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

Margaret Loudermilk[1] Gloria Sheu[2] Charles Taragin[3]

[1]U.S. Department of Justice

[2]Federal Reserve Board of Governors

[3]Federal Reserve Board of Governors

October 2023

Motivation

"Should the guidelines' traditional distinctions between horizontal and vertical mergers be revisited in light of recent economic trends in the modern economy? What aspects of modern market realities may be lost by focusing on these relationships categorically?"
(*Request for Information on Merger Enforcement*, Question 1g, DOJ and FTC, 2022)

- Few producers operate at only one level of a supply chain
  - Mergers frequently combine firms and impact rivals that are already vertically integrated
  - Nevertheless, standard merger analysis often simplifies a case into purely horizontal and vertical categories
- What happens when we incorporate some of these vertical relationships into a typical merger simulation model?

Research Goals

1. Incorporate additional vertical integration into the Sheu and Taragin (2021) merger simulation model
   - Allow some merging parties to already be integrated
   - Allow some rivals to be integrated
   - Calculate welfare effects balancing UPP, EDM, RRC
2. Study welfare effects of four types of mergers
   1. Vertical: merger between unintegrated upstream and unintegrated downstream firms
   2. Upstream: merger between an unintegrated upstream firm and an upstream firm that may already be integrated with a downstream firm
   3. Downstream: merger between an unintegrated downstream firm and a downstream firm that may already be integrated with a upstream firm
   4. Integrated: merger between two vertically integrated firms
3. Apply model to Republic/Santek merger (2021) in solid waste management

Findings

- Vertical effects in "horizontal" mergers (both upstream and downstream) create net consumer benefits only in limited cases
  - Mostly when upstream firms have more bargaining power (when EDM is expected to be larger)
- Mergers between two integrated firms are typically net harmful to consumers
  - Only beneficial when upstream firms have a significant edge in bargaining power
- The presence of integrated rivals does not have a large impact on realized harm
  - Can somewhat shift outcomes towards less harm, but differences not dramatic
- We can model Republic/Santek using limited inputs and generate realistic RRC and EDM effects

Related Literature

- Merger simulation papers: Sheu and Taragin (2021); Werden and Froeb (1994); Werden and Froeb (2008)
- Bargaining in vertical supply chains: Draganska, Klapper, and Villas-Boas (2010); Crawford, Lee, Whinston, and Yurukoglu (2018); Ho and Lee (2019)
- Measuring impacts of vertical mergers: Moresi and Salop (2013); Rogerson (2014); DasVarma and De Stefano (2020); Rogerson (2020); Domnenko and Sibley (2022)

Outline

1. **Theory**
2. Numerical Simulations
3. Republic/Santek Application
4. Conclusion

Model Overview

- Each wholesaler w in the set $\mathbb{W}$ offers a single product to retailers r in the set $\mathbb{R}$, who in turn sell to consumers
  1. Upstream: Nash bargaining between wholesalers and retailers
  2. Downstream: Bertrand differentiated products logit competition between retailers
- All prices (upstream and downstream) assumed to be determined simultaneously
- Calibration follows Sheu and Taragin (2021)

Downstream Bertrand Logit

- Assume firms set prices in Bertrand Nash equilibrium
- Market share of wholesaler w's product purchased through retailer r

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

- Profit function for retailer r with wholesale fee p^W_{rw} and other costs c^R_{rw}

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

- First order conditions for downstream equilibrium prices

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

Upstream Nash Bargaining

- Assume a linear wholesale price set by Nash Bargaining with λ bargaining power parameter

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

- Profit function for wholesaler w with marginal cost c^W_{rw}

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

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

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

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

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

Bargaining Equilibrium

- Given assumption of simultaneous pricing upstream and downstream, first order conditions have the form

$$\overbrace{[p_{rw}^W - c_{rw}^W]s_{rw} - \sum_{t \in \mathbb{R}^w \setminus \{r\}} [p_{tw}^W - c_{tw}^W]\Delta s_{tw}(\mathbb{W}^r \setminus \{w\})}^{\text{wholesaler GFT}} =$$

$$\frac{1-\lambda}{\lambda}\left(\underbrace{[p_{rw} - p_{rw}^W - c_{rw}^R]s_{rw} - \sum_{x \in \mathbb{W}^r \setminus \{w\}} [p_{rx} - p_{rx}^W - c_{rx}^R]\Delta s_{rx}(\mathbb{W}^r \setminus \{w\})}_{\text{retailer GFT}}\right)$$

- A larger disagreement payoff increases bargaining leverage

Integrated Firm Pricing: Retail

Assume that retailer r merges with wholesaler w. Then r's price downstream for product w is determined by

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

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

Integrated Firm Pricing: Wholesale Price to Rival Retailer

When wholesaler w bargains with unaffiliated retailer s, the wholesale price is determined by

$$[p^W_{sw} - c^W_{sw}]s_{sw} - \sum_{t \in \mathbb{R}^w \setminus \{r,s\}} [p^W_{tw} - c^W_{tw}]\Delta s_{tw}(\mathbb{W}^s \setminus \{w\})$$

$$\overbrace{\phantom{[p_{rw} - c^W_{rw} - c^R_{rw}]\Delta s_{rw}(\mathbb{W}^s \setminus \{w\}) - \sum_{x \in \mathbb{W}^r \setminus \{w\}} [p_{rx} - p^W_{rx} - c^R_{rx}]\Delta s_{rx}(\mathbb{W}^s \setminus \{w\})}}^{\text{RRC effect}}$$

$$\overbrace{[p_{rw} - c^W_{rw} - c^R_{rw}]\Delta s_{rw}(\mathbb{W}^s \setminus \{w\})}^{\text{indirect EDM effect}} - \sum_{x \in \mathbb{W}^r \setminus \{w\}} [p_{rx} - p^W_{rx} - c^R_{rx}]\Delta s_{rx}(\mathbb{W}^s \setminus \{w\}) =$$

$$\frac{1-\lambda}{\lambda}\left([p_{sw} - p^W_{sw} - c^R_{sw}]s_{sw} - \sum_{x \in \mathbb{W}^s \setminus \{w\}} [p_{sx} - p^W_{sx} - c^R_{sx}]\Delta s_{sx}(\mathbb{W}^s \setminus \{w\})\right)$$

Integrated Firm Pricing: Wholesale Price from Rival Wholesaler

When retailer r bargains with unaffiliated wholesaler v, the wholesale price is determined by

$$[p_{rv}^W - c_{rv}^W]s_{rv} - \sum_{t \in \mathbb{R}^v \setminus \{r\}} [p_{tv}^W - c_{tv}^W]\Delta s_{tv}(\mathbb{W}^r \setminus \{v\}) =$$

$$\frac{1-\lambda}{\lambda}\left([p_{rv} - p_{rv}^W - c_{rv}^R]s_{rv} - \sum_{x \in \mathbb{W}^r \setminus \{w,v\}} [p_{rx} - p_{rx}^W - c_{rx}^R]\Delta s_{rx}(\mathbb{W}^r \setminus \{v\})\right.$$

$$\left. - \underbrace{[p_{rw} - c_{rw}^W - c_{rw}^R]\Delta s_{rw}(\mathbb{W}^r \setminus \{v\})}_{\text{EDM recapture effect}} - \underbrace{\sum_{t \in \mathbb{R}^w \setminus \{r\}} [p_{tw}^W - c_{tw}^W]\Delta s_{tw}(\mathbb{W}^r \setminus \{v\})}_{\text{wholesale recapture leverage effect}}\right)$$

Outline

1. Theory
2. **Numerical Simulations**
3. Republic/Santek Application
4. Conclusion

Data Generating Process

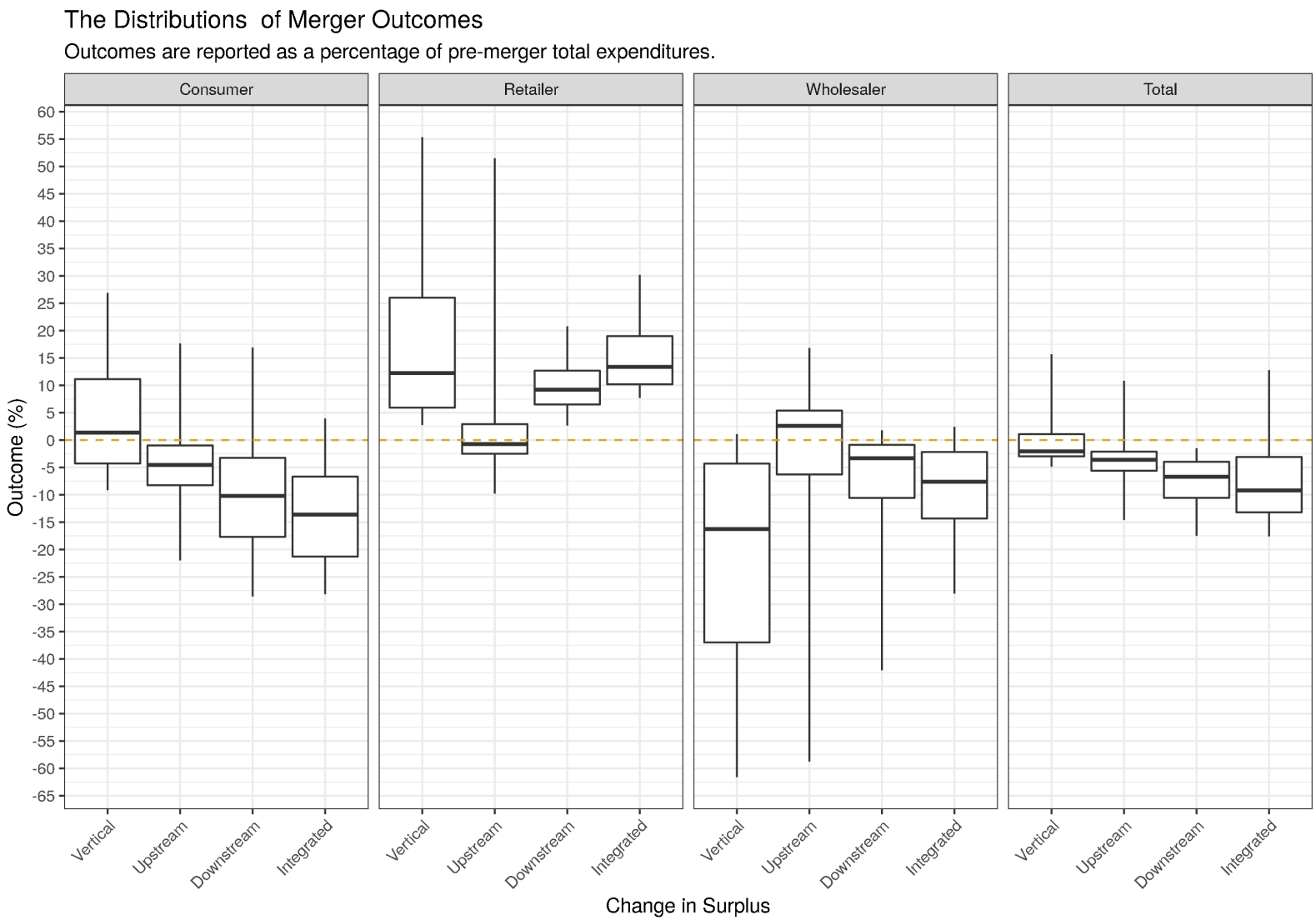
- Simulate markets with 2, 3, 4, or 5 wholesalers/retailers
- Have 0 to 4 non-siloed integrated incumbents pre-merger
  - 2 to 6 for integrated mergers
- Bargaining power parameter ranges from 0.1 to 0.9 in 0.1 increments
- Eliminate some instances
  - Unprofitable mergers
  - Downstream markets that do not pass the Hypothetical Monopolist Test
- Results in approximately 1.6 million markets

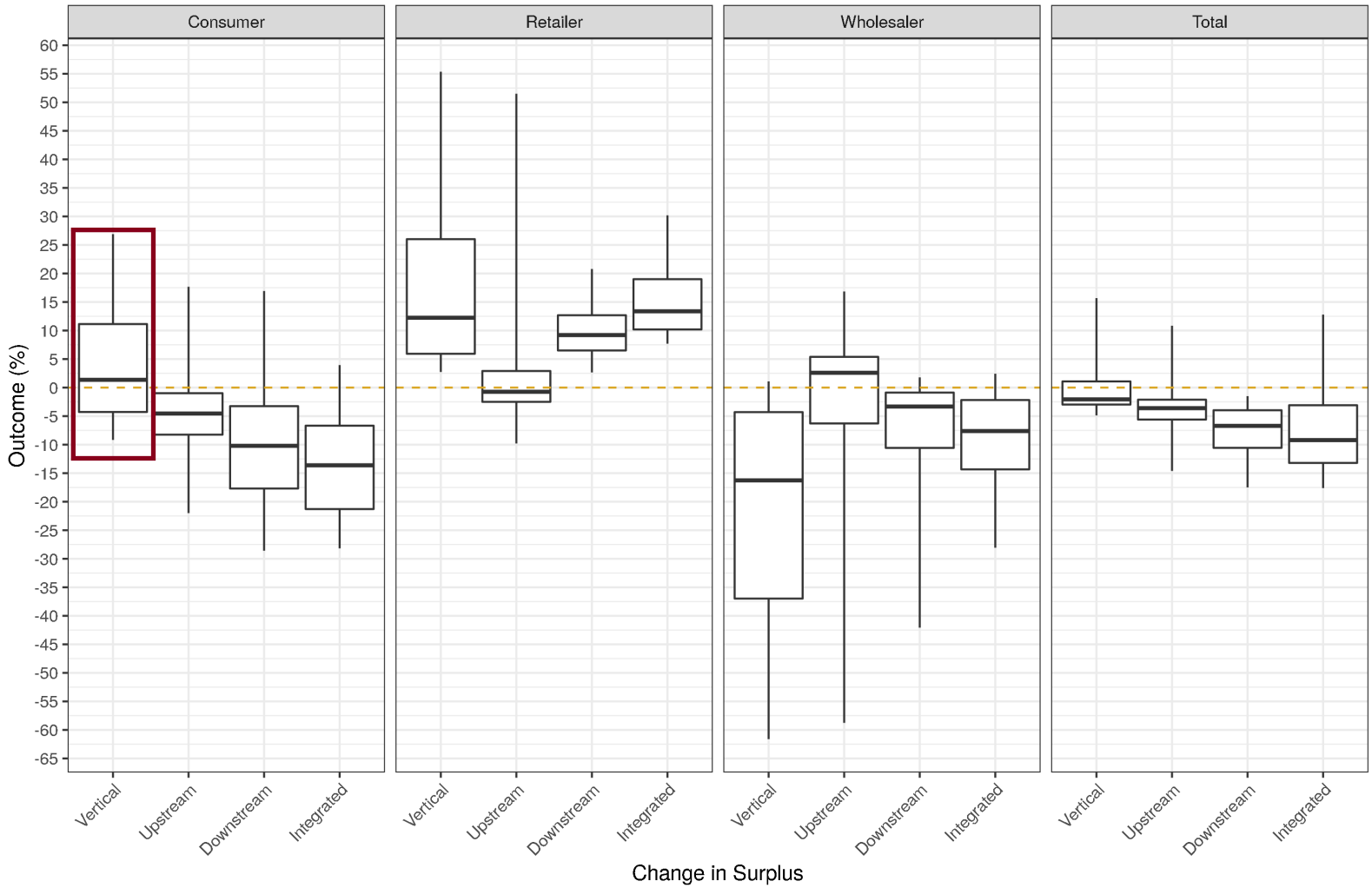
Include Four Types of Mergers

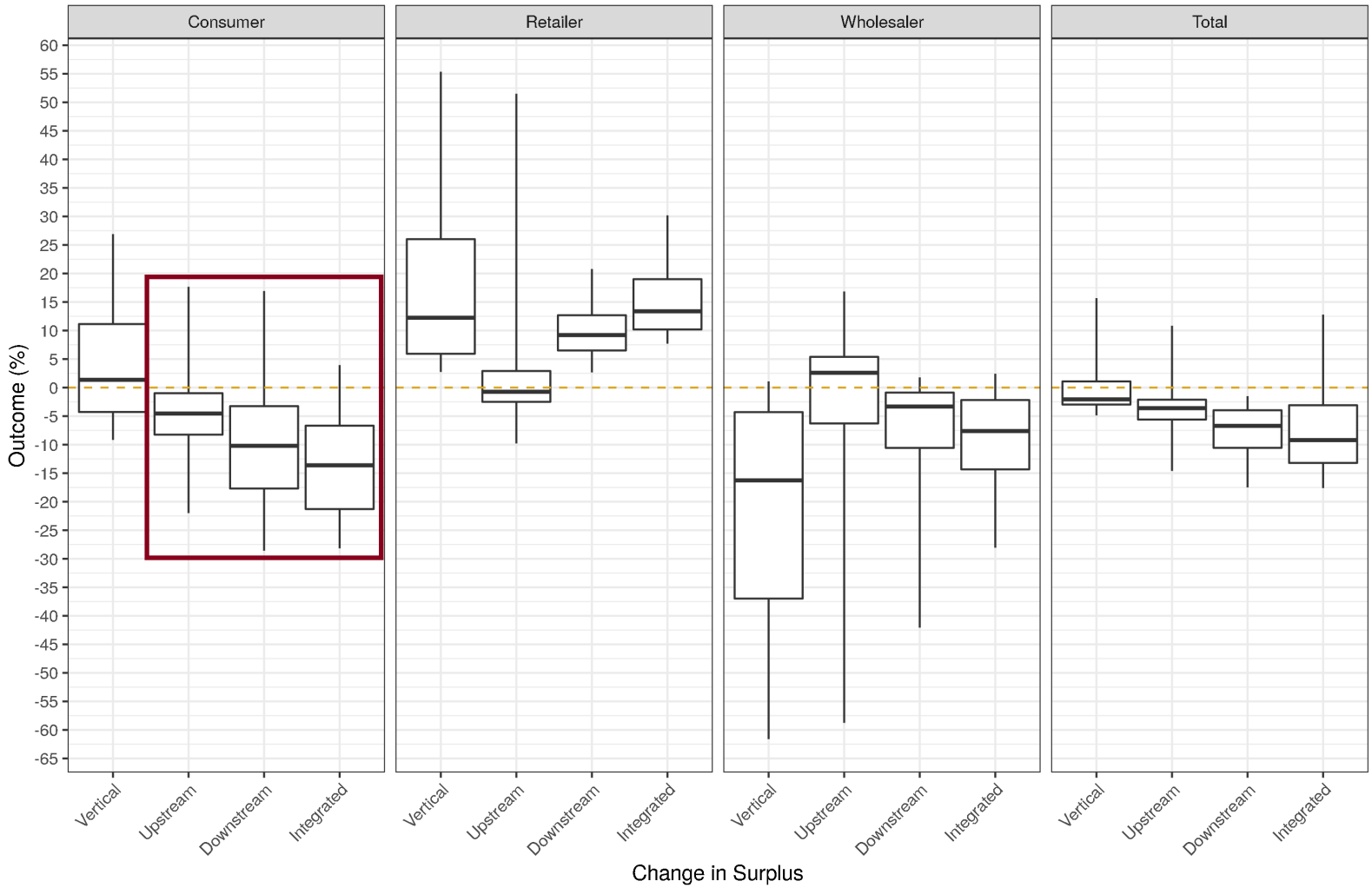
1. Vertical: merger between unintegrated upstream and unintegrated downstream firms
2. Upstream: merger between an unintegrated upstream firm and an upstream firm that may already be integrated with a downstream firm
3. Downstream: merger between an unintegrated downstream firm and a downstream firm that may already be integrated with a upstream firm
4. Integrated: merger between two vertically integrated firms

Summary Statistics

Variable	Merger	Markets	Min	25th	50th	75th	Max
# Wholesalers	All	1,560,433	2	3	4	5	7
# Retailers			2	3	4	5	7
# Integrated			0	1	1	3	6
Bargaining Power			0.1	0.3	0.6	0.8	0.9
Avg. Upstream Price ($)			0.59	2.6	5.8	14	305
Avg. Downstream Price ($)			6.4	11	15	24	314
Market Elasticity			-11	-0.85	-0.54	-0.39	-0.23
Pre-Merger HHI	Vertical	411,311	2,134	3,646	4,375	5,552	9,961
	Upstream	371,612	2,011	2,407	2,877	3,751	9,528
	Downstream	398,747	2,011	2,568	3,130	4,135	9,744
	Integrated	378,763	2,104	3,495	4,061	4,939	9,870
Post-Merger HHI	Vertical	411,311	3,112	5,122	6,047	7,249	10,000
	Upstream	371,612	2,936	4,031	4,963	6,712	10,000
	Downstream	398,747	2,945	4,130	5,150	7,247	10,000
	Integrated	378,763	3,283	6,091	6,998	8,207	10,000
Delta HHI	Vertical	411,311	27	1,067	1,329	1,811	4,384
	Upstream	371,612	472	1,574	2,068	2,933	5,000
	Downstream	398,747	89	1,480	2,127	3,086	5,000
	Integrated	378,763	130	2,472	2,803	3,183	4,944

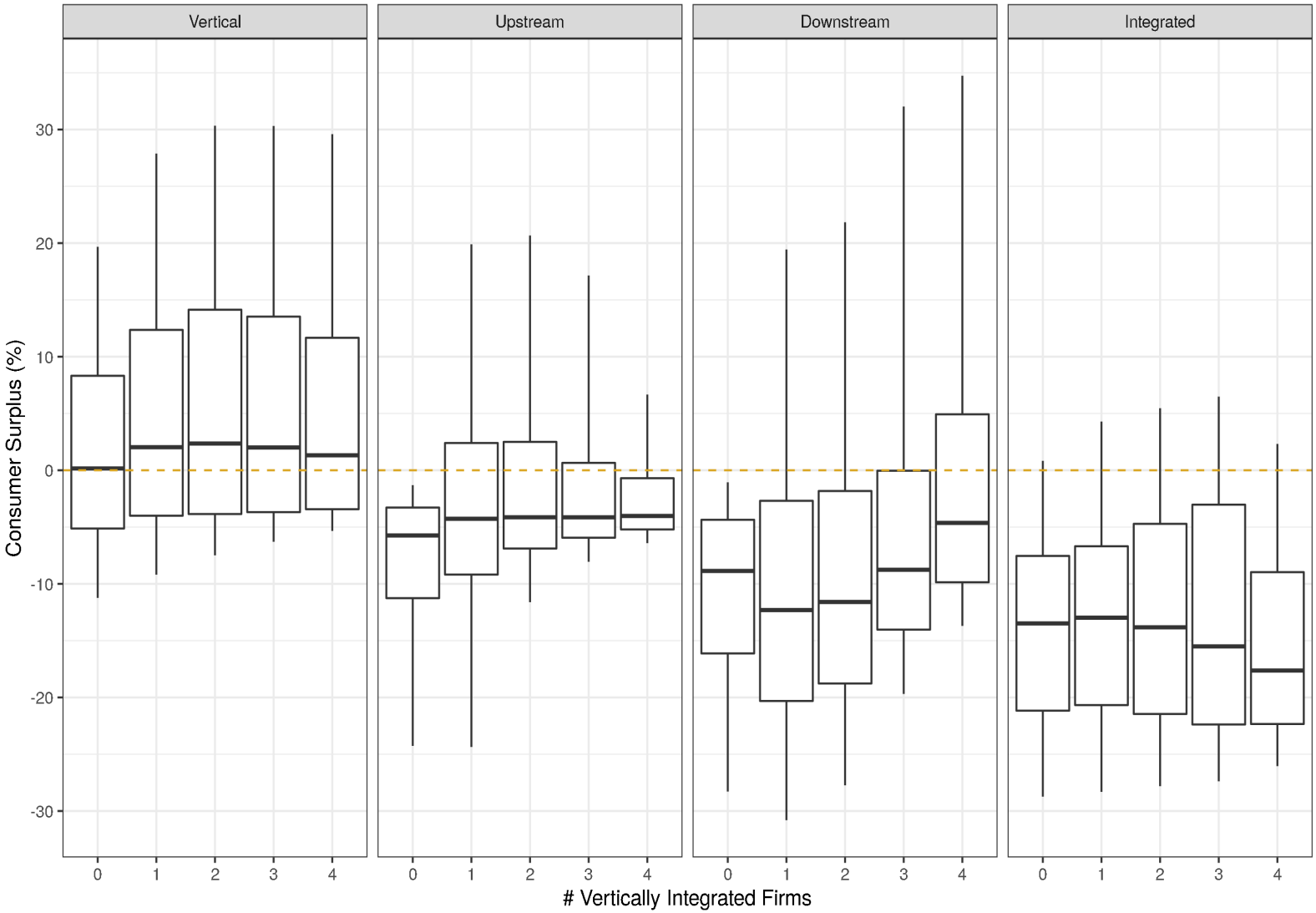

The Distributions of Merger Outcomes
Outcomes are reported as a percentage of pre-merger total expenditures.
Consumer
Retailer
Wholesaler
Total
Outcome (%)
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
Vertical
Upstream
Downstream
Integrated
Change in Surplus

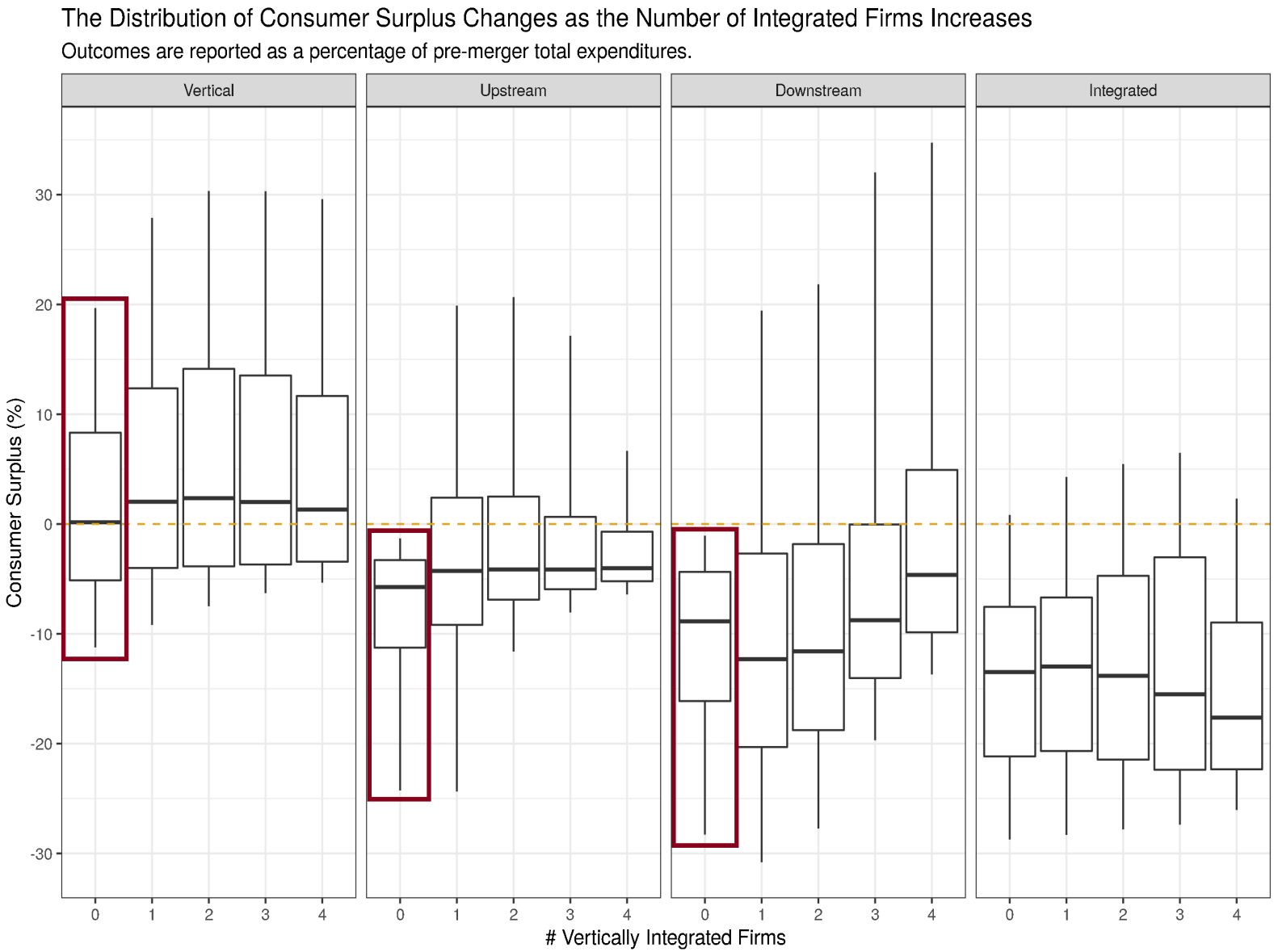

The Distributions of Merger Outcomes
Outcomes are reported as a percentage of pre-merger total expenditures.
Consumer
Retailer
Wholesaler
Total
Outcome (%)
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
Vertical
Upstream
Downstream
Integrated
Change in Surplus


The Distributions of Merger Outcomes
Outcomes are reported as a percentage of pre-merger total expenditures.
Consumer
Retailer
Wholesaler
Total
Outcome (%)
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
Vertical
Upstream
Downstream
Integrated
Change in Surplus

The Distribution of Consumer Surplus Changes as the Number of Integrated Firms Increases

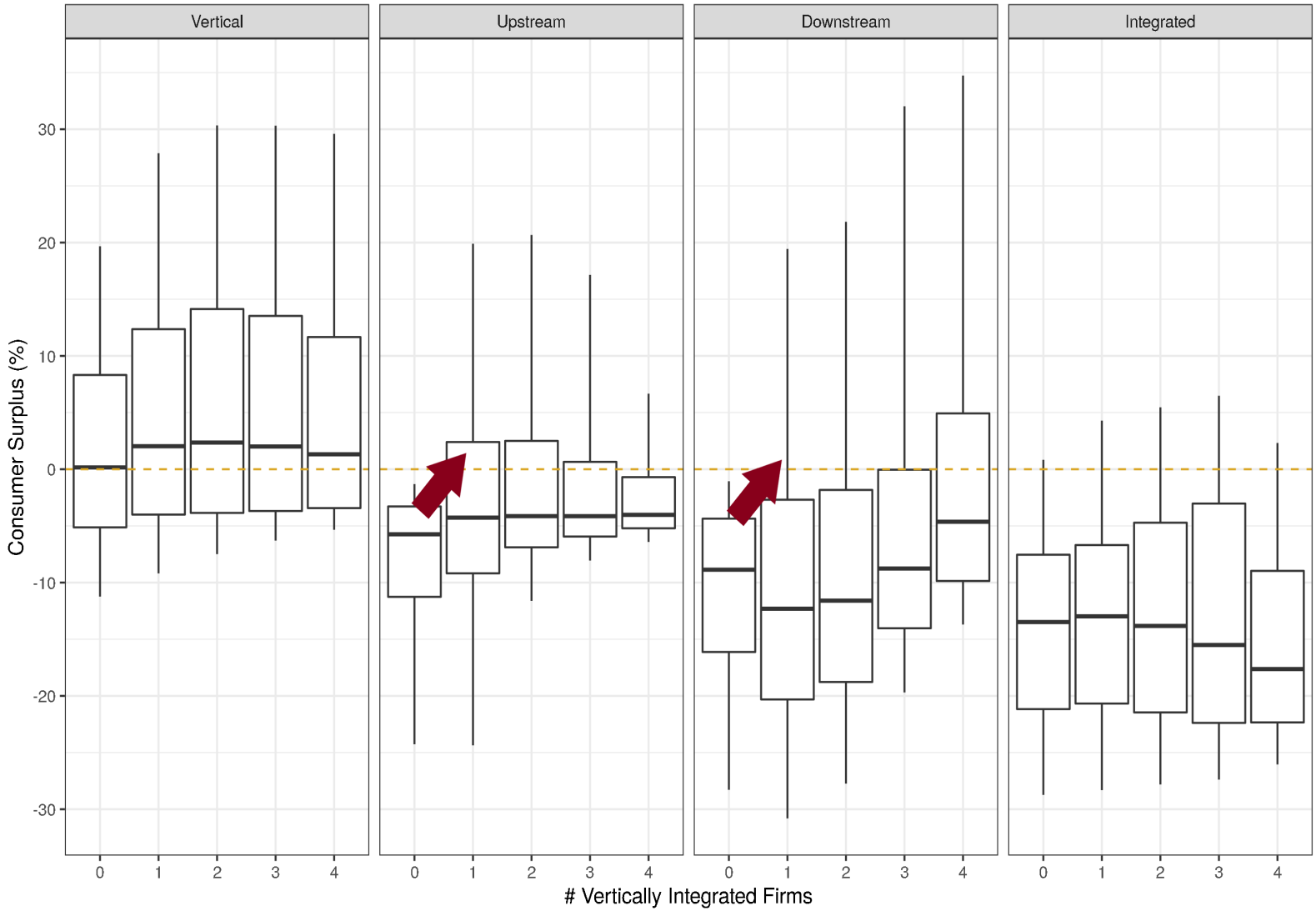
Outcomes are reported as a percentage of pre-merger total expenditures.




The Distribution of Consumer Surplus Changes as the Number of Integrated Firms Increases
Outcomes are reported as a percentage of pre-merger total expenditures.
Vertical
Upstream
Downstream
Integrated
Consumer Surplus (%)
30
20
10
0
-10
-20
-30
0
1
2
3
4
Vertically Integrated Firms

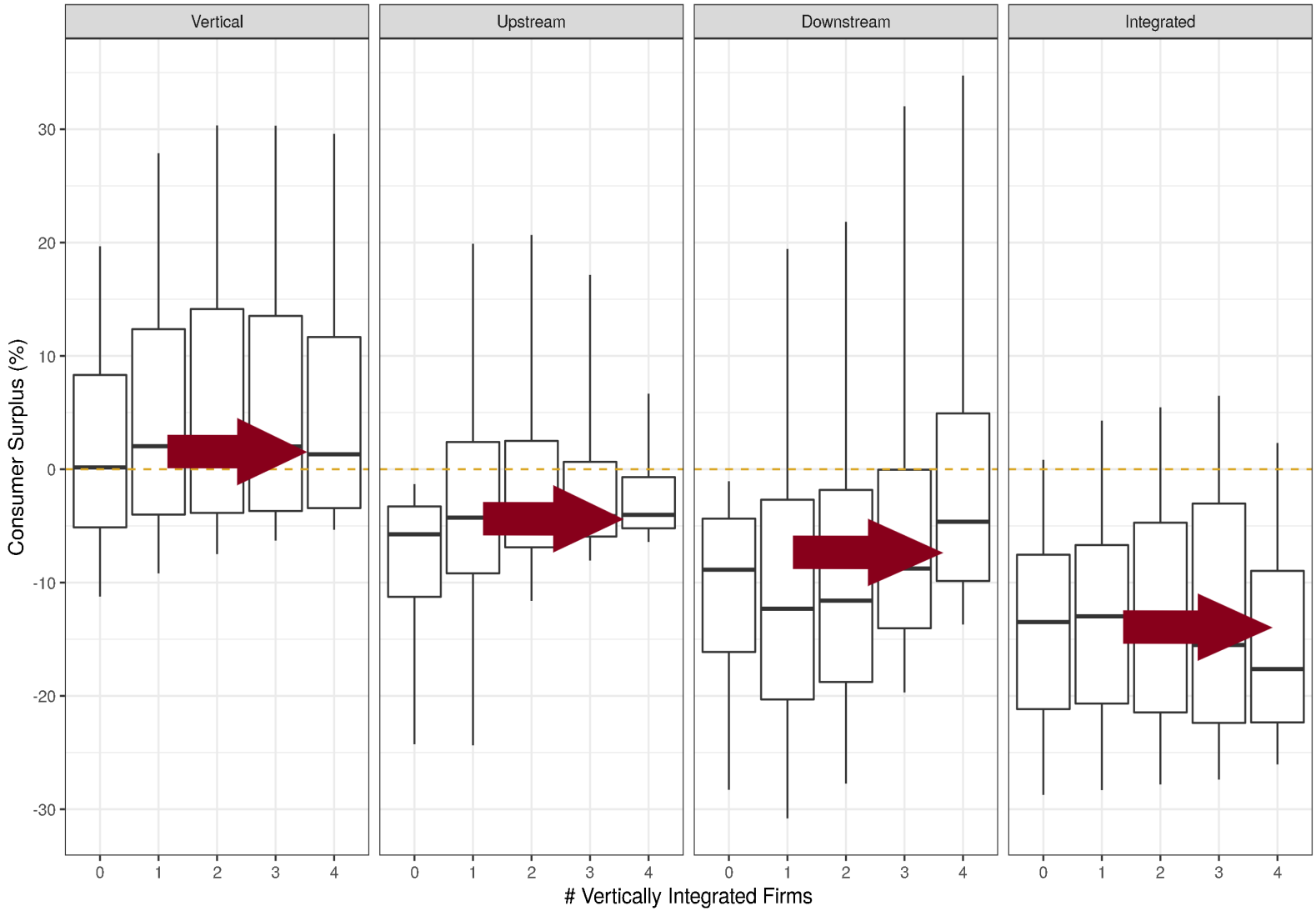
The Distribution of Consumer Surplus Changes as the Number of Integrated Firms Increases

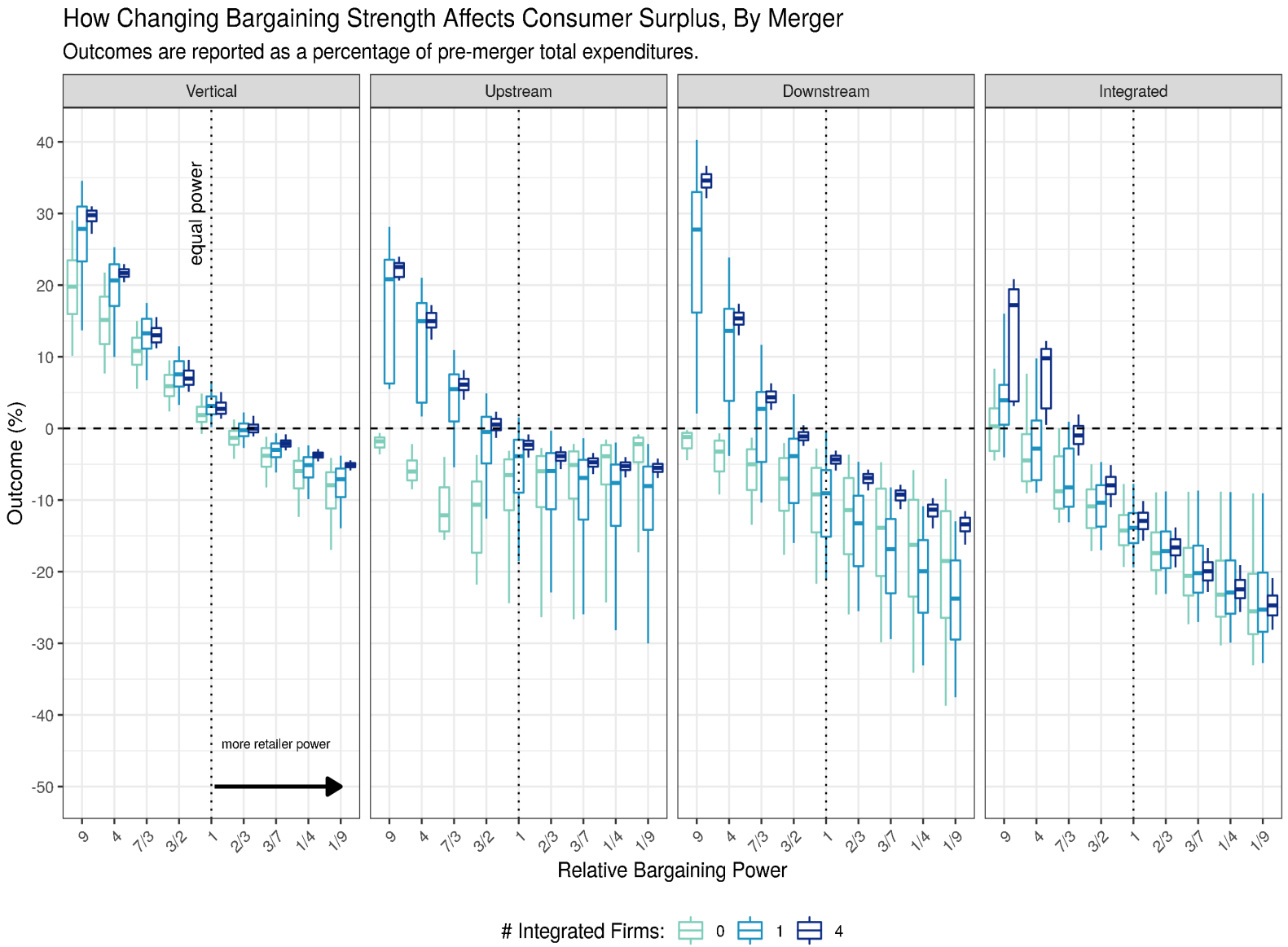
Outcomes are reported as a percentage of pre-merger total expenditures.

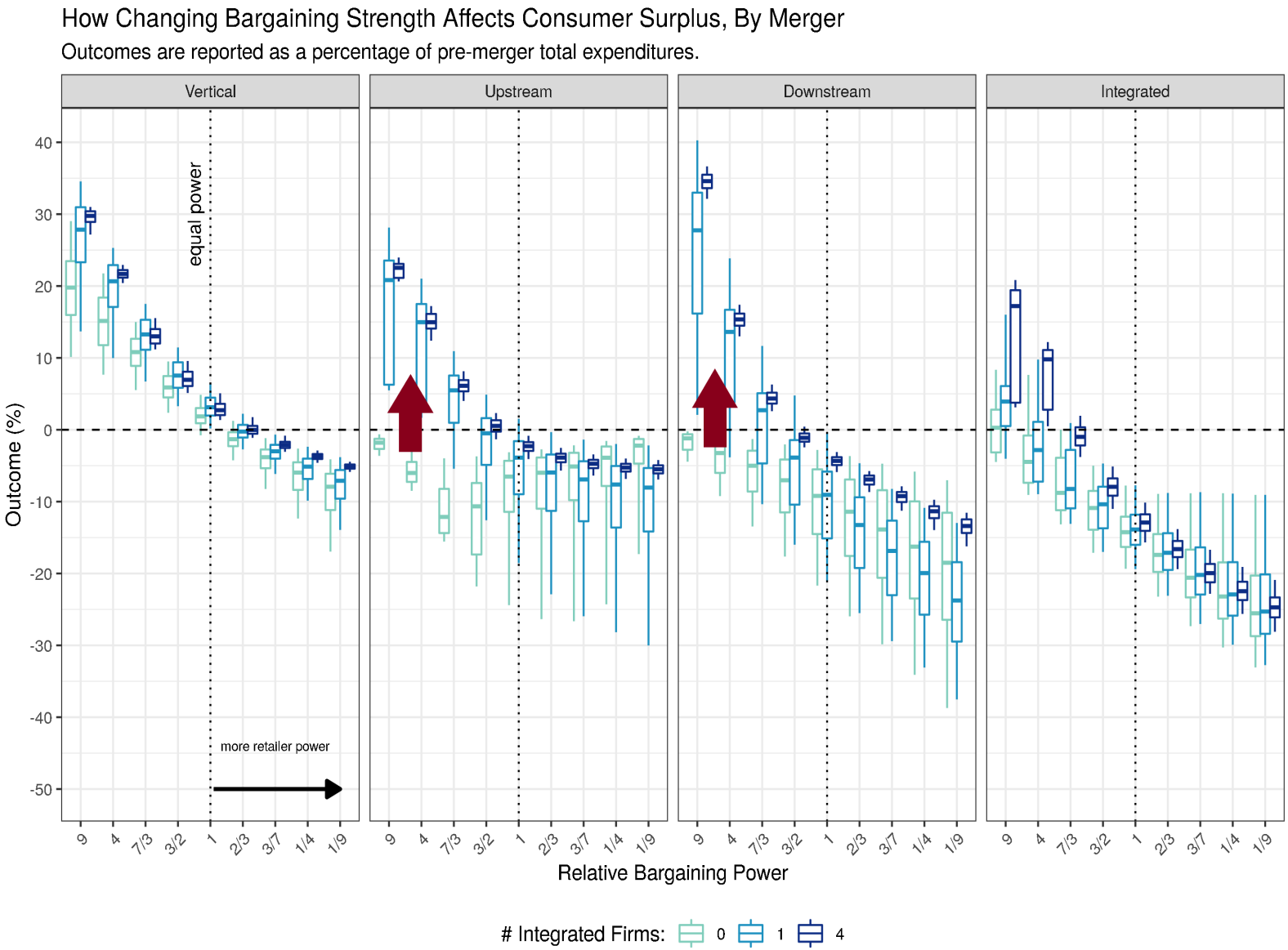


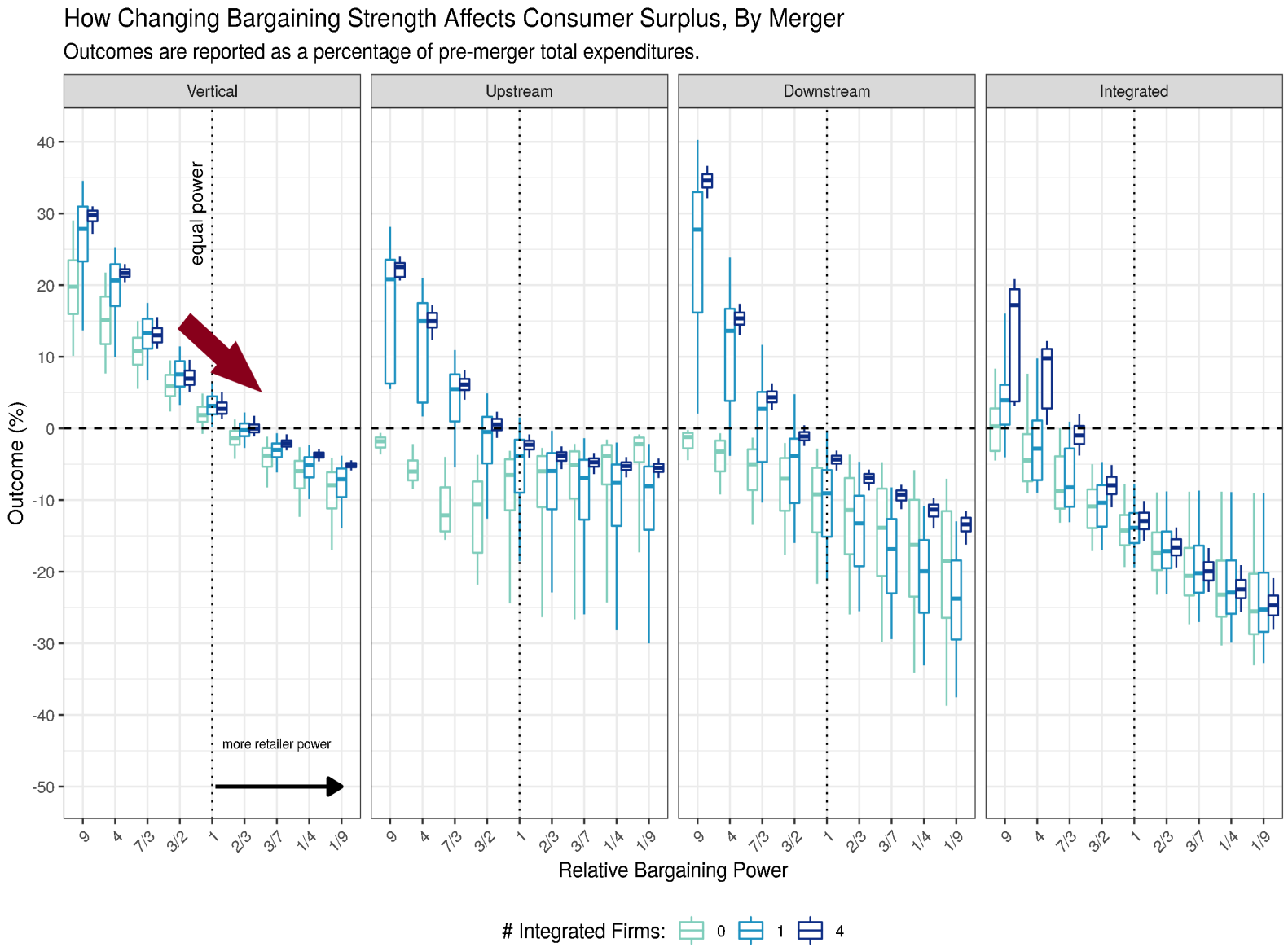
The Distribution of Consumer Surplus Changes as the Number of Integrated Firms Increases

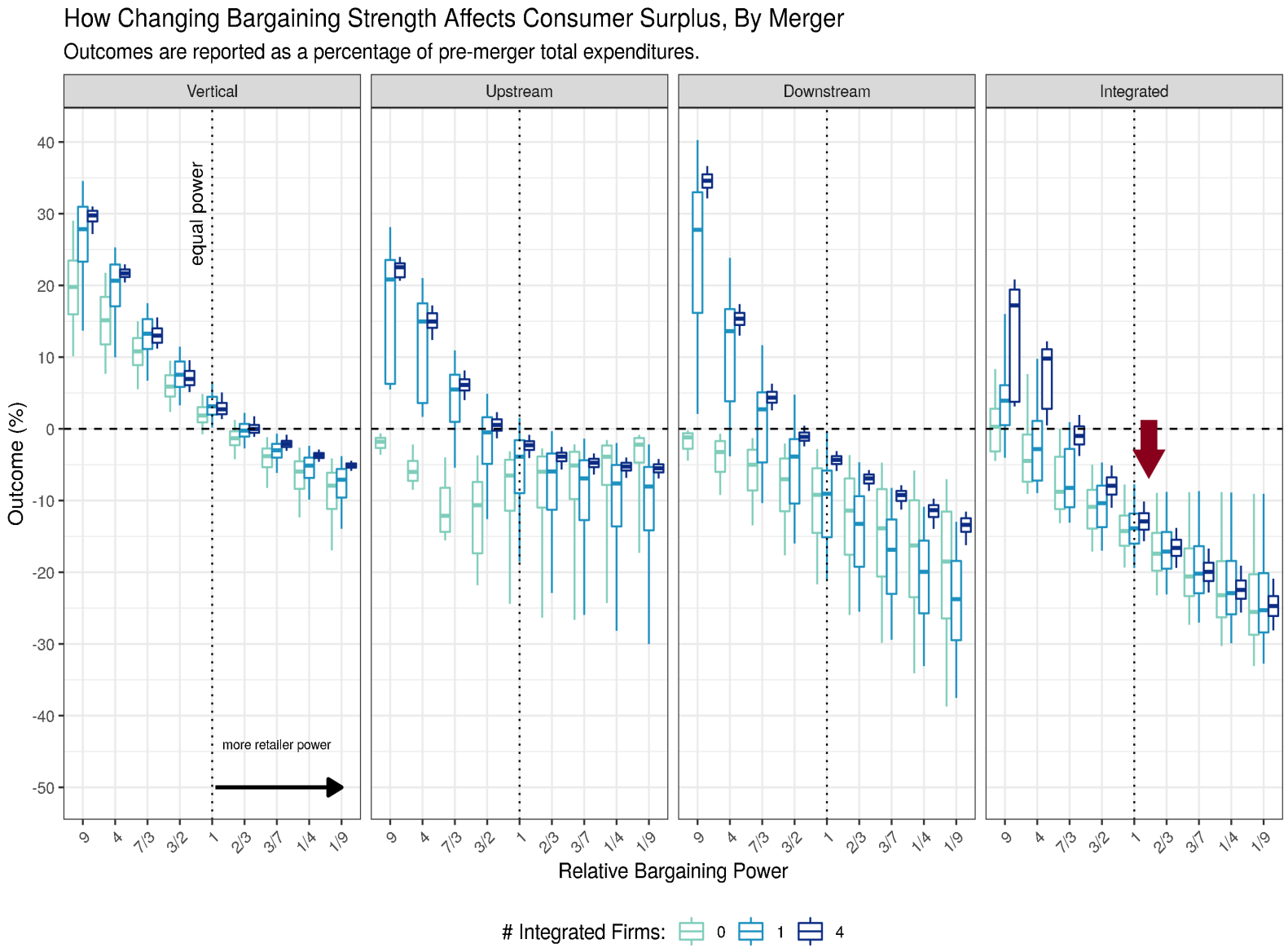
Outcomes are reported as a percentage of pre-merger total expenditures.

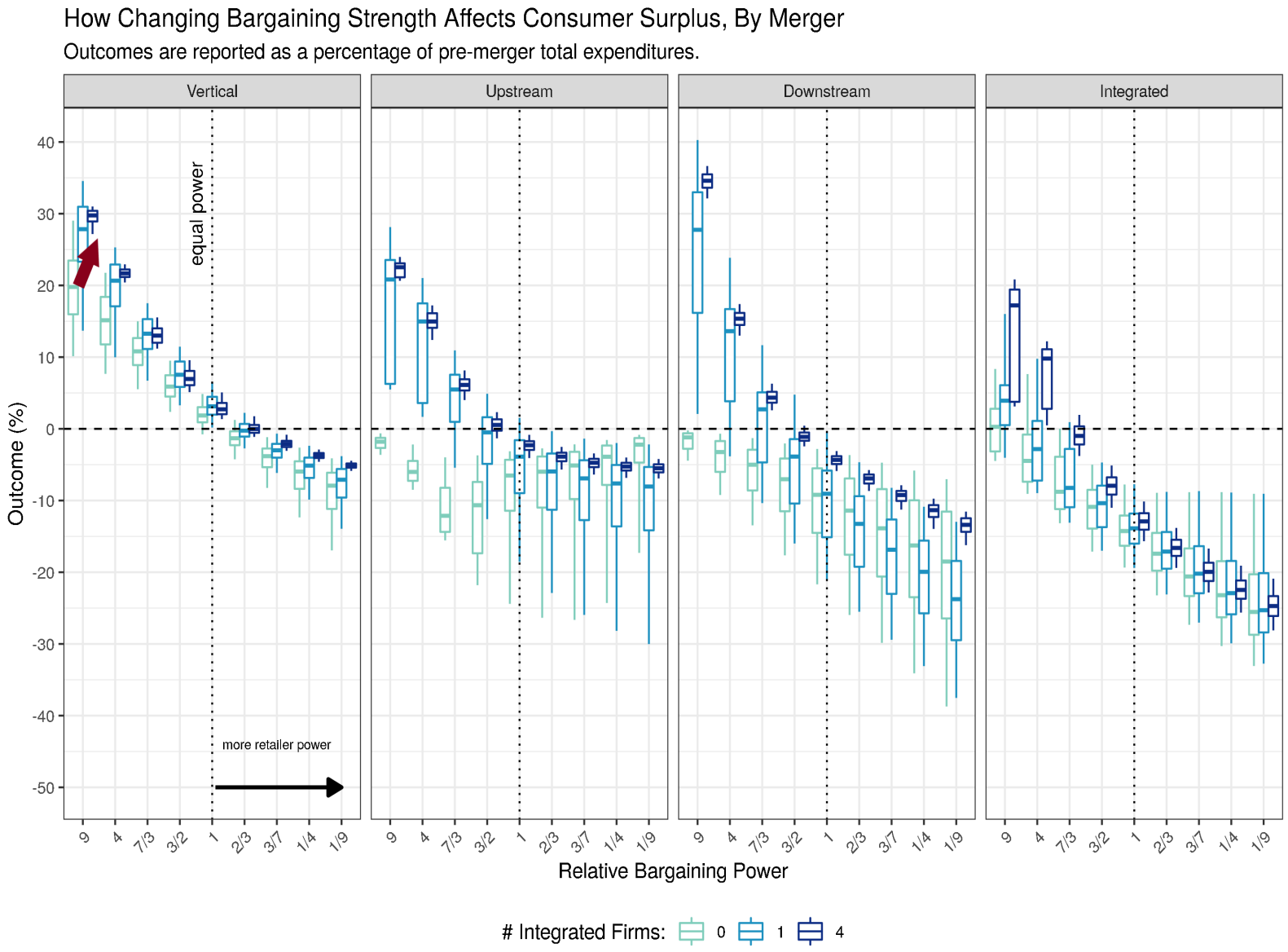



How Changing Bargaining Strength Affects Consumer Surplus, By Merger
Outcomes are reported as a percentage of pre-merger total expenditures.
Vertical
Upstream
Downstream
Integrated
equal power
more retailer power
Outcome (%)
40
30
20
10
0
-10
-20
-30
-40
-50
9
4
7/3
3/2
1
2/3
3/7
1/4
1/9
Relative Bargaining Power
Integrated Firms:
0
1
4


How Changing Bargaining Strength Affects Consumer Surplus, By Merger
Outcomes are reported as a percentage of pre-merger total expenditures.
Vertical
Upstream
Downstream
Integrated
equal power
more retailer power
Outcome (%)
40
30
20
10
0
-10
-20
-30
-40
-50
9
4
7/3
3/2
1
2/3
3/7
1/4
1/9
Relative Bargaining Power
Integrated Firms:
0
1
4


How Changing Bargaining Strength Affects Consumer Surplus, By Merger
Outcomes are reported as a percentage of pre-merger total expenditures.
Vertical
Upstream
Downstream
Integrated
Outcome (%)
40
30
20
10
0
-10
-20
-30
-40
-50
equal power
more retailer power
9
4
7/3
3/2
1
2/3
3/7
1/4
1/9
Relative Bargaining Power
Integrated Firms:
0
1
4


How Changing Bargaining Strength Affects Consumer Surplus, By Merger
Outcomes are reported as a percentage of pre-merger total expenditures.
Vertical
Upstream
Downstream
Integrated
equal power
more retailer power
Outcome (%)
40
30
20
10
0
-10
-20
-30
-40
-50
9
4
7/3
3/2
1
2/3
3/7
1/4
1/9
Relative Bargaining Power
Integrated Firms:
0
1
4


How Changing Bargaining Strength Affects Consumer Surplus, By Merger
Outcomes are reported as a percentage of pre-merger total expenditures.
Vertical
Upstream
Downstream
Integrated
equal power
more retailer power
Outcome (%)
40
30
20
10
0
-10
-20
-30
-40
-50
9
4
7/3
3/2
1
2/3
3/7
1/4
1/9
Relative Bargaining Power
Integrated Firms:
0
1
4

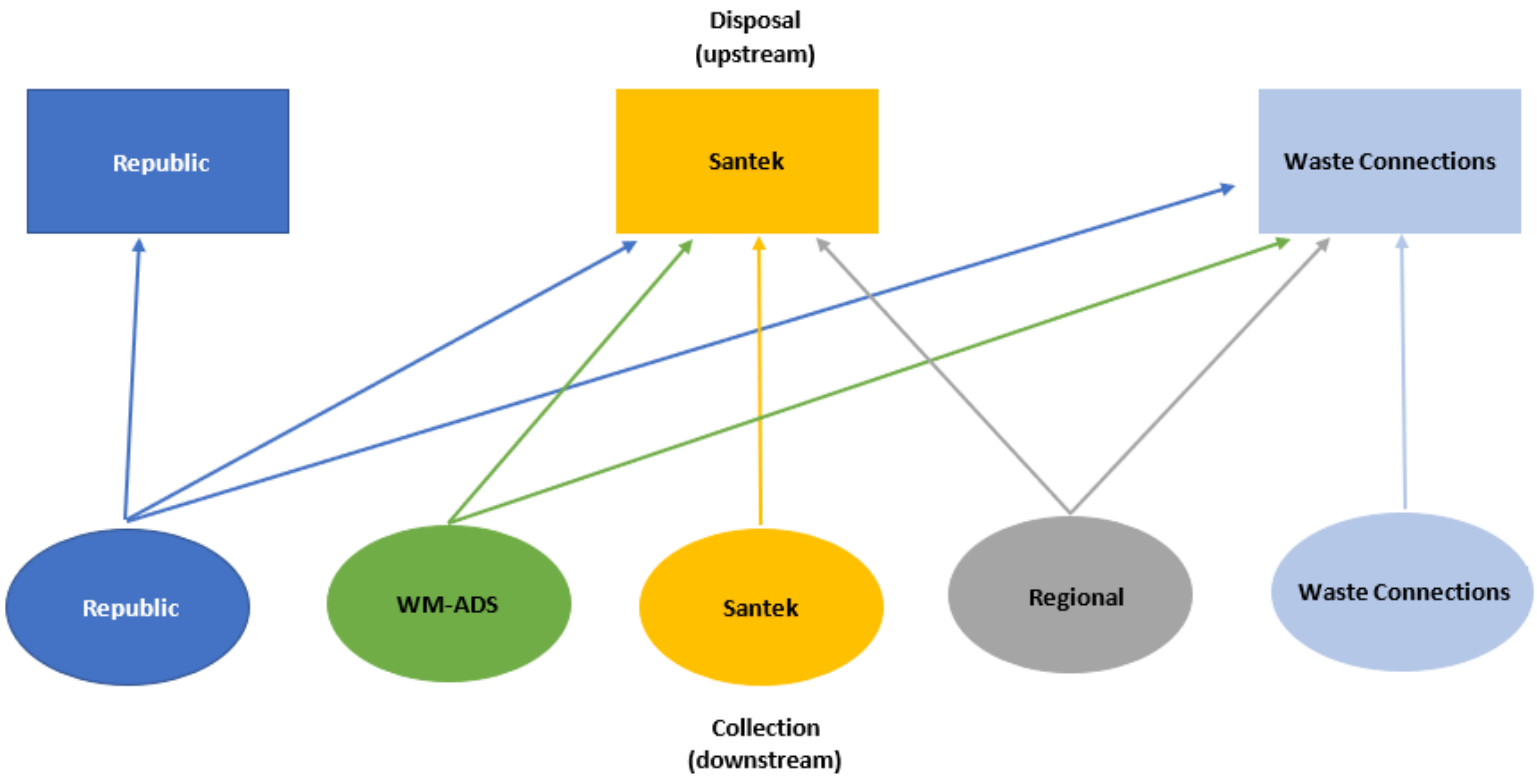
Outline

1. Theory
2. Numerical Simulations
3. **Republic/Santek Application**
4. Conclusion

Merger Background

- Republic Services bought Santek Environmental in 2021
  - Both operated in waste collection (downstream) and waste disposal (upstream)
- Many major competitors also vertically integrated
- DOJ negotiated a settlement in both collection and disposal for the Chattanooga Area market
  - Parties had 73 percent combined share in collection, 82 percent in disposal
  - Waste Connections only other disposal competitor, also competed in collection along with Waste Management-ADS and a regional company

Market Diagram



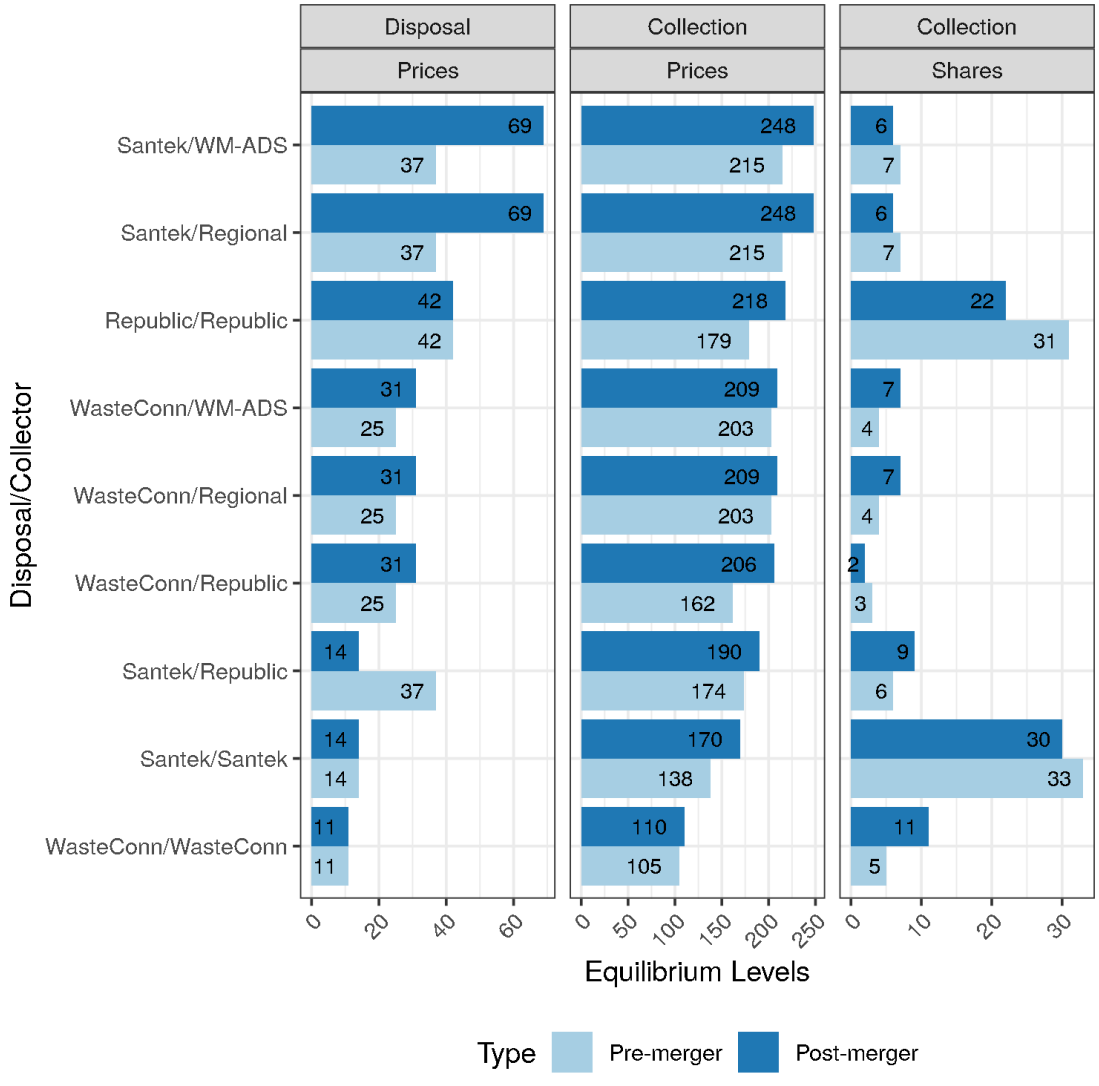
Data Inputs

Disposal Firm	Collection Firm	Volume	Disposal Price	Disposal Margin	Collection Margin	Collection Price
Republic	Republic	165	42	0	44	179
Santek	Republic	34	36	20		173
	Santek	218	16	0		134
	WM-ADS	30	36	20		221
	Regional	30	36	20		221
WasteConn	Republic	19	25	14		162
	WasteConn	48	11	0		110
	WM-ADS	17	25	14		210
	Regional	17	25	14		210

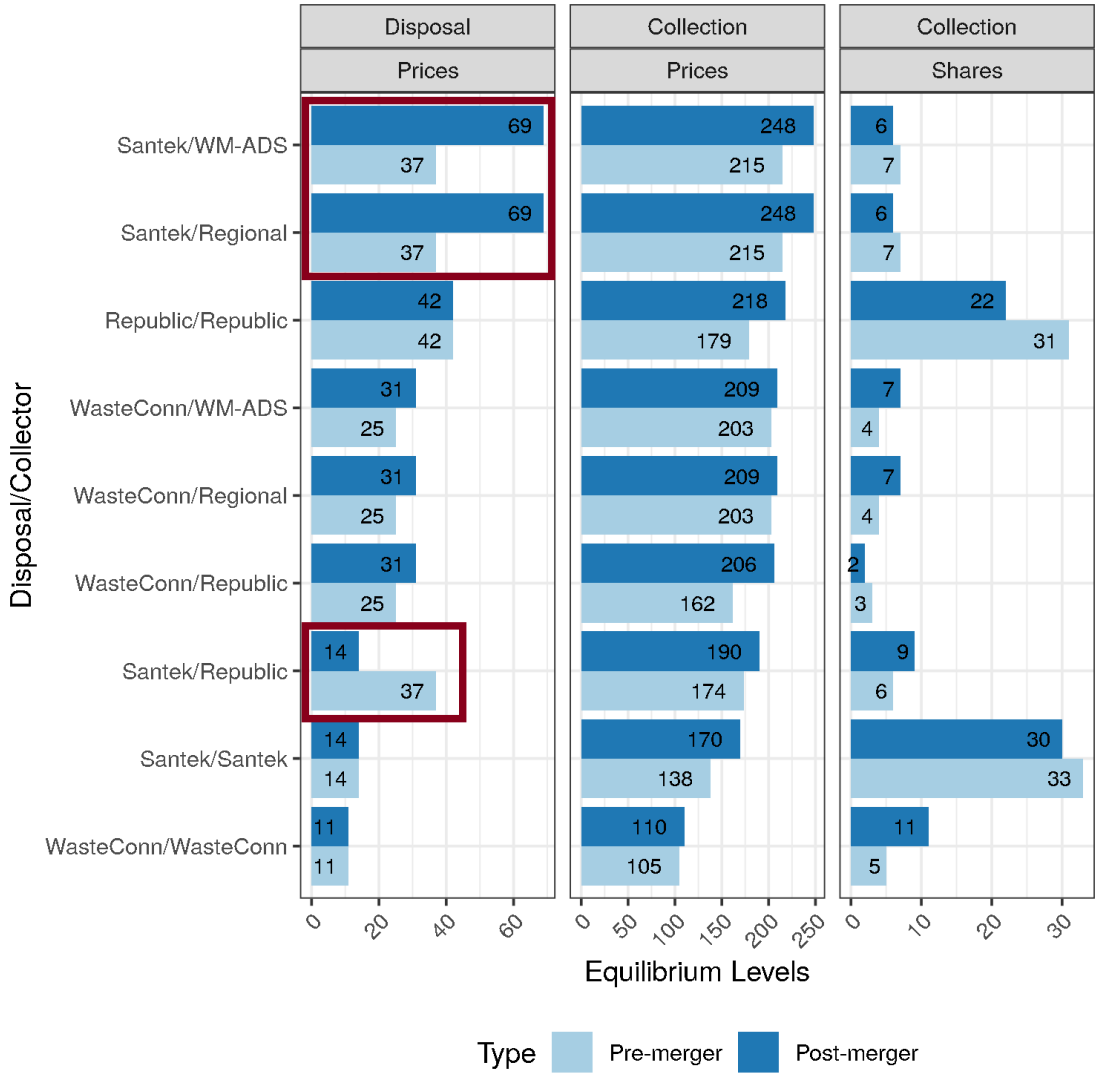
Notes: "WasteConn" stands for Waste Connections. Volume is reported in thousands of tons, whereas prices and margins are reported in dollars per ton.

- Data Sources
  - Volumes/market shares from DOJ Competitive Impact Statement and Tennessee Department of Environmental Quality reports
  - Prices from Waste Business Journal
  - Costs from firm financial statements
- Rely on public sources that may differ from information DOJ had access to

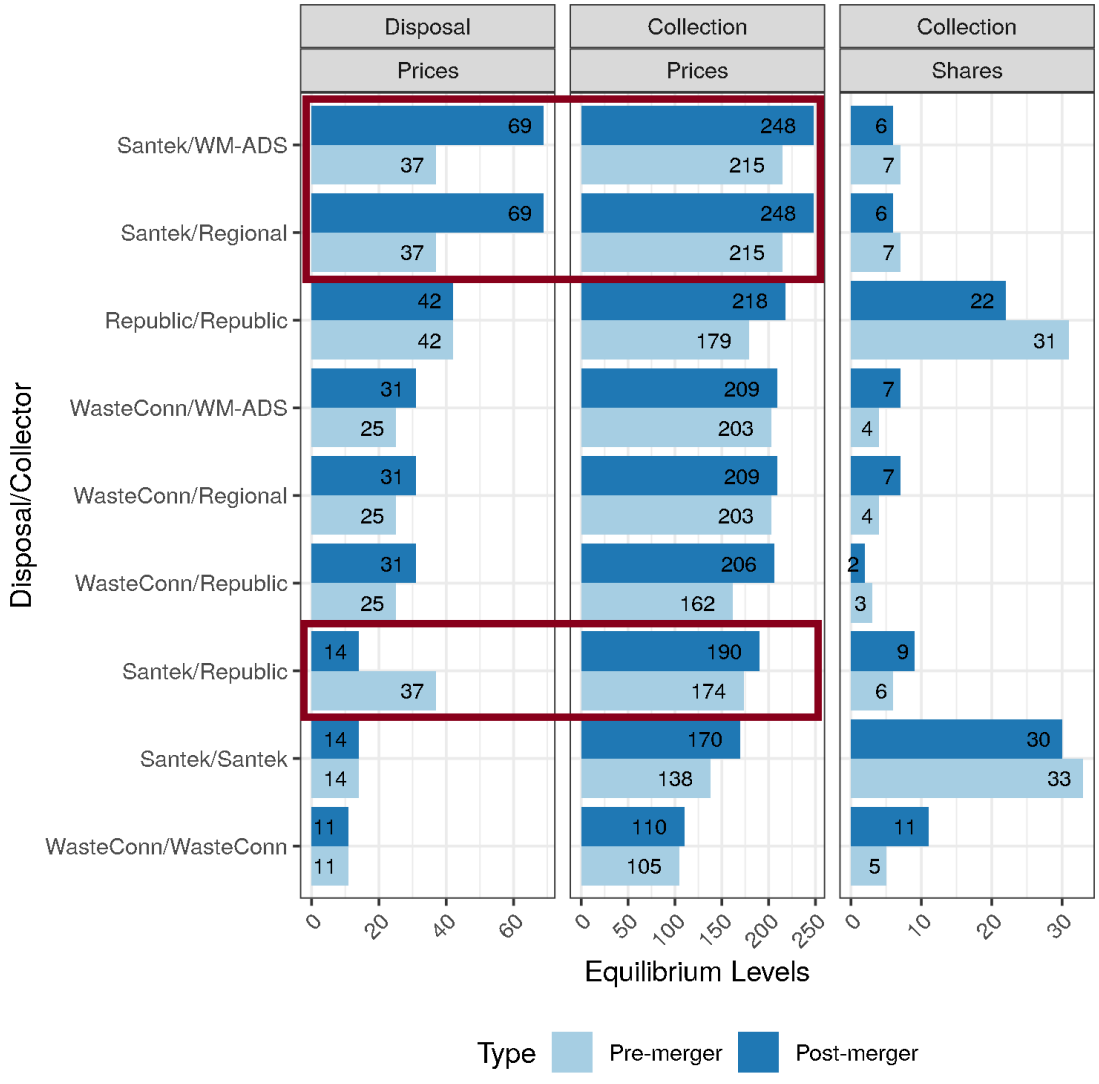
Results


Disposal
Prices
Collection
Prices
Collection
Shares
Disposal/Collector
Santek/WM-ADS
Santek/Regional
Republic/Republic
WasteConn/WM-ADS
WasteConn/Regional
WasteConn/Republic
Santek/Republic
Santek/Santek
WasteConn/WasteConn
69
37
69
37
42
42
31
25
31
25
31
25
14
37
14
14
11
11
248
215
248
215
218
179
209
203
209
203
206
162
190
174
170
138
110
105
6
7
6
7
22
31
7
4
7
4
2
3
9
6
30
33
11
5
0
20
40
60
0
50
100
150
200
250
0
10
20
30
Equilibrium Levels
Type
Pre-merger
Post-merger

Results


Disposal
Prices
Collection
Prices
Collection
Shares
Disposal/Collector
Santek/WM-ADS
Santek/Regional
Republic/Republic
WasteConn/WM-ADS
WasteConn/Regional
WasteConn/Republic
Santek/Republic
Santek/Santek
WasteConn/WasteConn
69
37
69
37
42
42
31
25
31
25
31
25
14
37
14
14
11
11
248
215
248
215
218
179
209
203
209
203
206
162
190
174
170
138
110
105
6
7
6
7
22
31
7
4
7
4
2
3
9
6
30
33
11
5
0
20
40
60
0
50
100
150
200
250
0
10
20
30
Equilibrium Levels
Type
Pre-merger
Post-merger

Results


Disposal
Prices
Collection
Prices
Collection
Shares
Disposal/Collector
Santek/WM-ADS
Santek/Regional
Republic/Republic
WasteConn/WM-ADS
WasteConn/Regional
WasteConn/Republic
Santek/Republic
Santek/Santek
WasteConn/WasteConn
69
37
69
37
42
42
31
25
31
25
31
25
14
37
14
14
11
11
248
215
248
215
218
179
209
203
209
203
206
162
190
174
170
138
110
105
6
7
6
7
22
31
7
4
7
4
2
3
9
6
30
33
11
5
0
20
40
60
0
50
100
150
200
250
0
10
20
30
Equilibrium Levels
Type
Pre-merger
Post-merger

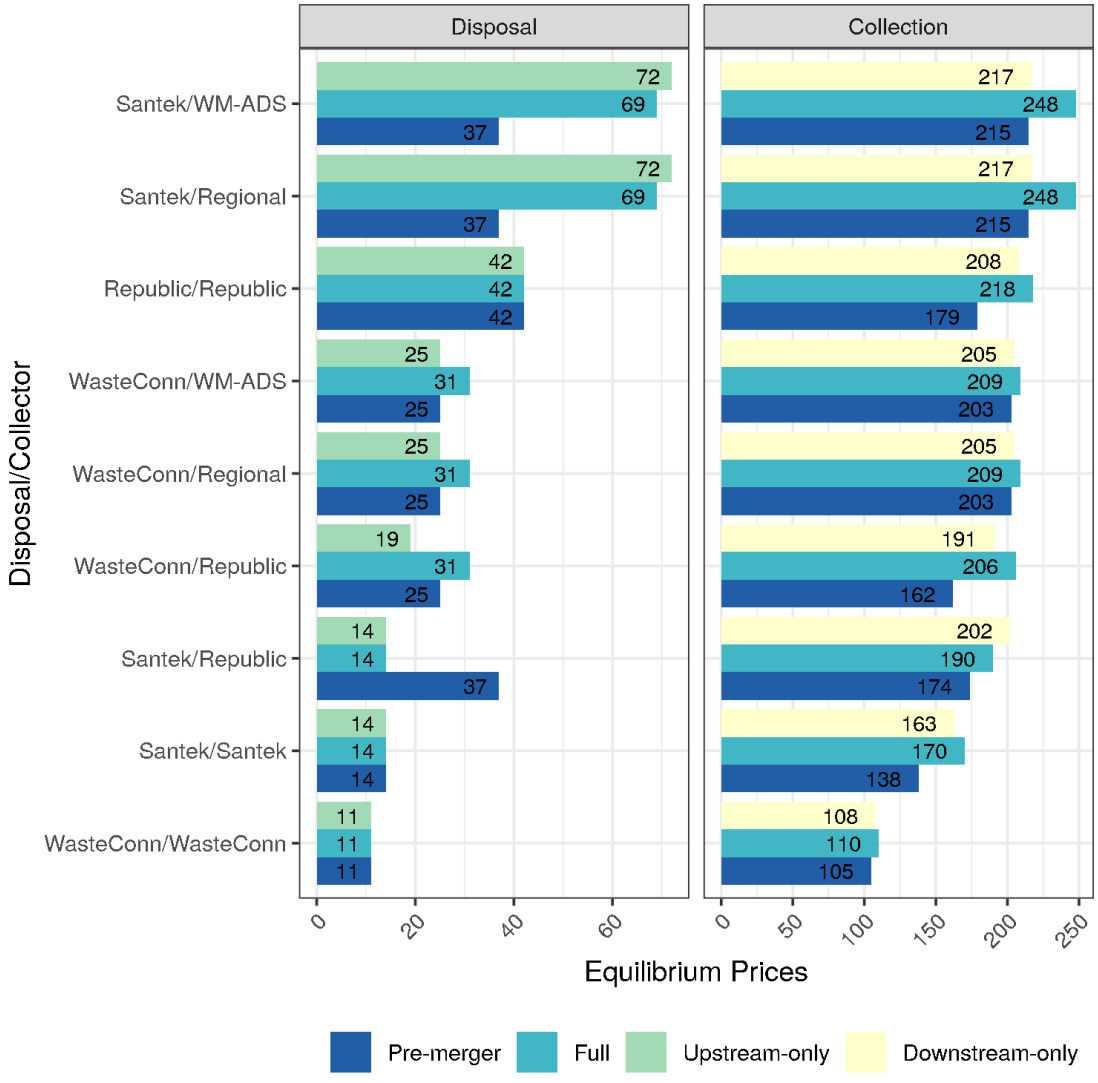
Results

- $16 million annual harm to consumers
- Average upstream prices decrease about 3% (EDM)
- Average downstream prices increase by about 12% (incomplete pass-through)

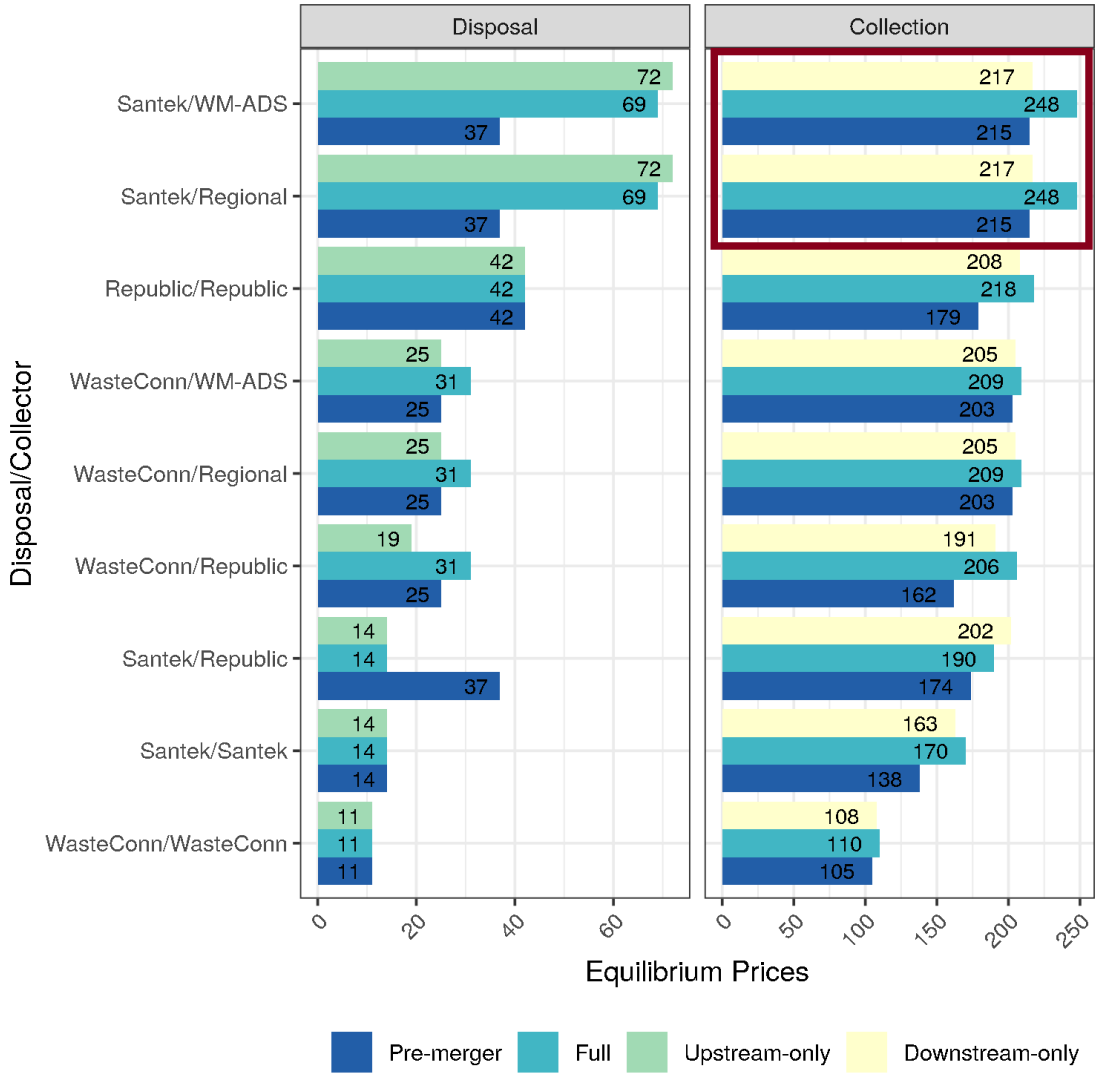
Comparing to Partial Models

- We compare our results from the full vertical model to two alternatives:
  1. Downstream-Only: hold prices of upstream products fixed, simulate merger in downstream logit model
  2. Upstream-Only: hold prices of downstream products fixed, simulate merger in upstream bargaining model
- Examine differences in prices and welfare

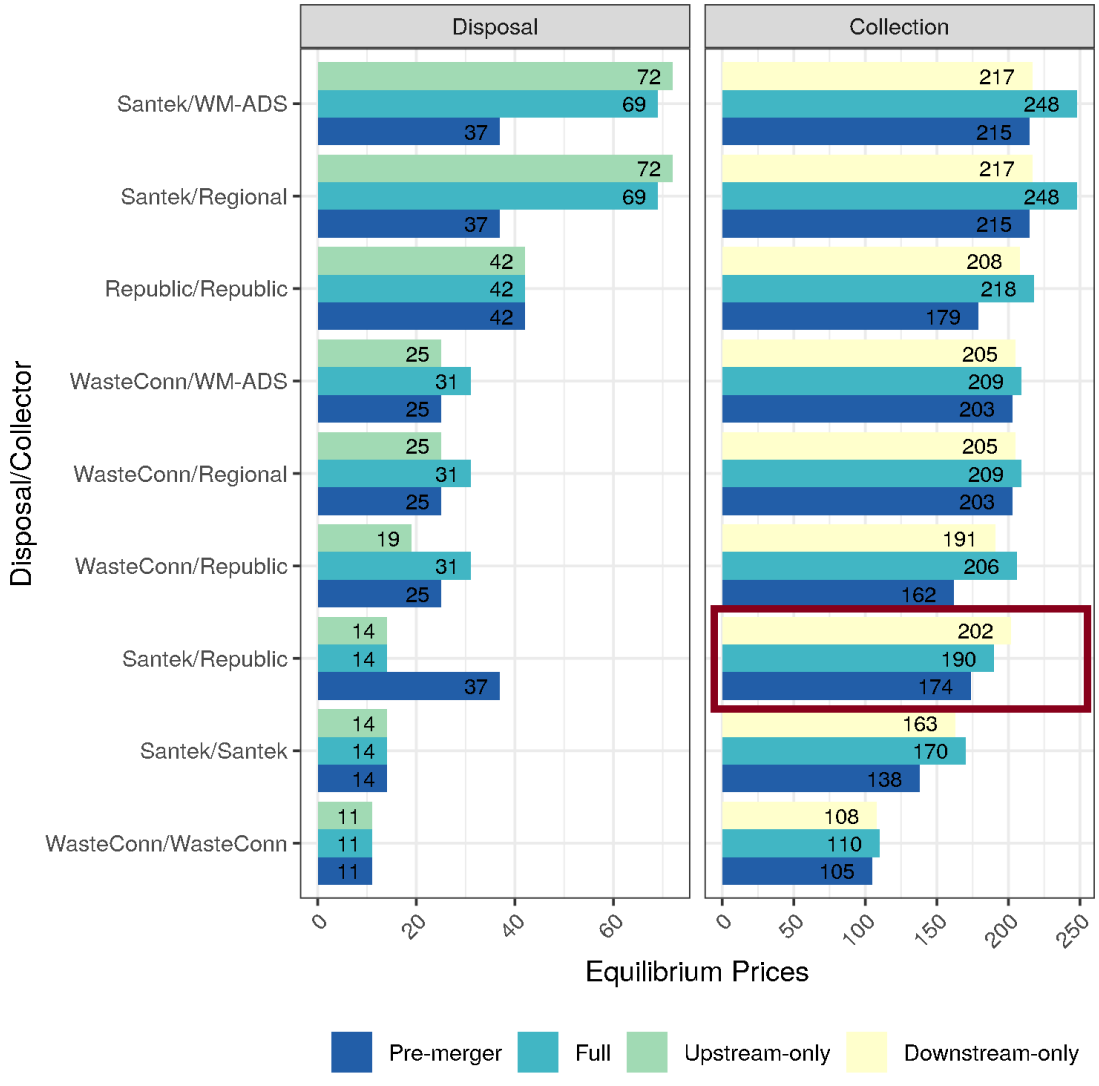
Partial Model Results



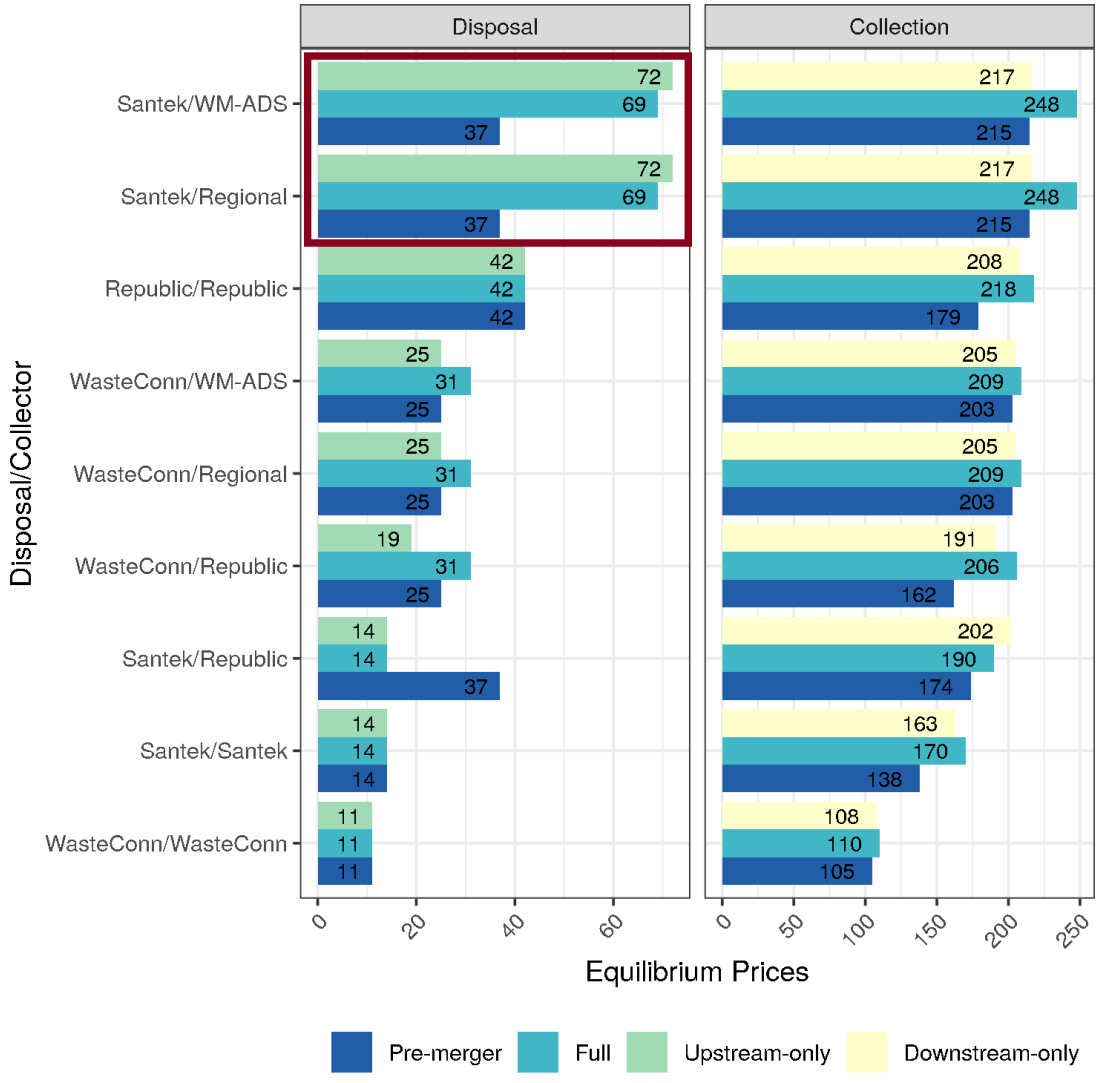
Partial Model Results



Partial Model Results



Partial Model Results



Partial Model Results

- Downstream-Only
  - $10 million annual harm to consumers
  - Collection prices for Santek/WM-ADS, Santek/Regional too low (misses RRC)
  - Collection price for Santek/Republic somewhat too high (misses EDM)
- Upstream-Only
  - Total welfare unchanged as effect is a transfer between firms
  - Average upstream prices increase by about 8%
  - Disposal prices for Santek/WM-ADS, Santek/Regional too high (overstates RRC)

Outline

1. Theory
2. Numerical Simulations
3. Republic/Santek Application
4. **Conclusion**

Summary

- We study the impacts of additional vertical integration on the welfare effects of mergers
  - Allow merging parties to already be integrated
  - Allow rivals to be integrated
- Most merger simulations show net negative impacts on consumers
  - Typically only result in net gains when upstream bargaining power is high (more potential for EDM)
  - Presence of integrated rivals does not strongly protect consumers from harm
- Model shows the effects of EDM and RRC in Republic/Santek
- Appendix to paper extends to case of increasing marginal costs
  - Allow marginal costs to increase linearly
  - Merger simulations tend to show more harm than under constant marginal costs

Thank You!