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## Beyond “Horizontal” and “Vertical”: The Welfare Effects of Complex Integration

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# Introduction

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# 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

## **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

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# The Model

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- 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

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Downstream



- 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  $\alpha$  are parameters to be calibrated

# Bertrand

- Assume firms set prices simultaneously in Bertrand Nash equilibrium
- Retailer marginal cost consists of wholesale fee  $p_{rw}^W$  and other **constant/linear** costs  $c_{rw}^R$
- Profit function for retailer  $r$  is

$$\pi^r = \sum_{w \in \mathbb{W}^r} [p_{rw} - p_{rw}^W - c_{rw}^R] s_{rw} M$$

- Resulting first order conditions determine downstream equilibrium prices

$$\sum_{x \in \mathbb{W}^r} [p_{rx} - p_{rx}^W - c_{rx}^R] \frac{\partial s_{rx}}{\partial p_{rw}} + s_{rw} = 0$$

# The Model

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Upstream

# Nash Bargaining

- Assume a **linear** wholesale price set by Nash Bargaining

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

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

$$\pi^w = \sum_{r \in \mathbb{R}^w} [p_{rw}^W - c_{rw}^W] s_{rw} M$$

- All wholesalers and retailers reach an agreement in equilibrium.

# Simplifying Assumptions

- First order condition is given by

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

- Use two simplifying assumptions

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

# Simplifying Assumptions

- First order condition is given by

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

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# Simplifying Assumptions

- First order condition is given by

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

- 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

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## 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

$$\begin{aligned}
 & [p_{sw}^W - c_{sw}^W]s_{sw} - \sum_{t \in \mathbb{R}^W \setminus \{r, s\}} [p_{tw}^W - c_{tw}^W] \Delta s_{tw}(\mathbb{W}^S \setminus \{w\}) \\
 & \quad \underbrace{\hspace{15em}}_{\text{RRC effect}} \\
 & \quad \underbrace{[p_{rw} - c_{rw}^W - c_{rw}^R] \Delta s_{rw}(\mathbb{W}^S \setminus \{w\})}_{\text{indirect EDM effect}} - \sum_{x \in \mathbb{W}^r \setminus \{w\}} [p_{rx} - p_{rx}^W - c_{rx}^R] \Delta s_{rx}(\mathbb{W}^S \setminus \{w\}) = \\
 & \frac{1 - \lambda}{\lambda} \left( [p_{sw} - p_{sw}^W - c_{sw}^R]s_{sw} - \sum_{x \in \mathbb{W}^r \setminus \{w\}} [p_{sx} - p_{sx}^W - c_{sx}^R] \Delta s_{sx}(\mathbb{W}^S \setminus \{w\}) \right).
 \end{aligned}$$

# 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

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

# Numerical Simulations

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# 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 not pass the HMT

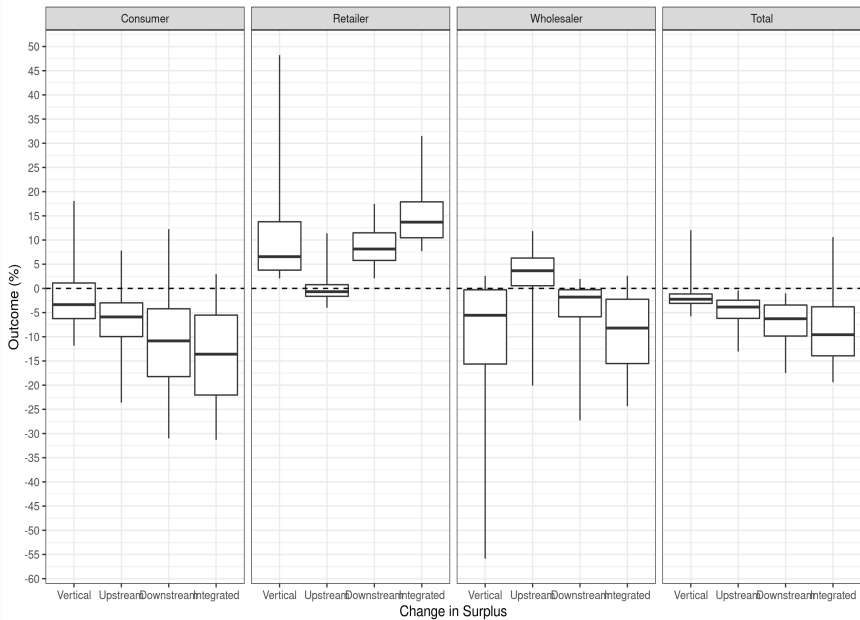
# Numerical Simulations

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## Overview

## The Distributions of Merger Outcomes

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



# Numerical Simulations

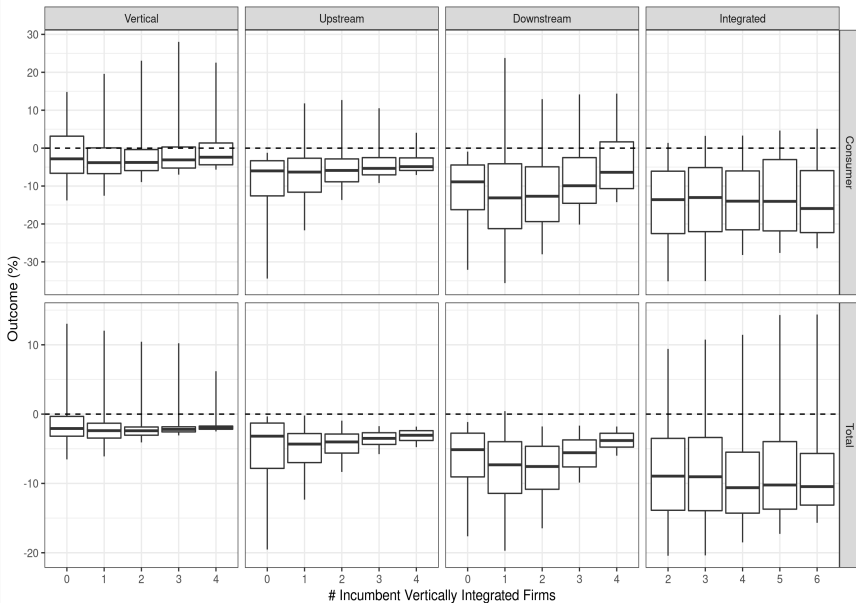
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## Integrated Firms

# The Distributions of Merger Outcomes as the Number of Integrated Firms Increases

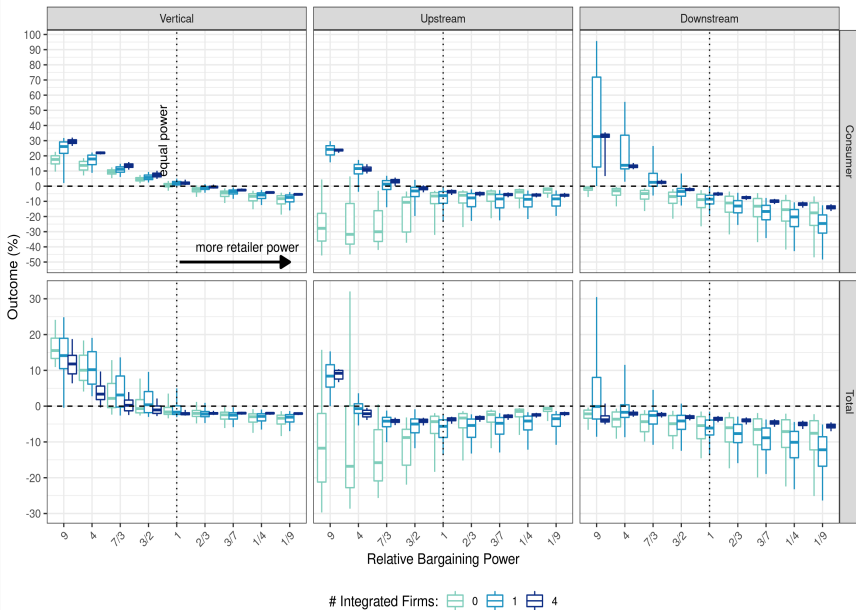
Outcomes are reported as a percentage of pre-merger total expenditures.

Horizontal mergers occur between a vertically integrated and unintegrated firm.



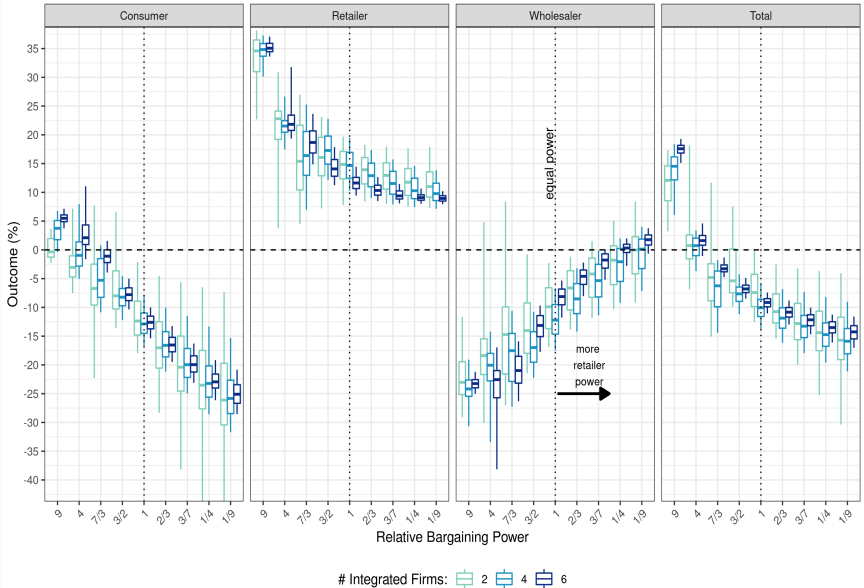
# How Changing Bargaining Strength Affects Consumer and Total Surplus, By Merger

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.





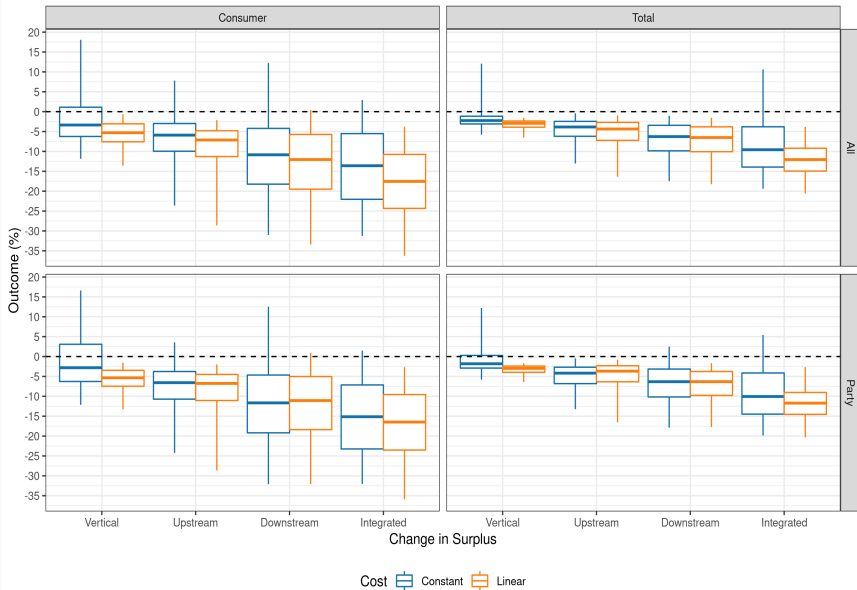
# Numerical Simulations

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## 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.



## Conclusion

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# 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

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

**Simulating mergers in a vertical supply chain with bargaining.**

*The RAND Journal of Economics* 52(3), 596–632.

Werden, G. J. and L. M. Froeb (1994).

**The Effects of Mergers in Differentiated Products Industries: Logit Demand and Merger Policy.**

*Journal of Law, Economics, and Organization* 10(2), 407–426.