Beyond "Horizontal" and "Vertical": The Welfare Effects of Complex Integration

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Introduction

Mergers in Supply Chains Are Complex

- literature has largely focused on mergers between unintegrated firms with unintegrated rivals. What about
  - mergers where **one** party is already vertically integrated and the other is not?
  - mergers where **both** parties are already vertically integrated?
  - mergers where **3rd parties** are vertically integrated?
- literature has focused on mergers between firms with **constant** marginal costs and no capacity constraints.
  - constant marginal costs can understate raising rivals costs
  - constant marginal costs can overstate EDM

Our Contribution

Use Sheu and Taragin (2021) to examine merger effects

- when an integrated firm merges with an unintegrated upstream firm,
- when an integrated firm merges with an unintegrated downstream firm,
- when two integrated firms merge,
- as the number of integrated rivals increases,
- when marginal costs are non-constant.

Case Studies: Solid Waste Management Mergers (In Progress)

- Waste Management/Advanced Disposal Services (2020)
- Republic/Santek (2020)

Overview

The Model

Overview

- We model a two-level supply chain
    1. Nash bargaining upstream
    2. Bertrand differentiated products logit downstream (Werden and Froeb (1994))
- Downstream model is purposefully kept in standard forms to facilitate calibration

The Model

Downstream

Demand

- Assume logit for downstream Bertrand
- Each wholesaler w in the set $\mathbb{W}$ offers a single product to retailers r in the set $\mathbb{R}$, which in turn sell to consumers
- Market share of wholesaler w's product purchased through retailer r is

$$s_{rw} = \frac{\exp(\delta_{rw} - \alpha p_{rw})}{1 + \sum_{t \in \mathbb{R}} \sum_{x \in \mathbb{W}^t} \exp(\delta_{tx} - \alpha p_{tx})}$$

- $\{\delta_{rw}; \forall r \in \mathbb{R}, \forall w \in \mathbb{W}\}$ and α are parameters to be calibrated

Bertrand

- Assume firms set prices simultaneously in Bertrand Nash equilibrium
- Retailer constant marginal cost consists of wholesale fee p^W_{rw} and other costs c^R_{rw}
- Profit function for retailer r is

$$\pi^r = \sum_{w \in \mathbb{W}^r} [p_{rw} - p^W_{rw} - c^R_{rw}] s_{rw} M$$

- Resulting first order conditions determine downstream equilibrium prices

$$\sum_{x \in \mathbb{W}^r} [p_{rx} - p^W_{rx} - c^R_{rx}] \frac{\partial s_{rx}}{\partial p_{rw}} + s_{rw} = 0$$

The Model

Upstream

Nash Bargaining

- Assume a linear wholesale price set by Nash Bargaining

$$\max_{p^W_{rw}} (\pi^r - d^r(\mathbb{W}^r \setminus \{w\}))^{\lambda_{rw}} (\pi^w - d^w(\mathbb{R}^w \setminus \{r\}))^{1-\lambda_{rw}}$$

- $\{\lambda_{rw}; \forall r \in \mathbb{R}, \forall w \in \mathbb{W}\}$ are parameters to be calibrated
- Wholesaler marginal costs are constant and equal c^W_{rw}
- Profit function for wholesaler w is

$$\pi^w = \sum_{r \in \mathbb{R}^w} [p^W_{rw} - c^W_{rw}] s_{rw} M$$

- All wholesalers and retailers reach an agreement in equilibrium.

Simplifying Assumptions

- First order condition is given by

$$\lambda_{rw}[\pi^w - d^w(\mathbb{R}^w \setminus \{r\})]\left(\frac{\partial \pi^r}{\partial p^W_{rw}} - \frac{\partial d^r(\mathbb{W}^r \setminus \{w\})}{\partial p^W_{rw}}\right) +$$

$$(1-\lambda_{rw})[\pi^r - d^r(\mathbb{W}^r \setminus \{w\})]\left(\frac{\partial \pi^w}{\partial p^W_{rw}} - \frac{\partial d^w(\mathbb{R}^w \setminus \{r\})}{\partial p^W_{rw}}\right) = 0,$$

- Use two simplifying assumptions

Simplifying Assumptions

- First order condition is given by

$$\lambda_{rw}[\pi^w - d^w(\mathbb{R}^w \setminus \{r\})]\left(\frac{\partial \pi^r}{\partial p^W_{rw}} - \frac{\partial d^r(\mathbb{W}^r \setminus \{w\})}{\partial p^W_{rw}}\right) +$$
$$(1-\lambda_{rw})[\pi^r - d^r(\mathbb{W}^r \setminus \{w\})]\left(\frac{\partial \pi^w}{\partial p^W_{rw}} - \frac{\partial d^w(\mathbb{R}^w \setminus \{r\})}{\partial p^W_{rw}}\right) = 0,$$

- Use two simplifying assumptions
  1. *Simultaneous negotiations*: treat other contracts as given

Simplifying Assumptions

- First order condition is given by

$$\lambda_{rw}[\pi^w - d^w(\mathbb{R}^w \setminus \{r\})] \left(\frac{\partial \pi^r}{\partial p^W_{rw}} - 0 \right) +$$
$$(1 - \lambda_{rw})[\pi^r - d^r(\mathbb{W}^r \setminus \{w\})] \left(\frac{\partial \pi^w}{\partial p^W_{rw}} - 0 \right) = 0,$$

- Use two simplifying assumptions
  1. *Simultaneous negotiations*: treat other contracts as given

Simplifying Assumptions

- First order condition is given by

$$\lambda_{rw}[\pi^w - d^w(\mathbb{R}^w \setminus \{r\})]\left(\frac{\partial \pi^r}{\partial p^W_{rw}} - 0\right) +$$
$$(1-\lambda_{rw})[\pi^r - d^r(\mathbb{W}^r \setminus \{w\})]\left(\frac{\partial \pi^w}{\partial p^W_{rw}} - 0\right) = 0,$$

- Use two simplifying assumptions
  1. *Simultaneous negotiations*: treat other contracts as given
  2. *Simultaneous downstream pricing*: treat downstream prices as given

Simplifying Assumptions

- First order condition is given by

$$\lambda_{rw}[\pi^w - d^w(\mathbb{R}^w \setminus \{r\})]\,(-s_{rw}M - 0) +$$
$$(1 - \lambda_{rw})[\pi^r - d^r(\mathbb{W}^r \setminus \{w\})]\,(s_{rw}M - 0) = 0,$$

- Use two simplifying assumptions
  1. *Simultaneous negotiations*: treat other contracts as given
  2. *Simultaneous downstream pricing*: treat downstream prices as given

Simplifying Assumptions

- Simplified first order condition is given by

$$\pi^w - d^w(\mathbb{R}^w \setminus \{r\}) = \frac{1-\lambda_{rw}}{\lambda_{rw}}(\pi^r - d^r(\mathbb{W}^r \setminus \{w\}))$$

- Use two simplifying assumptions
    1. *Simultaneous negotiations*: treat other contracts as given
    2. *Simultaneous downstream pricing*: treat downstream prices as given

Disagreement Payoffs

- Profit for wholesaler w if it does not sell to retailer r is

$$d^w(\mathbb{R}^w \setminus \{r\}) = \sum_{t \in \mathbb{R}^w \setminus \{r\}} [p_{tw}^W - c_{tw}^W] s_{tw}(\mathbb{W}^r \setminus \{w\}) M$$

- Profit for retailer r if it does not buy from wholesaler w is

$$d^r(\mathbb{W}^r \setminus \{w\}) = \sum_{x \in \mathbb{W}^r \setminus \{w\}} [p_{rx} - p_{rx}^W - c_{rx}^R] s_{rx}(\mathbb{W}^r \setminus \{w\}) M$$

- Other things equal, a larger disagreement payoff increases bargaining leverage

The Model

Merger Simulation

Integrated Firm: Own Retail Prices

Assume that retailer r acquires wholesaler w. r's price downstream is determined by

$$\sum_{x \in \mathbb{W}^r \setminus \{w\}} [p_{rx} - p_{rx}^W - c_{rx}^R] \frac{\partial s_{rx}}{\partial p_{rw}} + s_{rw}$$

$$\underbrace{[p_{rw} - c_{rw}^R - c_{rw}^W] \frac{\partial s_{rw}}{\partial p_{rw}}}_{\text{EDM}} + \underbrace{\sum_{t \in \mathbb{R}^w \setminus \{r\}} [p_{tw}^W - c_{tw}^W] \frac{\partial s_{tw}}{\partial p_{rw}}}_{\text{UPP}} = 0.$$

Integrated Firm: Wholesale Price to Rival Retailer

Assume that retailer r acquires wholesaler w. w bargains with *unaffiliated* retailer u, yielding a wholesale price determined by

$$
\begin{aligned}
&[p_{sw}^W - c_{sw}^W]s_{sw} - \sum_{t \in \mathbb{R}^w \setminus \{r,s\}} [p_{tw}^W - c_{tw}^W]\Delta s_{tw}(\mathbb{W}^s \setminus \{w\}) \\
&- \overbrace{\overbrace{[p_{rw} - c_{rw}^W - c_{rw}^R]\Delta s_{rw}(\mathbb{W}^s \setminus \{w\})}^{\text{indirect EDM effect}} - \sum_{x \in \mathbb{W}^r \setminus \{w\}} [p_{rx} - p_{rx}^W - c_{rx}^R]\Delta s_{rx}(\mathbb{W}^s \setminus \{w\})}^{\text{RRC effect}} = \\
&\frac{1-\lambda}{\lambda}\left([p_{sw} - p_{sw}^W - c_{sw}^R]s_{sw} - \sum_{x \in \mathbb{W}^r \setminus \{w\}} [p_{sx} - p_{sx}^W - c_{sx}^R]\Delta s_{sx}(\mathbb{W}^s \setminus \{w\})\right).
\end{aligned}
$$

Integrated Firm: Wholesale Price from Wholesaler Rival

Assume that retailer r acquires wholesaler w. r bargains with *unaffiliated* wholesaler v, yielding a wholesale price determined by

$$
\begin{aligned}
&[p^W_{rv} - c^W_{rv}]s_{rv} - \sum_{t \in \mathbb{R}^v \setminus \{r\}} [p^W_{tv} - c^W_{tv}]\Delta s_{tv}(\mathbb{W}^r \setminus \{v\}) = \\
&\frac{1-\lambda}{\lambda}\Bigg([p_{rv} - p^W_{rv} - c^R_{rv}]s_{rv} - \sum_{x \in \mathbb{W}^r \setminus \{w,v\}} [p_{rx} - p^W_{rx} - c^R_{rx}]\Delta s_{rx}(\mathbb{W}^r \setminus \{v\}) \\
&- \underbrace{[p_{rw} - c^W_{rw} - c^R_{rw}]\Delta s_{rw}(\mathbb{W}^r \setminus \{v\})}_{\text{EDM recapture effect}} - \underbrace{\sum_{t \in \mathbb{R}^w \setminus \{r\}} [p^W_{tw} - c^W_{tw}]\Delta s_{tw}(\mathbb{W}^r \setminus \{v\})}_{\text{wholesale recapture leverage effect}}\Bigg).
\end{aligned}
$$

Numerical Simulations

Objective

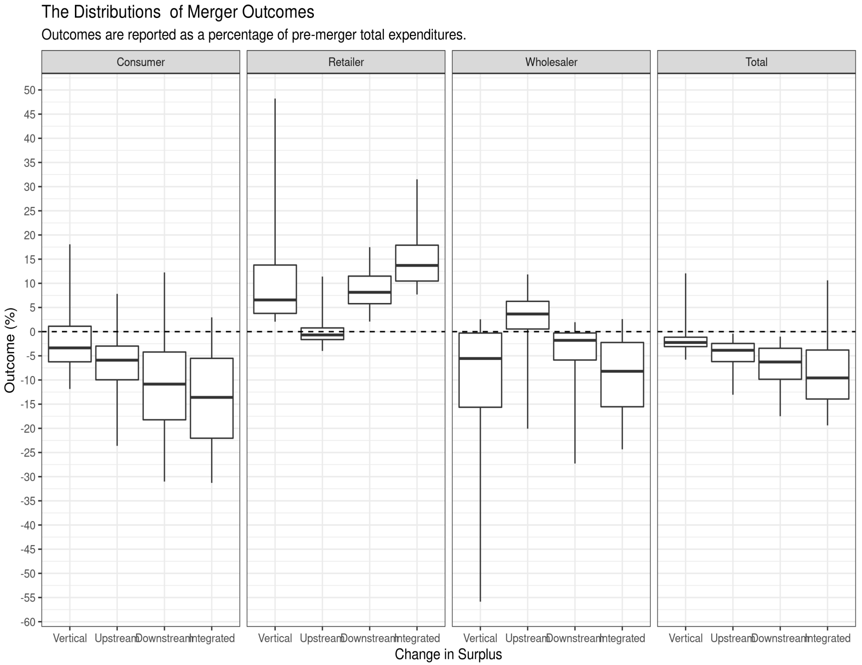
The purpose of these numerical simulations is to use the above model to explore how these different mergers can affect market participants under a wide array of market conditions.

Data Generating Process (1.4 million simulated mergers)

- simulate markets with either 2, 3, 4 or 5 wholesalers/retailers
- 0 to 4 **non-siloed** integrated incumbents pre-merger
    - up to 6 for integrated mergers
- bargaining power parameter ranges from 0.1 to 0.9 in 0.1 increments
- marginal costs are either constant or linear.
- eliminate
    - unprofitable mergers
    - mergers that do no pass the HMT

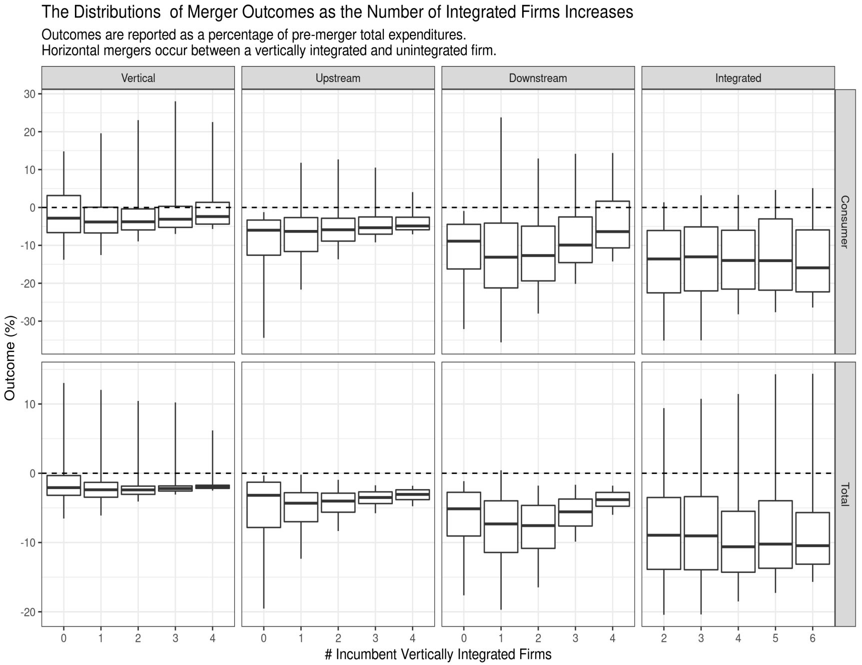
Numerical Simulations

Overview


The Distributions of Merger Outcomes
Outcomes are reported as a percentage of pre-merger total expenditures.
Consumer
Retailer
Wholesaler
Total
Outcome (%)
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
Vertical
Upstream
Downstream
Integrated
Change in Surplus

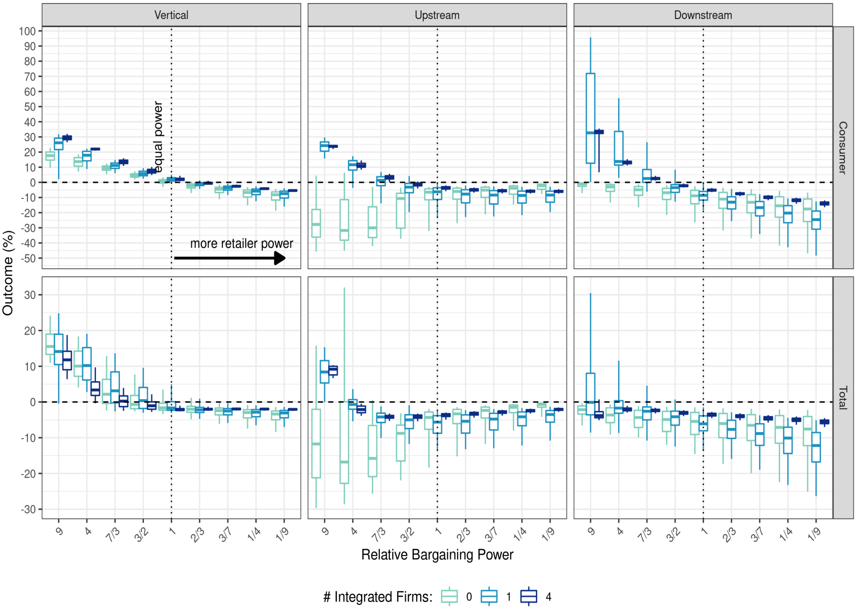
Numerical Simulations

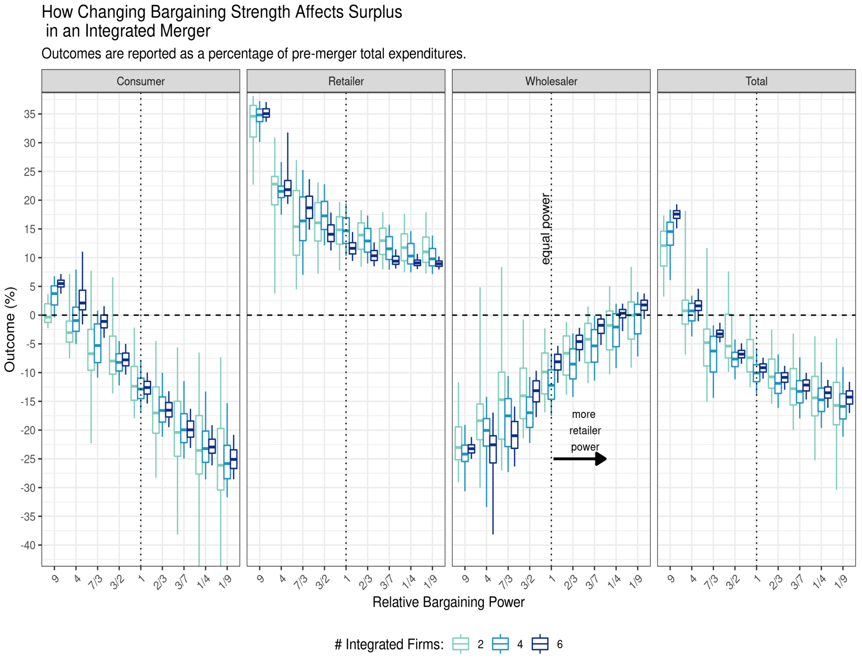
Integrated Firms


The Distributions of Merger Outcomes as the Number of Integrated Firms Increases
Outcomes are reported as a percentage of pre-merger total expenditures.
Horizontal mergers occur between a vertically integrated and unintegrated firm.
Vertical
Upstream
Downstream
Integrated
Consumer
Total
Outcome (%)
30
20
10
0
-10
-20
-30
Incumbent Vertically Integrated Firms
0
1
2
3
4
5
6

How Changing Bargaining Strength Affects Consumer and Total Surplus, By Merger

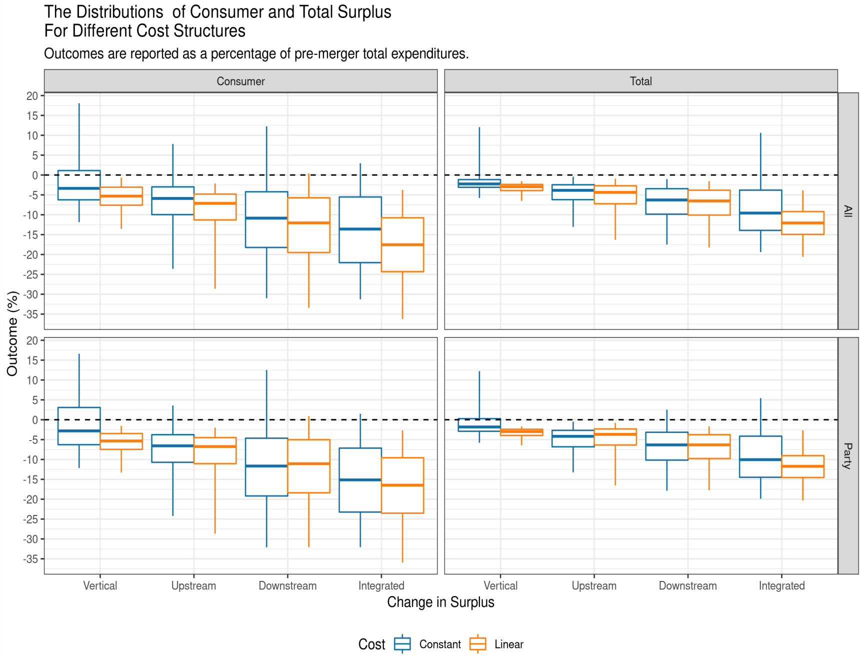
Outcomes are reported as a percentage of pre-merger total expenditures.




How Changing Bargaining Strength Affects Surplus
in an Integrated Merger
Outcomes are reported as a percentage of pre-merger total expenditures.
Consumer
Retailer
Wholesaler
Total
equal power
more
retailer
power
Outcome (%)
Relative Bargaining Power
9
4
7/3
3/2
1
2/3
3/7
1/4
1/9
Integrated Firms:
2
4
6

Numerical Simulations

Convex Marginal Costs


The Distributions of Consumer and Total Surplus
For Different Cost Structures
Outcomes are reported as a percentage of pre-merger total expenditures.
Consumer
Total
All
Party
Outcome (%)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
Vertical
Upstream
Downstream
Integrated
Change in Surplus
Cost
Constant
Linear

Conclusion

Summary

- paper relaxes two strong assumptions
    - pre-merger, no firms are vertically integrated,
    - all firms employ constant marginal cost technology,
- simulations with these assumptions relaxed yield markedly different outcomes from those when assumptions are maintained.
- relative bargaining power is a useful indicia for predicting consumer and total harm in these mergers.

References

Sheu, G. and C. Taragin (2021).
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