ratio of pre-merger shares on two sides of markets determines the changes in the subsidization incentives;
  - ex) merger between firms that are large on “subsidizing segment" increases the subsidization incentives.

Related literature

1. Network externalities: Katz and Shapiro (1984, 1985), Cabral (2011), etc.
2. Mergers in two-sided markets:
   - Empirics: Affeldt et al. (2013), Jeziroski (2014),
   - Theory: Correia-da-Silva et al. (2019)
3. Welfare effects of mergers: Williamson (1968), Farrell and Shapiro (1990), Nocke and Schutz (2018ab), etc.

1. Model
2. Merger Analysis with Direct Network Externalities
3. Merger Analysis in Two-Sided Markets

Framework


Side A
(ex. Users)
SNS 1
SNS 2
SNS 3
Firm
(ex. Social network)
Side B
(ex. Advertisers)
Display ads
Video ads
Banner ads

Framework

Environment:

- Two sided market with side $J = A, B$
- A mass of consumers in each side J.
  - Consumer z purchases one product from a set $\mathcal{N}^J$.
- Set of firms $\mathcal{F}$.
  - Firm f produces a set $\mathcal{N}_f^J$ of products on side J.
- Consumers derive firm-level network externalities from a purchase.

Model of consumer demand

- Multinomial-logit model (for today's talk).
- Indirect utility from a purchase of product $i \in \mathcal{N}_f^J$

$$\log h_i^J(p_i) + \alpha_J \log n_f^J + \beta_J \log n_f^I + \varepsilon_{iz}^J,$$

  - $\log h_i^J(p_i) = \frac{a_i - p_i}{\lambda^J}$: stand-alone indirect subutility;
  - p_i: unit price;
  - $\alpha_J \in [0, 1)$: direct network externalities;
  - $\beta_J \in [0, 1)$: indirect network externalities;
  - n_f^J, n_f^I: network share of firm f on side J and $I \neq J$.
  - $\varepsilon_{iz}^J \sim$ TIEV.

- Single-homing and no outside option.

Model of consumer demand

Network size is determined by rational expectation equilibrium:

- Given network sizes, share s_i of each product $i \in \mathcal{N}_f$ is given by logit demand formula:

$$s_i^J = \frac{h_i^J(p_i)\left(n_f^J\right)^{\alpha_J}\left(n_f^I\right)^{\beta_J}}{\sum_{f' \in \mathcal{F}} \sum_{j \in \mathcal{N}_{f'}^J} h_j^J(p_j)\left(n_{f'}^J\right)^{\alpha_J}\left(n_{f'}^I\right)^{\beta_J}}.$$

- The network share n_f is the sum of the share of products:

$$n_f = \sum_{i \in \mathcal{N}_f} s_i.$$

Model of consumer demand

- Firm-level and industry-level aggregators on each side: for $p_f^J := (p_i)_{i \in \mathcal{N}_f^J}$,

$$H_f^J(p_f^J) = \sum_{i \in \mathcal{N}_f^J} h_i^J(p_i),$$

$$H^J(p) = \sum_{f \in \mathcal{F}} \left(H_f^J(p_f^J)\right)^{\frac{1-\alpha_I}{\Gamma}} \left(H_f^I(p_f^I)\right)^{\frac{\beta_J}{\Gamma}},$$

where $\Gamma = (1 - \alpha_J)(1 - \alpha_I) - \beta_I \beta_J$.

- Firm-level aggregator: total stand-alone value that a firm provides to consumers.
- Network share in rational expectation equilibrium is given by

$$n_f^J(p) = \frac{1}{H^J(p)} \left[\left(\left(H_f^J(p_f^J)\right)^{\frac{1-\alpha_I}{\Gamma}} \left(H_f^I(p_f^I)\right)^{\frac{\beta_J}{\Gamma}} \right]. $$

Model of consumer demand

- Finally, the demand for product $i \in \mathcal{N}_f^J$ under discrete-continuous choice is given by

$$\hat{D}_i^J\left(p_i, H_f^A, H_f^B, H^A, H^B\right)$$

$$= \underbrace{n_f^J}_{\text{network share}} \times \underbrace{\frac{h_i^J}{H_f^J}}_{s_i/n_f}$$

- Consumer surplus is given by

$$CS^J = (1-\alpha_J)\log H^J - \beta_J \log H^I$$

Firm pricing

- Each product $i \in \mathcal{N}$ has a constant marginal cost $c_i > 0$ of production.
- Firm f's profit is $\Pi_f = \Pi_f^A + \Pi_f^B$, where

$$\Pi_f^J = \sum_{i \in \mathcal{N}_f^J} \hat{D}_i^J \left(p_i, H_f^A, H_f^B, H^A, H^B\right)(p_i - c_i)$$

- Pricing game: firms simultaneously choose their price profiles.

Firm pricing

- With logit-type demand, common markup property obtains:
  - For any $i \in N_f^J$, firm f's optimal price satisfies
$$p_i = c_i + \lambda^J \mu_f^J,$$

  where

$$\mu_f^J = \frac{1}{1 - n_f^J}\left(1 - \alpha_J - \beta_I \frac{n_f^I}{n_f^J}\right)$$

- $\frac{1}{1-n_f^J}$ captures the market power.
- $\alpha_J + \beta_I \frac{n_f^I}{n_f^J}$ captures the incentive to discount.

Type aggregation

- Finally, network share can be written as

$$n_f^J = \frac{\left(T_f^J\right)^{\frac{1-\alpha_I}{\Gamma}} \left(T_f^I\right)^{\frac{\beta_J}{\Gamma}}}{H^J} \exp\left(-\frac{(1-\alpha_I)\mu_f^J + \beta_J \mu_f^I}{\Gamma}\right),$$

where

$$T_f^J = \sum_{i \in \mathcal{N}_f^J} \exp\left(\frac{a_i - c_i}{\lambda^J}\right),$$

is the “type" of firm f on side J.

  - the value the firm can offer by marginal cost pricing.

Type aggregation and equilibrium aggregators

- Thus, network shares of each firm at best response can be written as a function

$$N^J(T_f^A, T_f^B, H^A, H^B), \quad J = A, B.$$

- N^J is increasing in T_f^A, T_f^B and decreasing in H^A, H^B.

- Equilibrium condition for the aggregator:

$$\sum_{f \in \mathcal{F}} N^J(T_f^A, T_f^B, H^A, H^B) = 1$$

for $J = A, B$.

Summary of the model

1. Each firm's best response yields the network share function (N^A, N^B).

2. Given a type profile, the equilibrium industry-level aggregators H^A and H^B are computed using the equilibrium condition $\sum_f N^J = 1,\ J = A, B$.

3. Finally, consumer surplus on side J is given by

$$CS^J = (1 - \alpha_J)H^J - \beta_J H^I$$

4. Aggregate consumer surplus is given by

$$\begin{aligned} CS &= CS^A + CS^B \\ &= (1 - \alpha_A - \beta_B)H^A + (1 - \alpha_B - \beta_A)H^B. \end{aligned}$$

Modelling a merger

Merger between firms f and g:

- Firms f and g with types (T_f^A, T_f^B) and (T_g^A, T_g^B) are transformed into firm M with

$$T_M^J = T_f^J + T_g^J + \Delta^J,$$

- Δ^J is the technological synergy on side J generated by the merger.

Merger analysis

- Focus of the analysis: CS-neutral mergers.

- A merger is CS-neutral if and only if $(T_M^A, T_M^B) = (\hat{T}_M^A, \hat{T}_M^B)$, where

$$\begin{aligned} & N^J(\hat{T}_M^A, \hat{T}_M^B, H^A, H^B) \\ = & N^J(T_f^A, T_f^B, H^A, H^B) + N^J(T_g^A, T_g^B, H^A, H^B) \end{aligned}$$

  with pre-merger equilibrium aggregators (H^A, H^B).

- $\hat{\Delta}_M^J := \hat{T}_M^J - T_f^J - T_g^J$: CS-neutral technological synergy on side J.

Roadmap:

- Interpreting $\hat{\Delta}_M^J$ as the scrutiny of merger review,
- separately analyze the impacts of direct and indirect network externalities on $\hat{\Delta}_M^J$.

1 Model

2 Merger Analysis with Direct Network Externalities

3 Merger Analysis in Two-Sided Markets

Direct network effects: key tradeoff

Suppose that $\beta_A = \beta_B = 0$ and drop the script J.

Direct network externalities affects welfare properties of mergers in two ways:

1. Consumer benefit from network expansion $(+)$.
2. Magnifying the increase in markup accompanying the merger $(-)$.

- When the former dominates, network externalities can serve as a form of efficiency gain that benefits consumers.

Small merger or merger in symmetric industry

Propositions (merger and firm sizes)

- When one of the merging parties is small enough, $\hat{\Delta} < 0$
- When all firms have the same type T, then $\hat{\Delta} < 0$ if α is above some critical value $\hat{\alpha} > 0$.

Network effects and technological synergies

- Fix $(T_{f'})_{f' \in \mathcal{F}}$ and let H^* be the pre-merger equilibrium value of the aggregator.
- I say firm f is *strong* if

$$\frac{d}{d\alpha}\left\{N\left(\frac{\gamma(T_f)}{H^*}, \alpha\right)\right\} > 0.$$

- Otherwise, I say firm f is *weak*.
- There exists a critical value T^* such that firm f is strong if and only if $T_f > T^*$.

Results: Network effects and merger policy

Proposition (network effects and technological synergies)

Consider a merger between firms f and g with pre-merger network shares N_f and N_g.

1. If both f and g are weak, then $\hat{\Delta}$ decreases with α.
2. If f is strong and g is weak, then there exists $\hat{N} \in (0, 1)$ such that if $N_f + N_g < \hat{N}$, then $\hat{\Delta}$ decreases with α.
3. If both f and g are strong and $N_f + N_g$ is close to 1. Then $\hat{\Delta}$ increases with α.

Results: Network effects and merger policy

Intuition:

- For weak firms, greater network externalities make them less viable alone and make merger more attractive to consumers.
  - Benefit from network expansion dominates.
- For strong firms, greater network externalities make *outsiders* less viable, which increases the market power of merged entity and leads to a sharp increase in markups.
  - Loss from an increase in market power dominates.

Numerical example:

- 12 firms, including 10 firms with $T_f = 5$, one firm with $T_f = 20$, and one firm with $T_f = 25$.

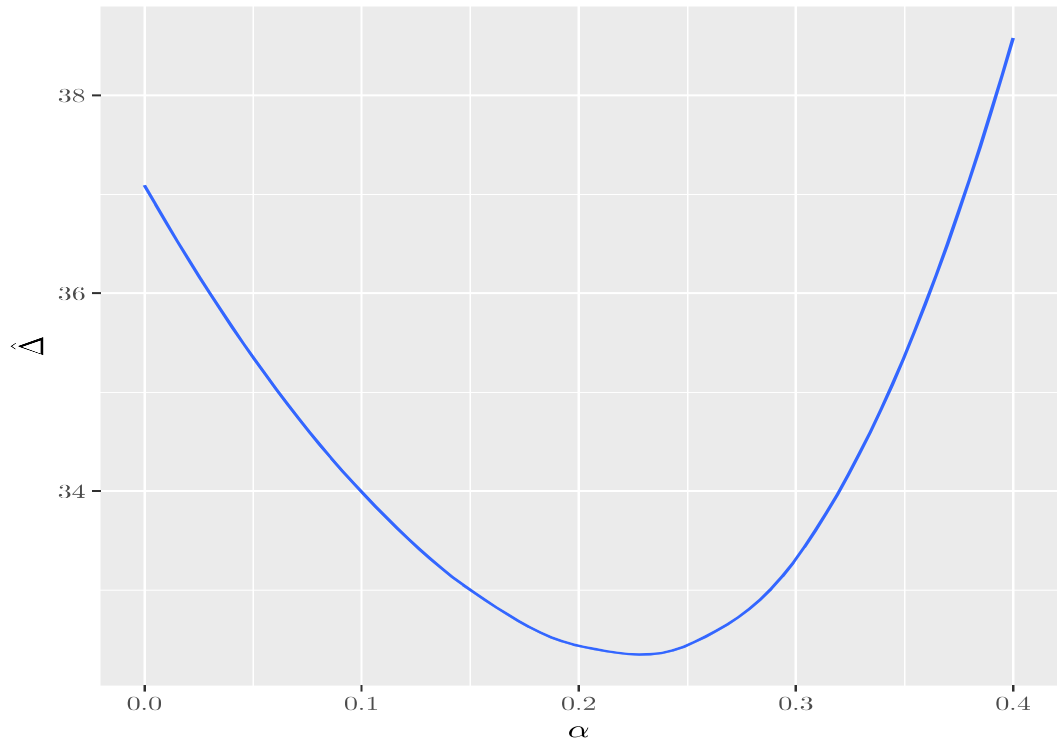


Figure: Strong firms ($T_f = 25$, $T_g = 20$).

Results: Summary

Tentative summary:

- When merging parties are small or firms are symmetric, greater network externalities should lead to more lenient merger policy.
- When merging parties are dominant, greater network externalities should lead to more stringent merger policy.

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Merger Analysis in Two-Sided Markets

Suppose that $\alpha_A = \alpha_B = 0$, and also that $\beta_A = \beta > 0$ and $\beta_B = 0$.

Three effects of merger in two-sided markets:

- Benefit from network expansion
- Accompanying increase in markup
- **Change in subsidization incentives**

Merger Analysis in Two-Sided Markets

Cross-subsidization incentives:

- The formula for m_f^A and m_f^B are given by

$$\mu_f^A = \frac{1}{1 - n_f^A}$$

$$\mu_f^B = \frac{1}{1 - n_f^B} \left(1 - \beta \frac{n_f^A}{n_f^B} \right)$$

- The larger a firm is on side A relative to side B, the lower price it sets on side B.

- Relative sizes between sides A and B now become important!

Illustrative result

Proposition (CS-neutral synergies in two-sided markets)

Suppose that merging firms f and g have the same pre-merger network shares n^A and n^B. Then,

1. $\hat{\Delta}^A > 0$ if and only if n^A is greater than some critical value $\hat{n}^A > 0$, and
2. $\hat{\Delta}^B > 0$ if and only if $1 - \beta \frac{n^A}{n^B} > 0$.

Illustrative result

- For consumers on side A (those who benefit from network effects), the trade-off is scale-economy vs. market power.
- For consumers on side B (those who generate network effects), the issue is whether they are sufficiently subsidized.

Policy implication

See-saw effects:

- Market power on side A make merger beneficial for side B.
- Ex) merger between platforms dominant on advertiser side may improve post-merger quality on consumer side..
  - But such merger is likely to hurt advertisers.
- Merger policy that ignores advertiser side may be
  1. too stringent for consumer side, and
  2. either too lenient or too stringent for advertiser side, depending on the size of merging parties.

Conclusion

Main findings:

- Implications of network externalities on merger policy depend on firm sizes relative to markets
    - The larger the firm is, market power effects tend to dominate
    - In two-sided markets, expansion in benefiting side increases subsidizing incentives

Other exercises:

- Acquisition of innovative entrants
- Merger among ad-sponsored media

Future direction

Issues on mergers in digital industry (again, Ocello and Sjödin, CPI)

- Fast-moving nature (innovation)
- Non-monetary-price competition
- Multi-homing
- Data accumulation
- **Network effects**
- **Two- or multi-sidedness**

Other issues:

- Entry barriers,
- Foreclosure.