Beyond Horizontal and Vertical: Measuring the Welfare Effects of Complex Integration

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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 that are already vertically integrated
  - Nevertheless, standard merger analysis often simplifies cases 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, resulting in "complex" mergers
   - Model welfare effects for consumers accounting for elimination of double marginalization (EDM) and raising rivals' cost (RRC)
2. Apply model to Republic/Santek merger (2021) in solid waste management
   - Compare results to partial models that do not account for vertical aspects
   - Explore model implications for counterfactual mergers, comparing pure horizontal and pure vertical mergers to complex options

Findings

- We simulate Republic/Santek using limited data inputs and generate realistic RRC and EDM effects. We find net harm to consumers.
- Simulating Republic/Santek as separate upstream and downstream horizontal mergers using a partial model can greatly misrepresent the extent of harm
- None of the counterfactual complex mergers we study result in net benefits to consumers

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 (2023); De Stefano and Salinger (2024)

Outline

1. **Theory**
2. Republic/Santek Application
3. Conclusion

Model Overview

- Each wholesaler w in the set $\mathcal{W}$ offers a single product to retailers r in the set $\mathcal{R}$, who in turn sell to consumers
  1. Upstream: Nash bargaining between wholesalers and retailers
  2. Downstream: Bertrand differentiated products logit competition between retailers (nested logit for sensitivity analysis)
- 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

$$s_{rw} = \frac{\exp(\delta_{rw} - \alpha p_{rw})}{1 + \sum_{x \in \mathcal{R}} \sum_{y \in \mathcal{W}^x} \exp(\delta_{xy} - \alpha p_{xy})}$$

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

$$\pi^r = \sum_{x \in \mathcal{W}^r} [p_{rx} - p^W_{rx} - c^R_{rx}] s_{rx} M$$

- First order conditions for downstream equilibrium prices

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

Upstream Nash Bargaining

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

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

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

$$\pi^w = \sum_{x \in \mathcal{R}^w} [p^W_{xw} - c^W_{xw}] s_{xw} M$$

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

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

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

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

Bargaining Equilibrium

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

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

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

- A larger disagreement payoff increases bargaining leverage

Integrated Firm Pricing: Retail

Assume that retailer t merges with wholesaler v. Then t's price downstream for product v is determined by

$$\sum_{x \in \mathcal{W}^t \setminus \{v\}} [p_{tx} - p_{tx}^W - c_{tx}^R] \frac{\partial s_{tx}}{\partial p_{tv}} + s_{tv}$$

$$\underbrace{[p_{tv} - c_{tv}^R - c_{tv}^W] \frac{\partial s_{tv}}{\partial p_{tv}}}_{\text{EDM effect}} + \underbrace{\sum_{x \in \mathcal{R}^v \setminus \{t\}} [p_{xv}^W - c_{xv}^W] \frac{\partial s_{xv}}{\partial p_{tv}}}_{\text{upstream UPP effect}} = 0.$$

Integrated Firm Pricing: Wholesale Price to Rival Retailer

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

$$[p_{jv}^W - c_{jv}^W]s_{jv} - \sum_{x \in \mathcal{R}^v \setminus \{t,j\}} [p_{xv}^W - c_{xv}^W]\Delta s_{xv}(\mathcal{W}^j \setminus \{v\})$$

$$\overbrace{\overbrace{-[p_{tv} - c_{tv}^W - c_{tv}^R]\Delta s_{tv}(\mathcal{W}^j \setminus \{v\})}^{\text{indirect EDM effect}} - \sum_{x \in \mathcal{W}^t \setminus \{v\}} [p_{tx} - p_{tx}^W - c_{tx}^R]\Delta s_{tx}(\mathcal{W}^j \setminus \{v\})}^{\text{RRC effect}} =$$

$$\frac{1 - \lambda_v}{\lambda_v} \left([p_{jv} - p_{jv}^W - c_{jv}^R]s_{jv} - \sum_{x \in \mathcal{W}^j \setminus \{v\}} [p_{jx} - p_{jx}^W - c_{jx}^R]\Delta s_{jx}(\mathcal{W}^j \setminus \{v\}) \right)$$

Integrated Firm Pricing: Wholesale Price from Rival Wholesaler

When retailer t bargains with unaffiliated wholesaler k, the wholesale price is determined by

$$[p_{tk}^W - c_{tk}^W]s_{tk} - \sum_{x \in \mathcal{R}^k \setminus \{t\}} [p_{xk}^W - c_{xk}^W]\Delta s_{xk}(\mathcal{W}^t \setminus \{k\}) =$$

$$\frac{1-\lambda_k}{\lambda_k}\left([p_{tk} - p_{tk}^W - c_{tk}^R]s_{tk} - \sum_{x \in \mathcal{W}^t \setminus \{v,k\}} [p_{tx} - p_{tx}^W - c_{tx}^R]\Delta s_{tx}(\mathcal{W}^t \setminus \{k\})\right.$$

$$\left. - \underbrace{[p_{tv} - c_{tv}^W - c_{tv}^R]\Delta s_{tv}(\mathcal{W}^t \setminus \{k\})}_{\text{EDM recapture effect}} - \underbrace{\sum_{x \in \mathcal{R}^v \setminus \{t\}} [p_{xv}^W - c_{xv}^W]\Delta s_{xv}(\mathcal{W}^t \setminus \{k\})}_{\text{wholesale recapture leverage effect}}\right)$$

Outline

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2. **Republic/Santek Application**
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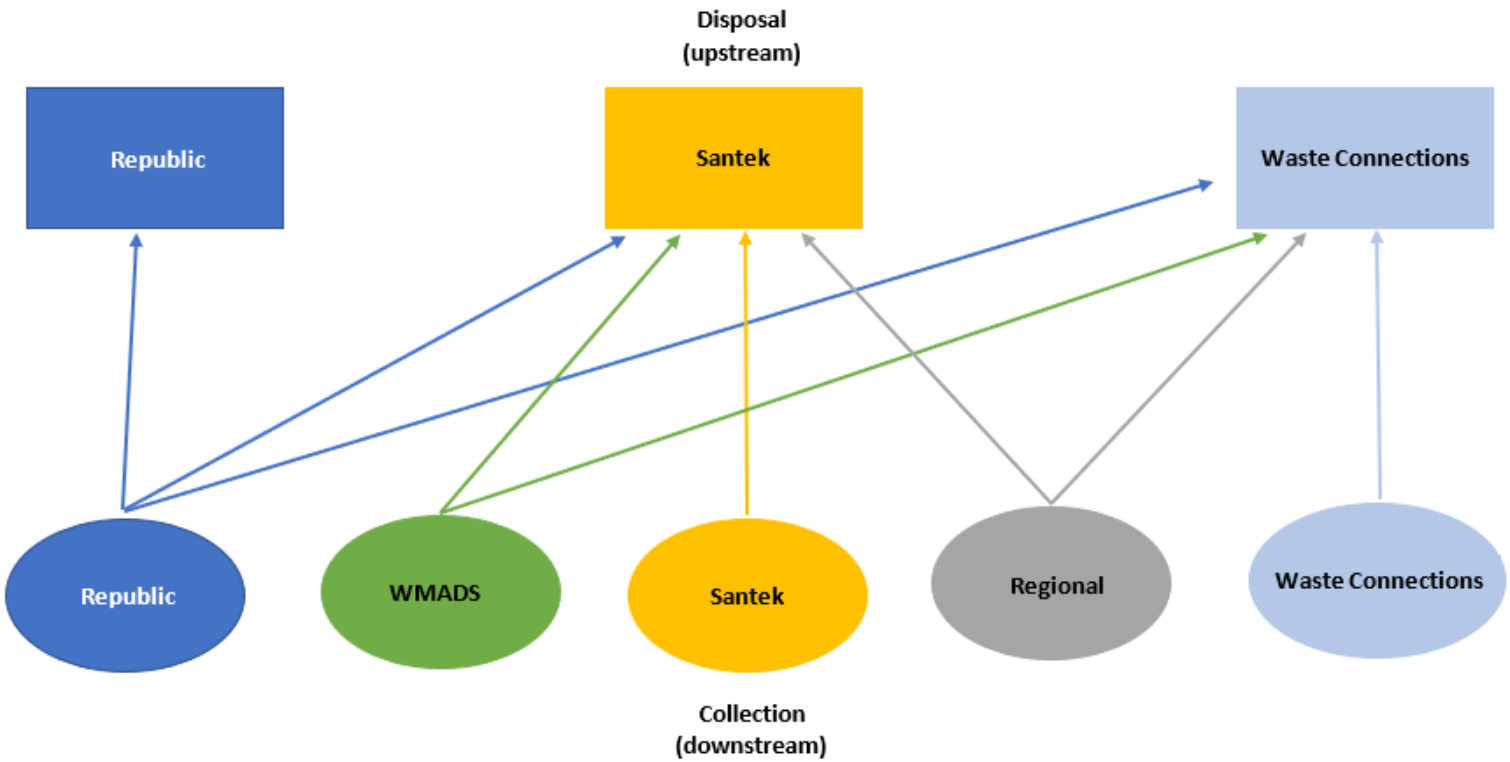
Merger Background

- 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 (WMADS) and a regional company (Regional)

Market Diagram



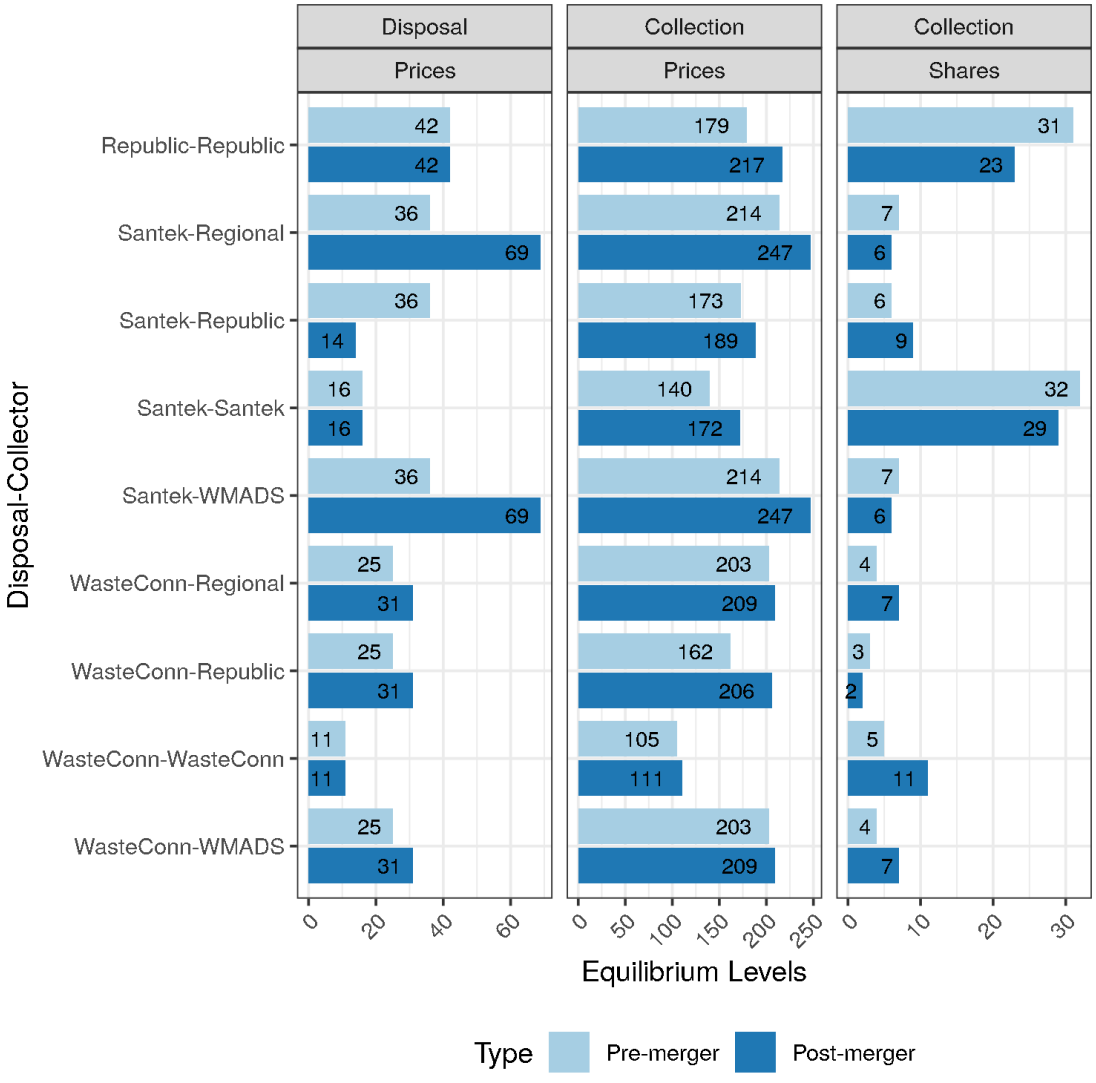
Data Inputs

Disposal Firm	Collection Firm	Volume	Disposal Price	Disposal Margin	Collection Margin	Collection Cost
Republic	Republic	165	42	0	44	93
Santek	Republic	34	36	20		93
	Santek	218	16	0		74
	WMADS	30	36	20		148
	Regional	30	36	20		148
WasteConn	Republic	19	25	14		93
	WasteConn	48	11	0		63
	WMADS	17	25	14		148
	Regional	17	25	14		148

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

- Data are for 2019
- Data sources:
  - Volumes/market shares from DOJ Competitive Impact Statement and Tennessee Department of Environmental Quality reports
  - Prices from Waste Business Journal
  - Margins from firm financial statements
- Rely on public sources that may differ from information DOJ had access to
- Assume no substitution outside of market, due to environmental regulations

Results


Disposal
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Prices
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Santek-Regional
Santek-Republic
Santek-Santek
Santek-WMADS
WasteConn-Regional
WasteConn-Republic
WasteConn-WasteConn
WasteConn-WMADS
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Equilibrium Levels
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Post-merger

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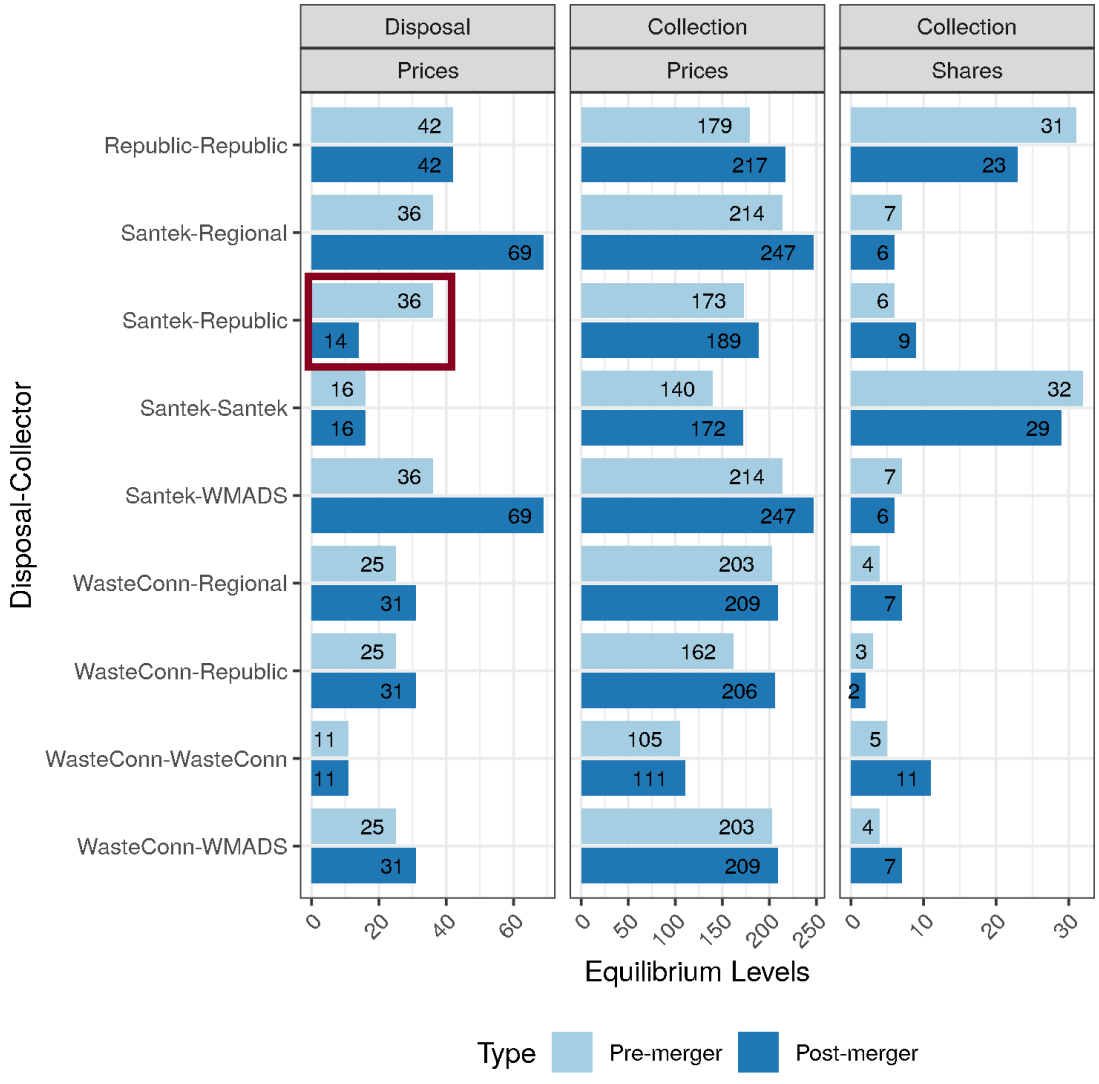
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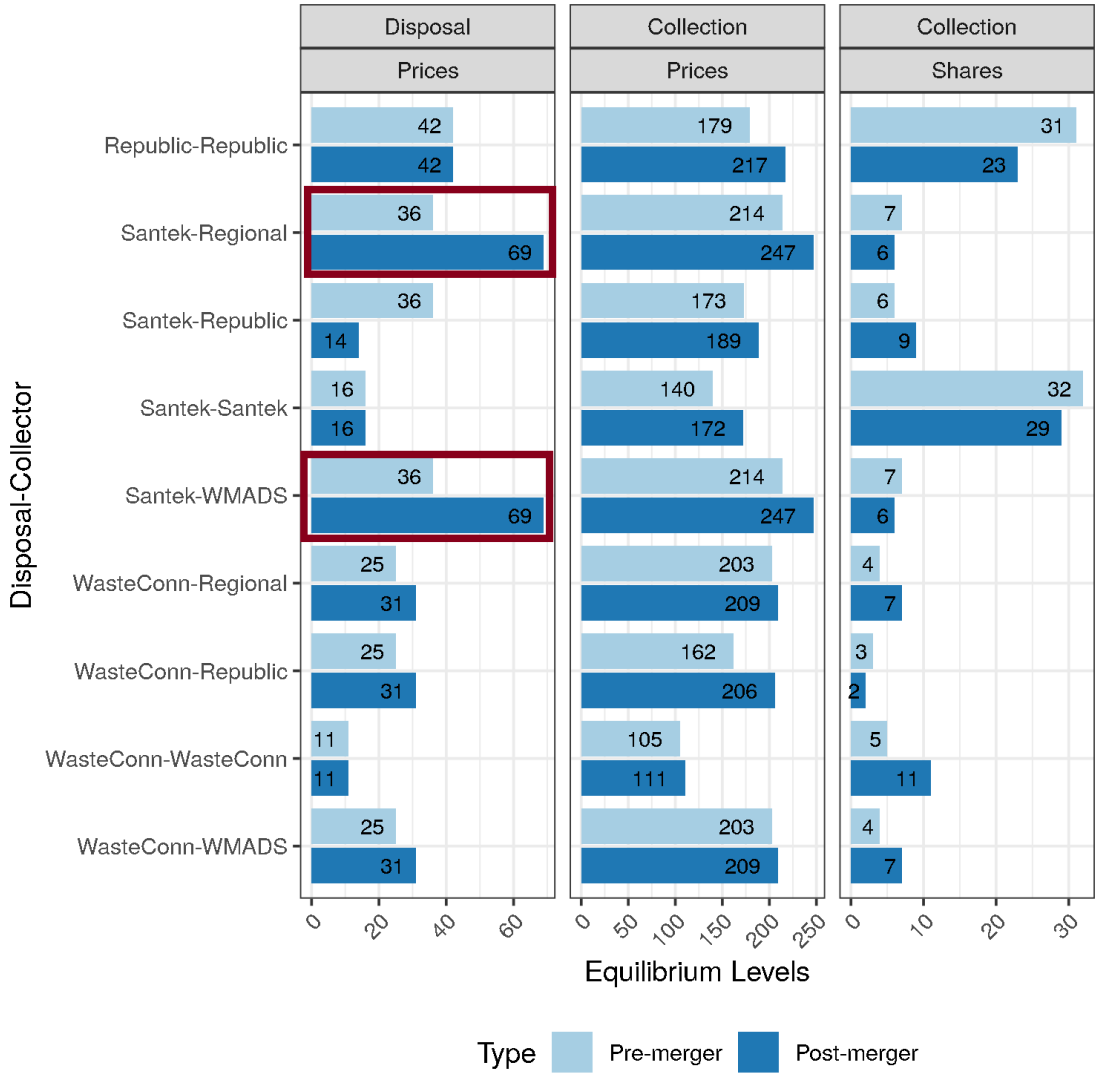
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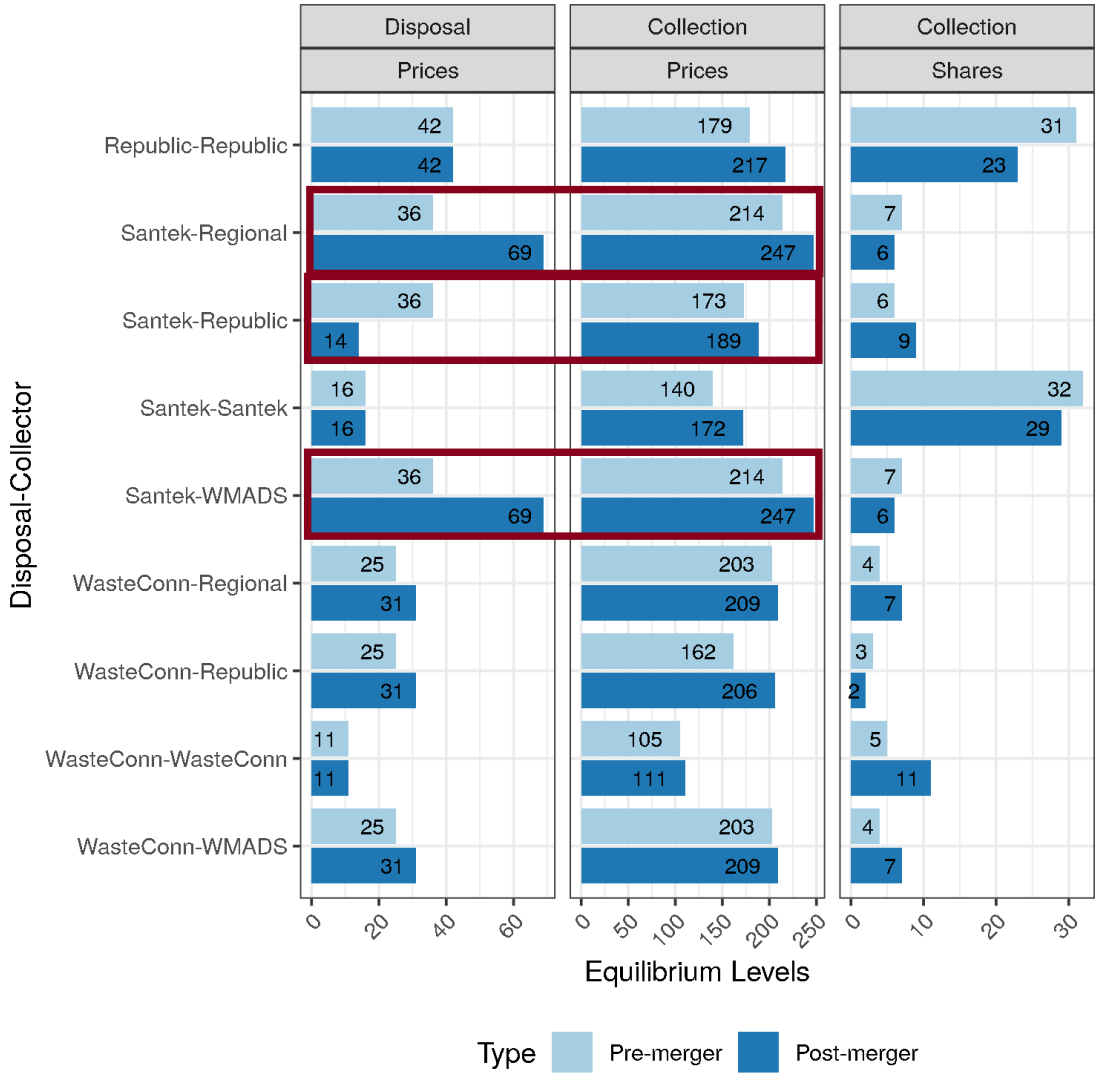
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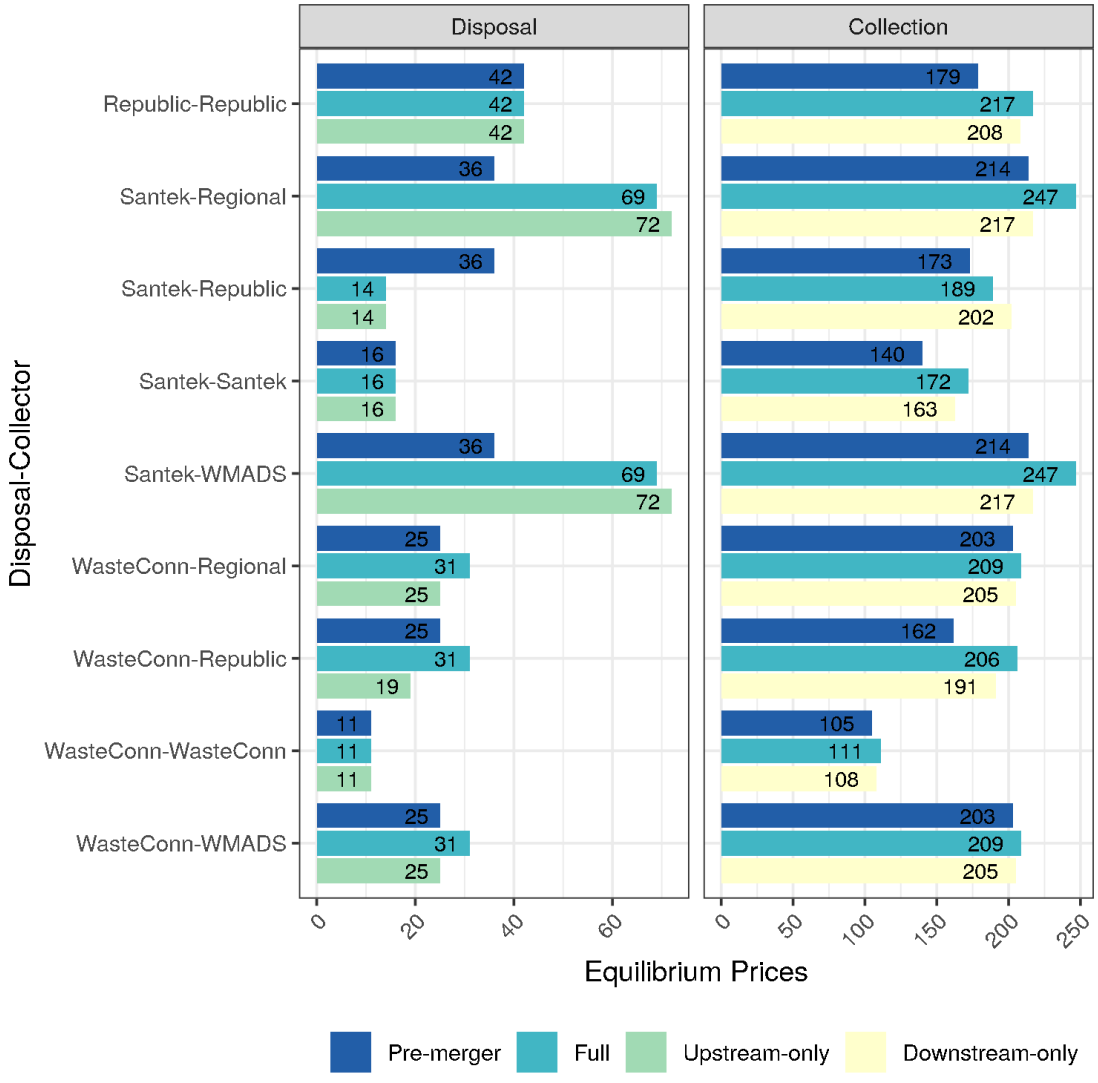
Results

- $16.6 million annual harm to consumers
- Average upstream prices decrease about 3% (EDM)
- Average downstream prices increase by 12.5% (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



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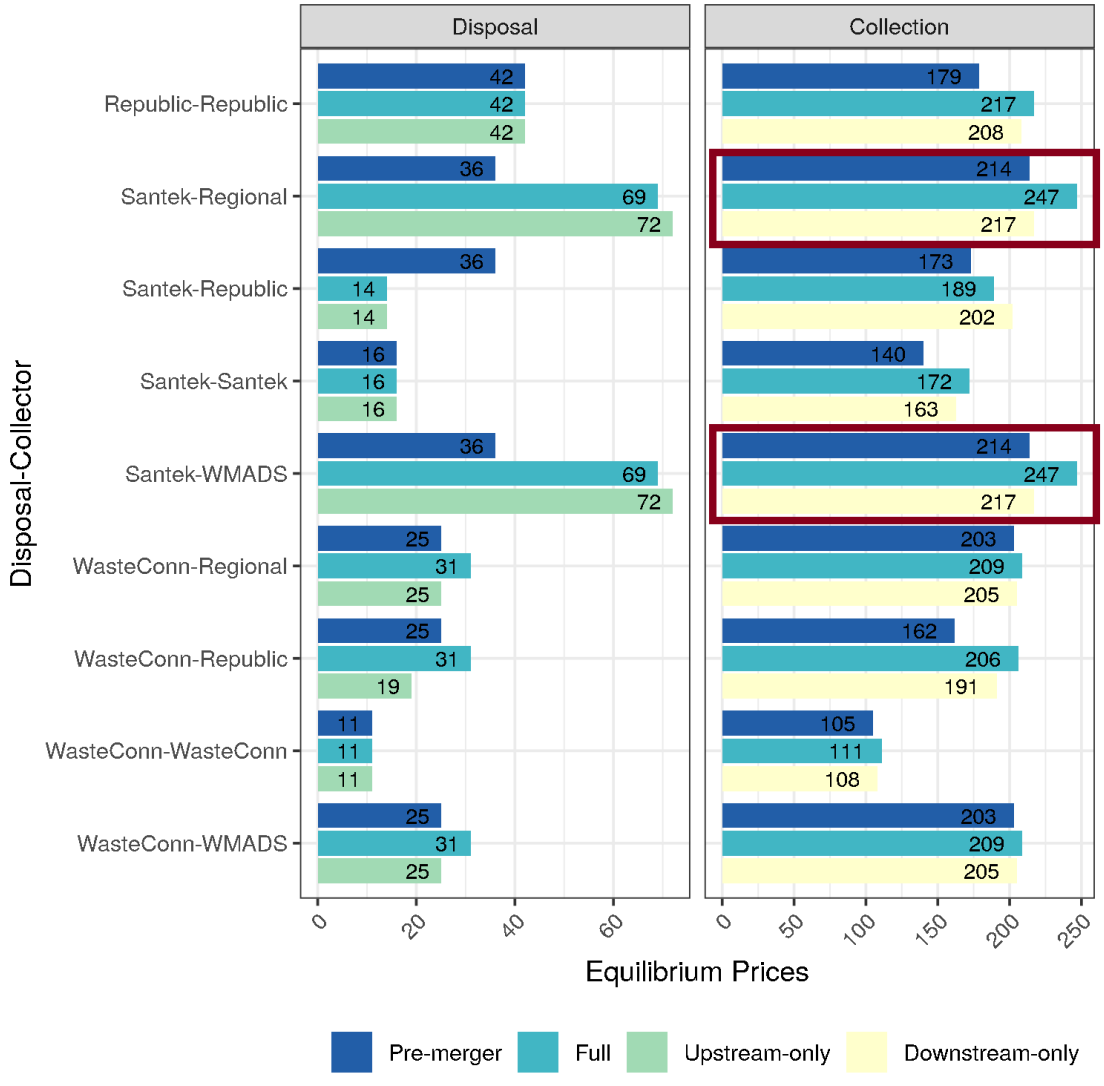

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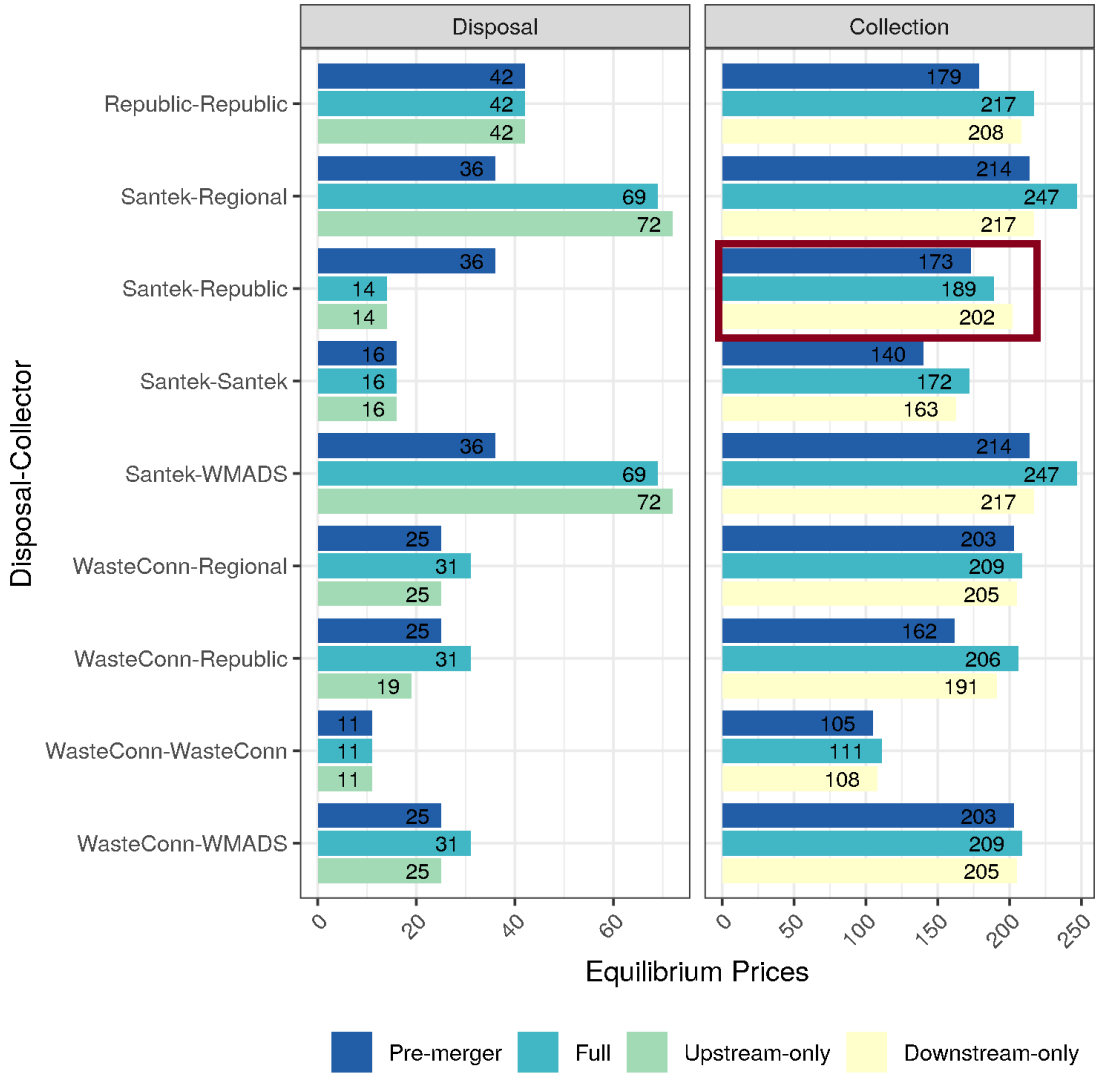

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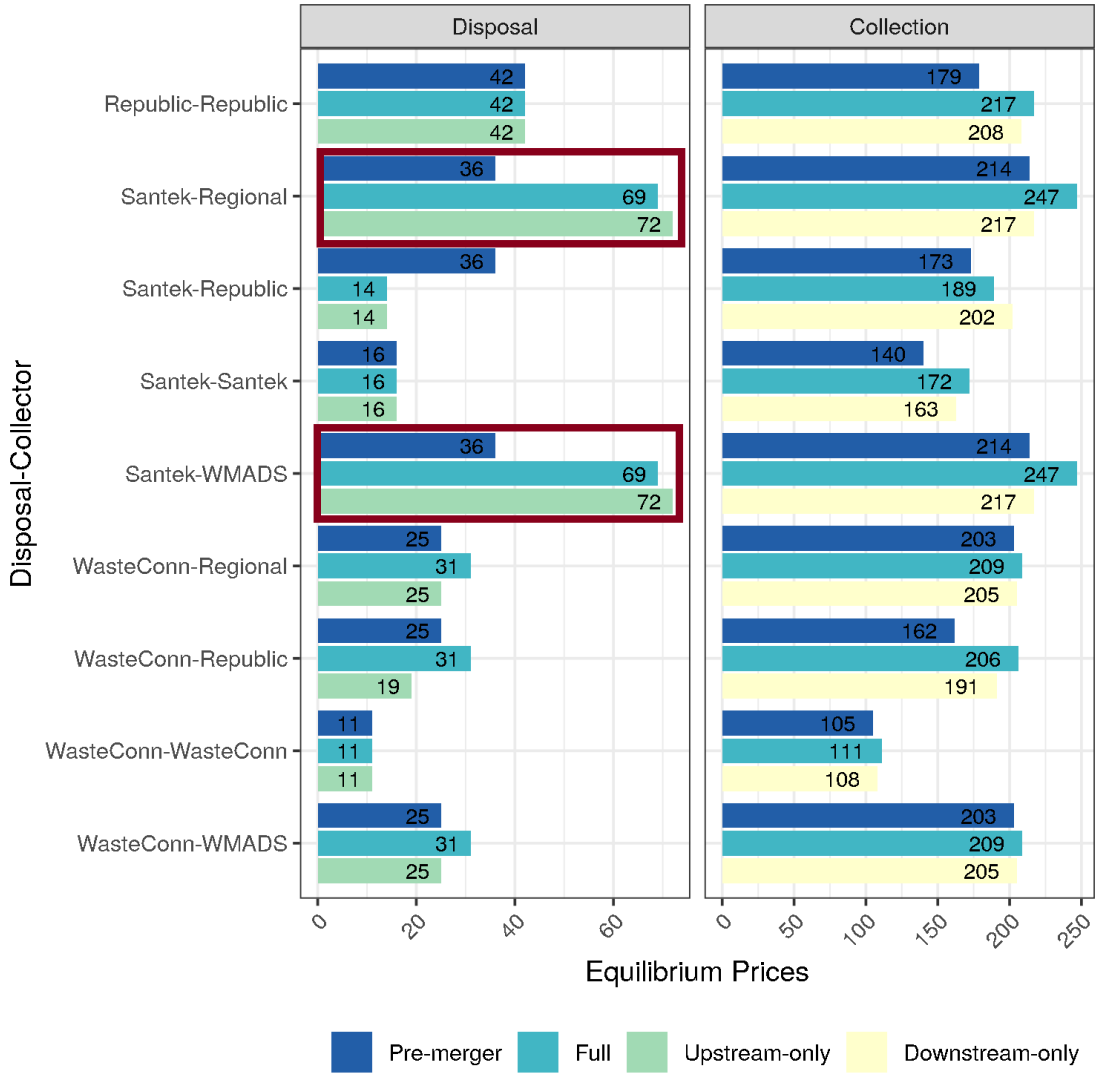


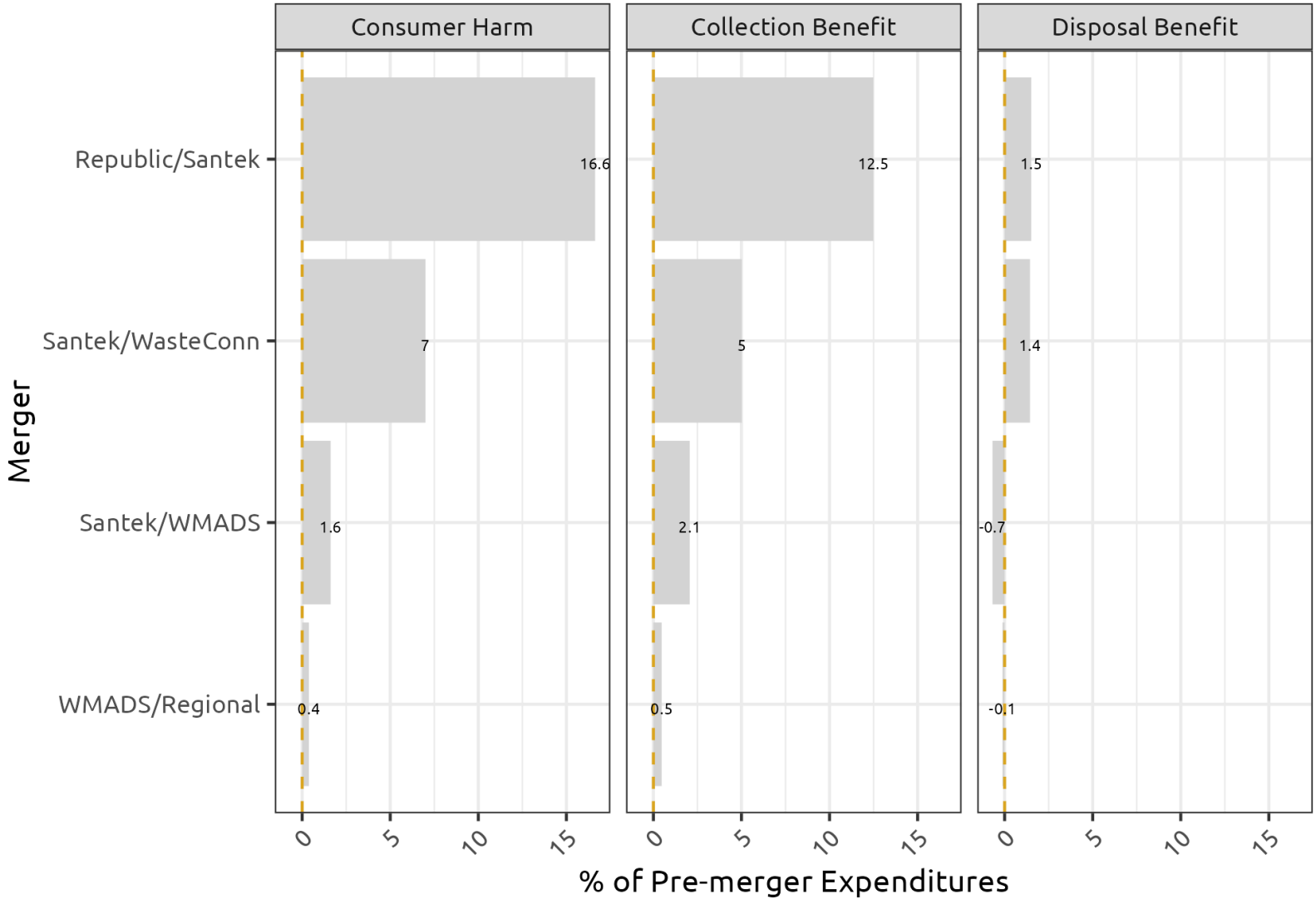
Partial Model Results

- 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
  - Average upstream prices increase by about 11%
  - Disposal prices for Santek/WM-ADS, Santek/Regional too high (overstates RRC)

Comparing to Counterfactual Mergers

- We compare welfare effects of Republic/Santek to three other merger options:
  1. Santek/Waste Connections: two fully integrated firms that are not capacity constrained
  2. Santek/WMADS: integrated firm with a collection-only firm
  3. WMADS/Regional: horizontal merger between two collection-only firms
- Allows us to examine examples of different complex mergers

Results for Other Mergers



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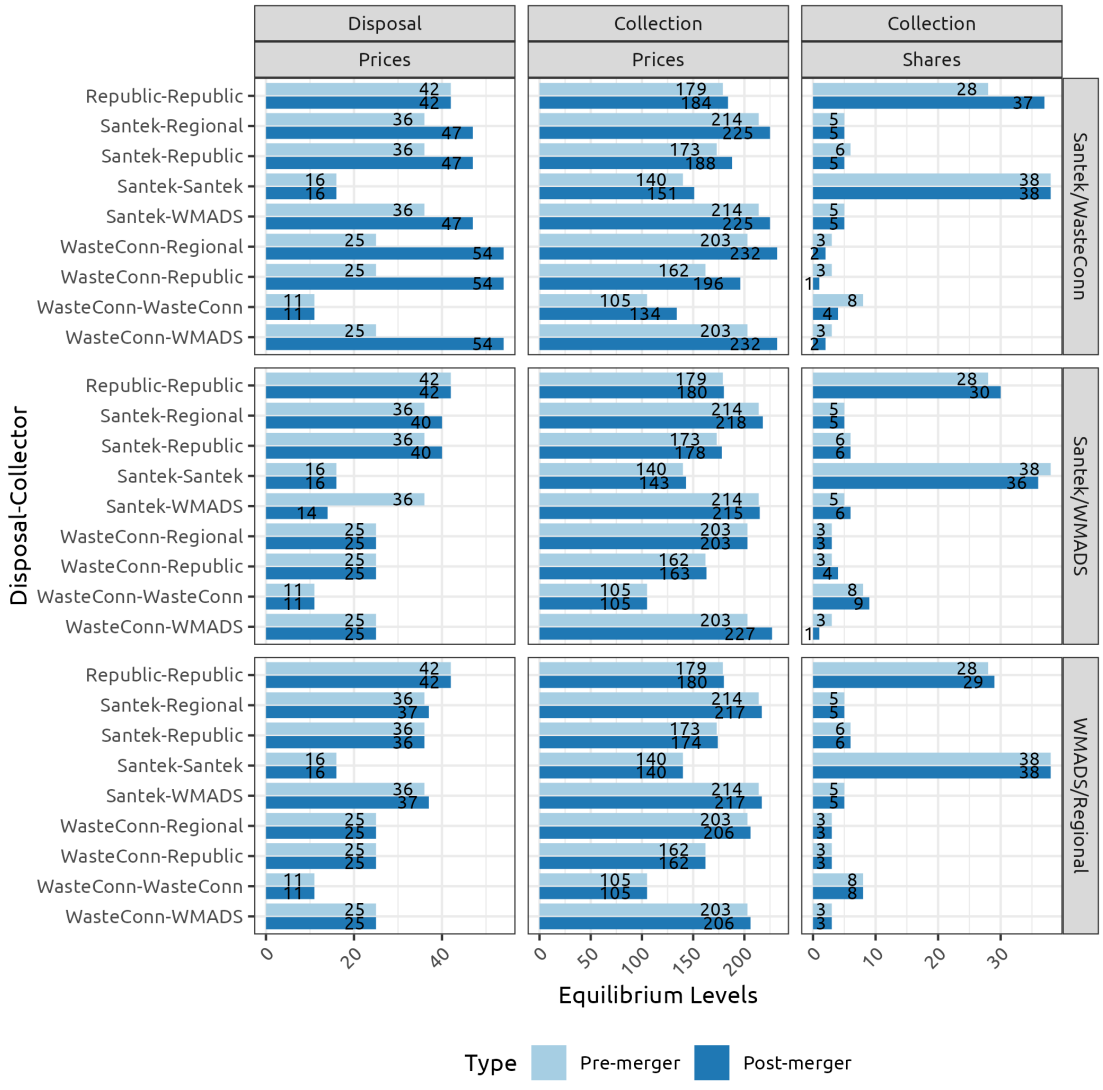

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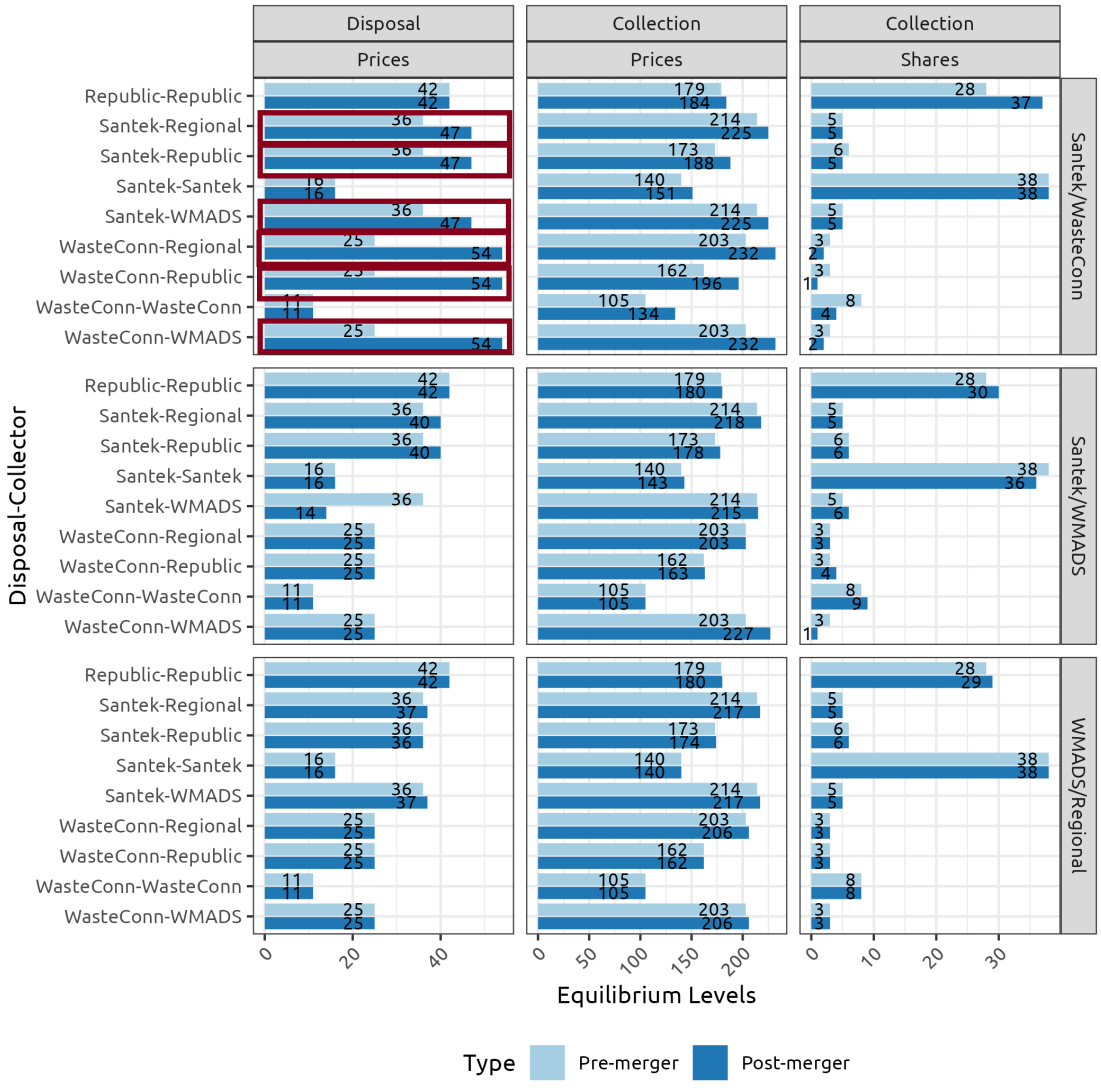

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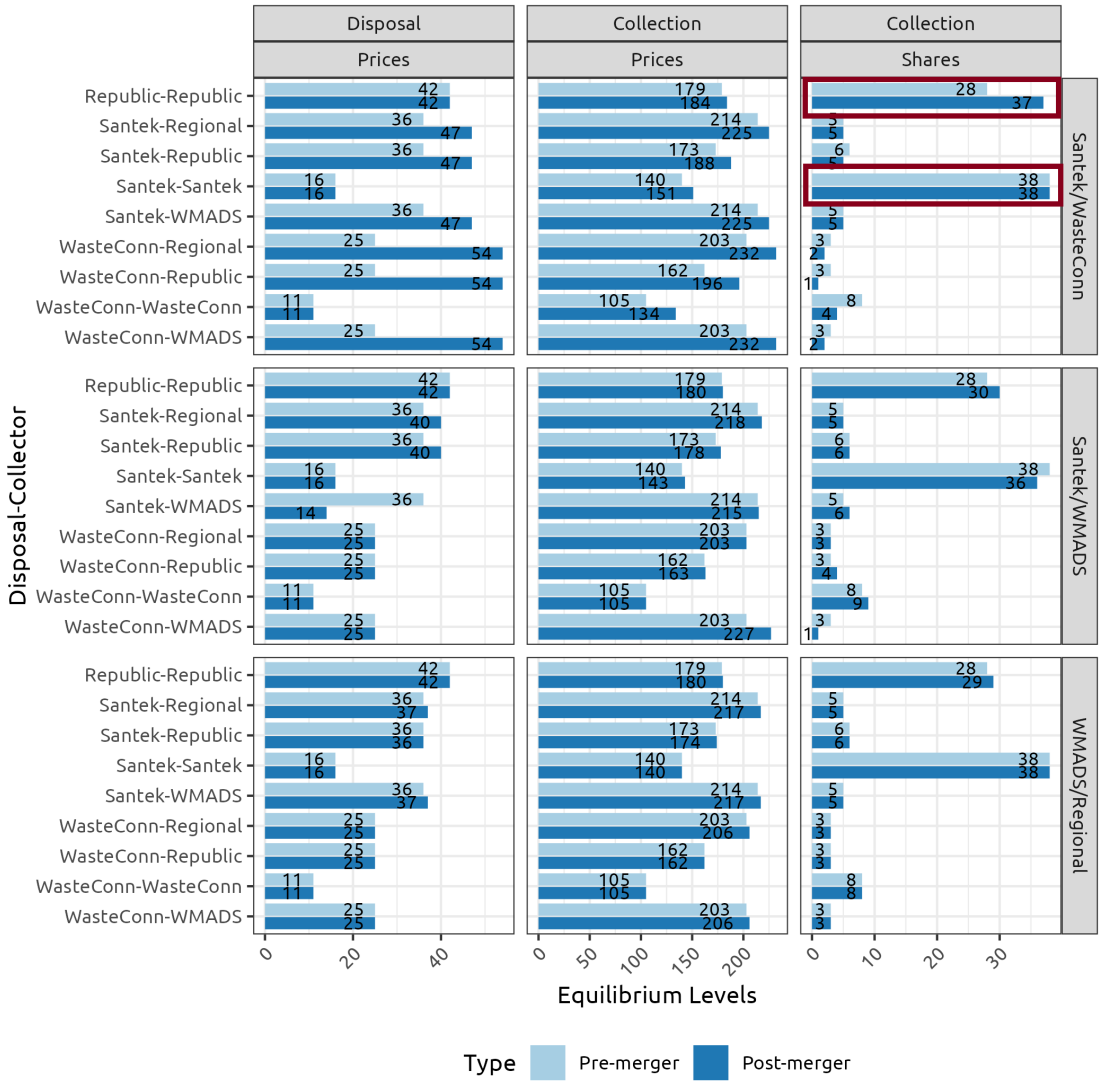

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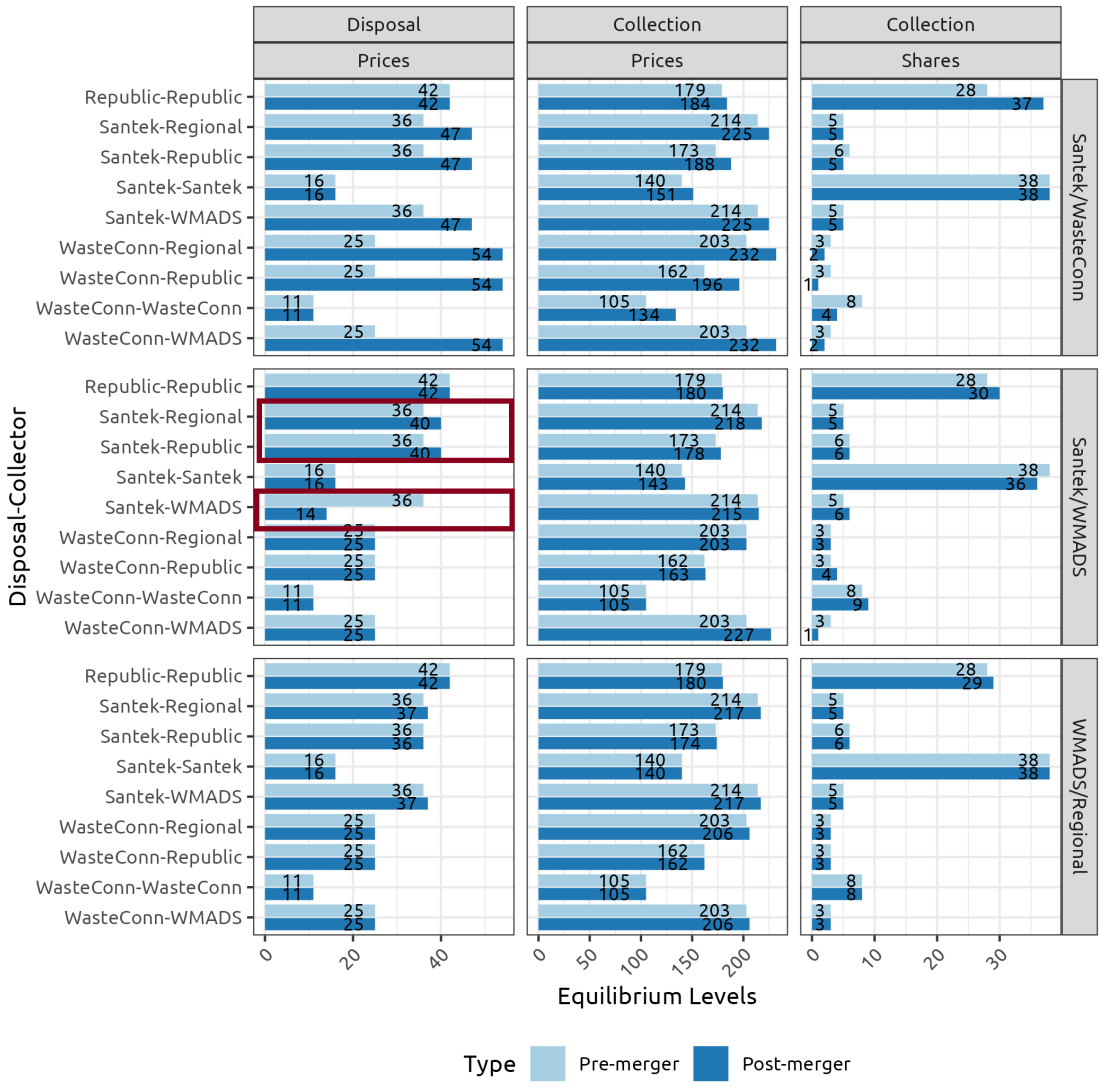

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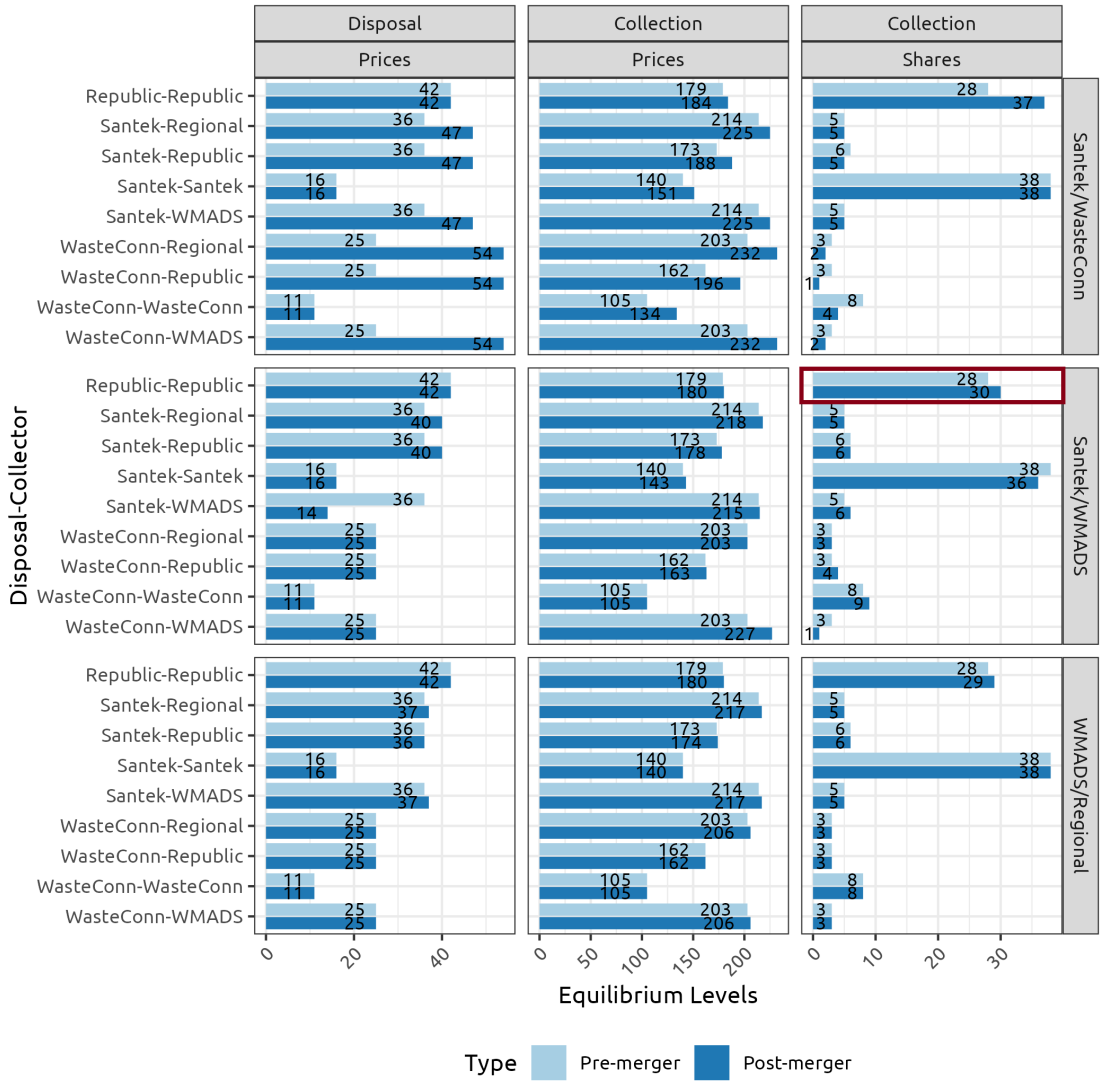

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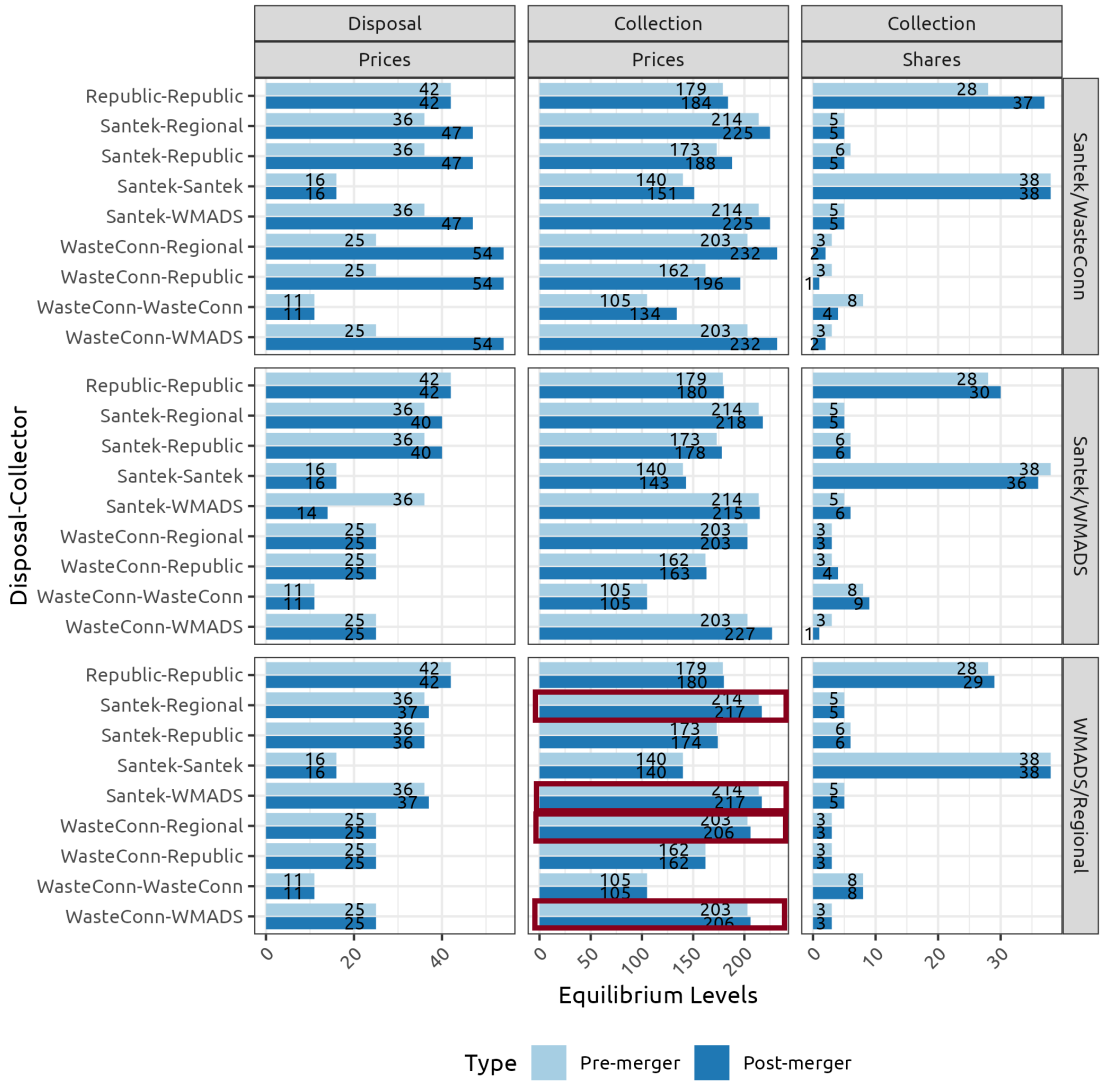

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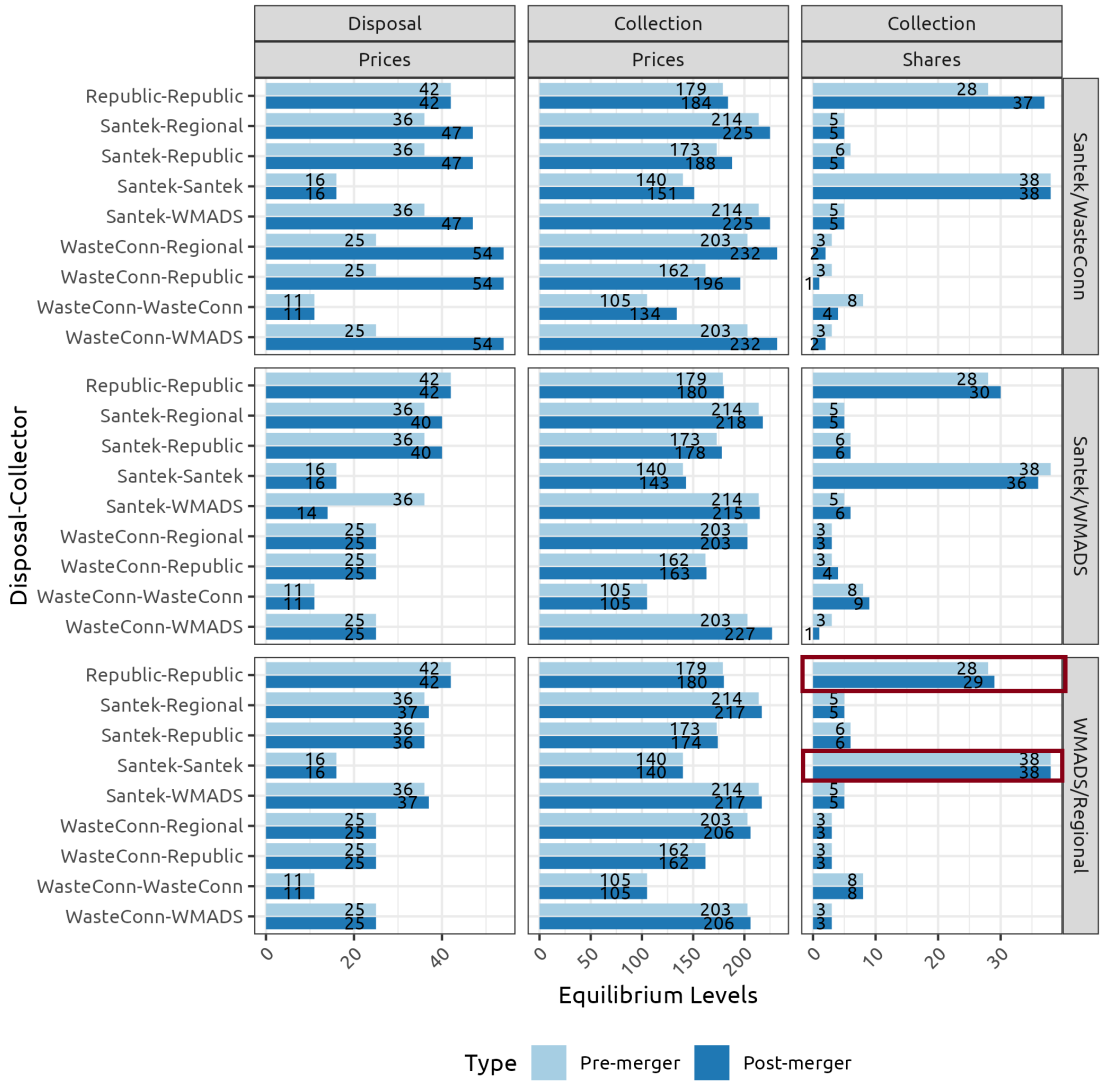
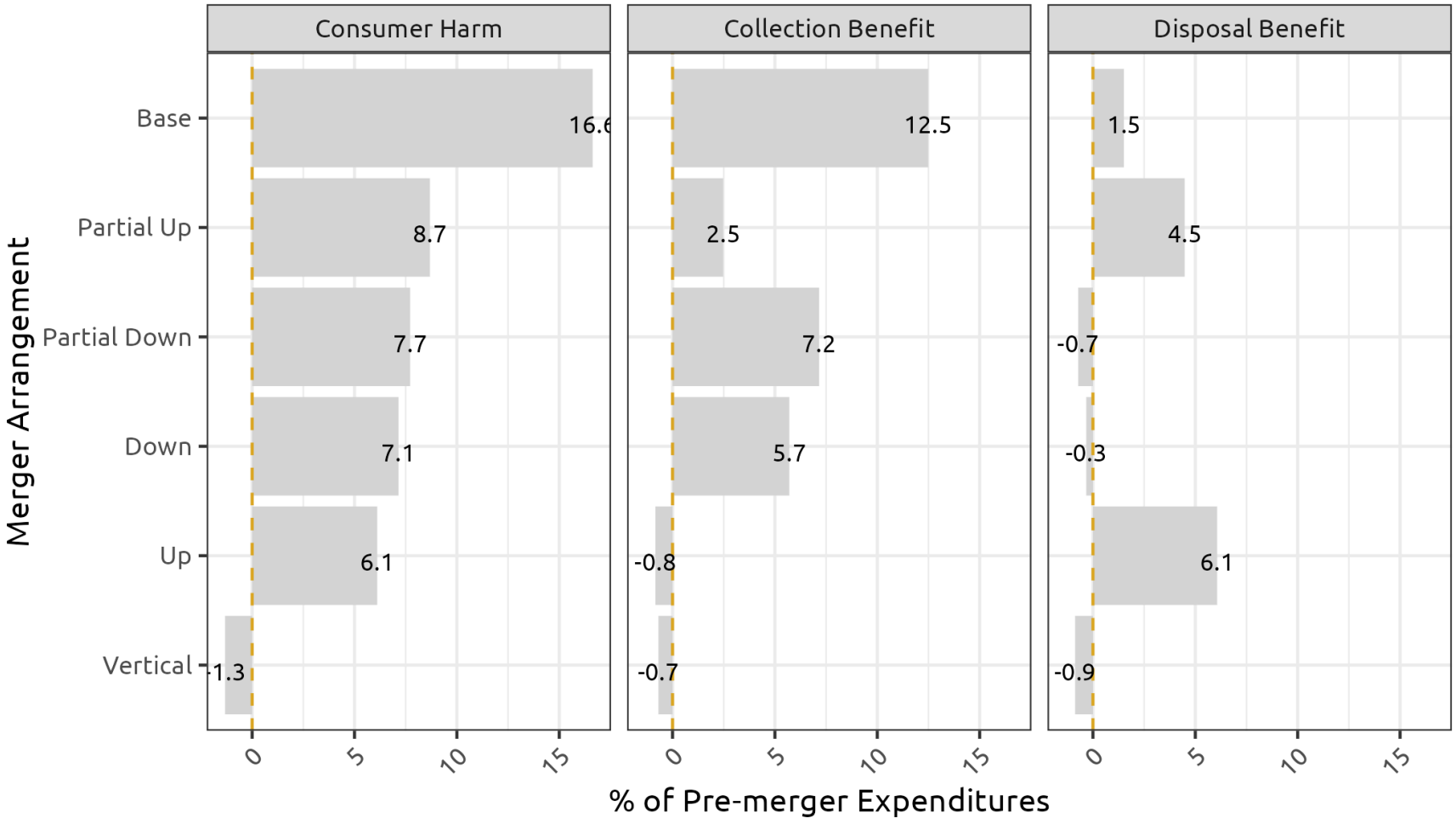


Comparing to Mergers of Counterfactual Firms

- Suppose we split the upstream and downstream components of Republic and Santek into independent entities
- Simulate a new set of counterfactual mergers:
  1. Non-complex: pure downstream horizontal, pure upstream horizontal, pure vertical
  2. Complex with one merging firm being integrated: integrated Santek with Republic collection, integrated Santek with Republic disposal
- Allows us to study complex mergers that involve the most popular products (Republic-Republic and Santek-Santek)

Results for Other Republic/Santek Mergers



Results for Other Republic/Santek Mergers

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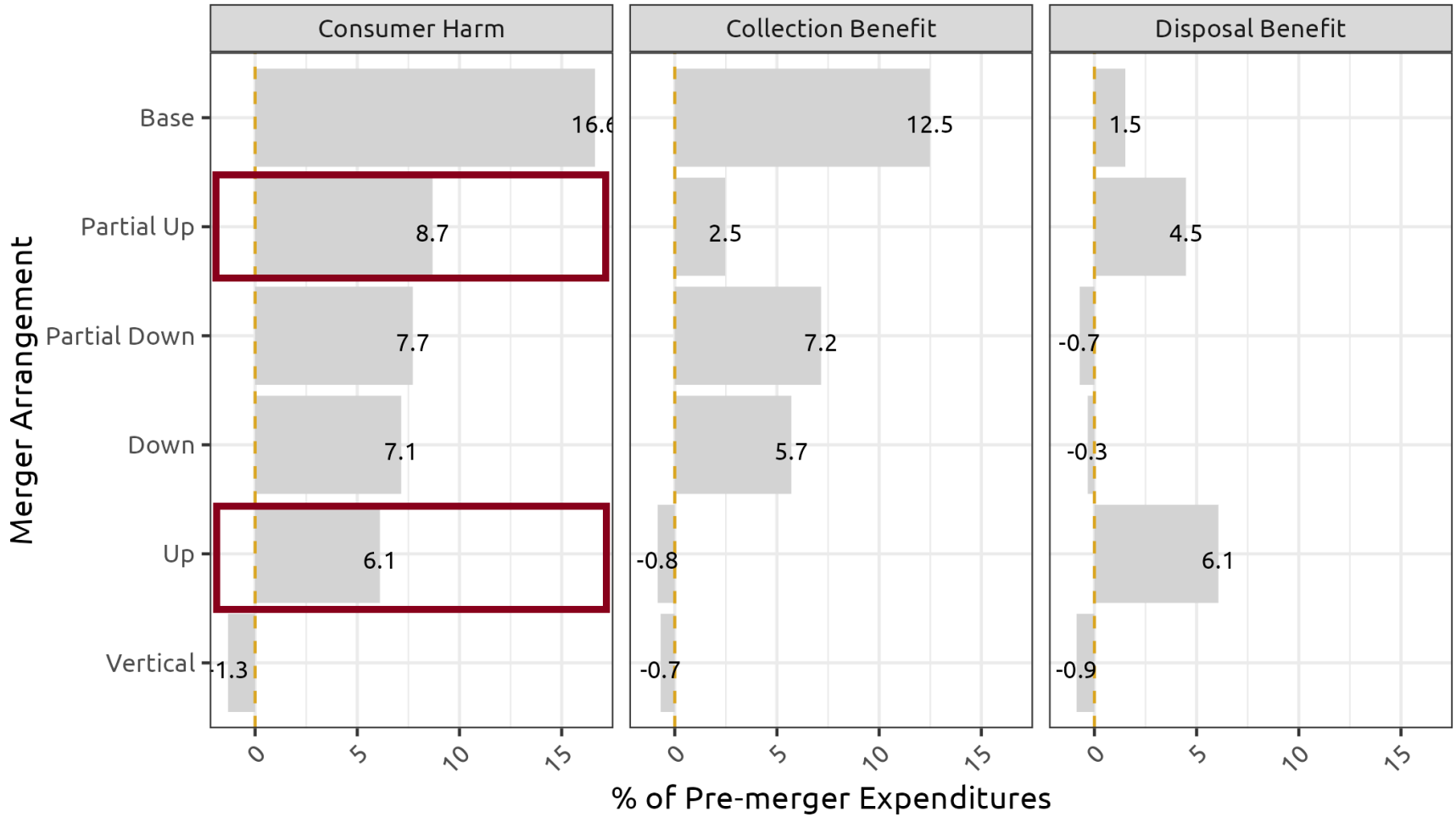

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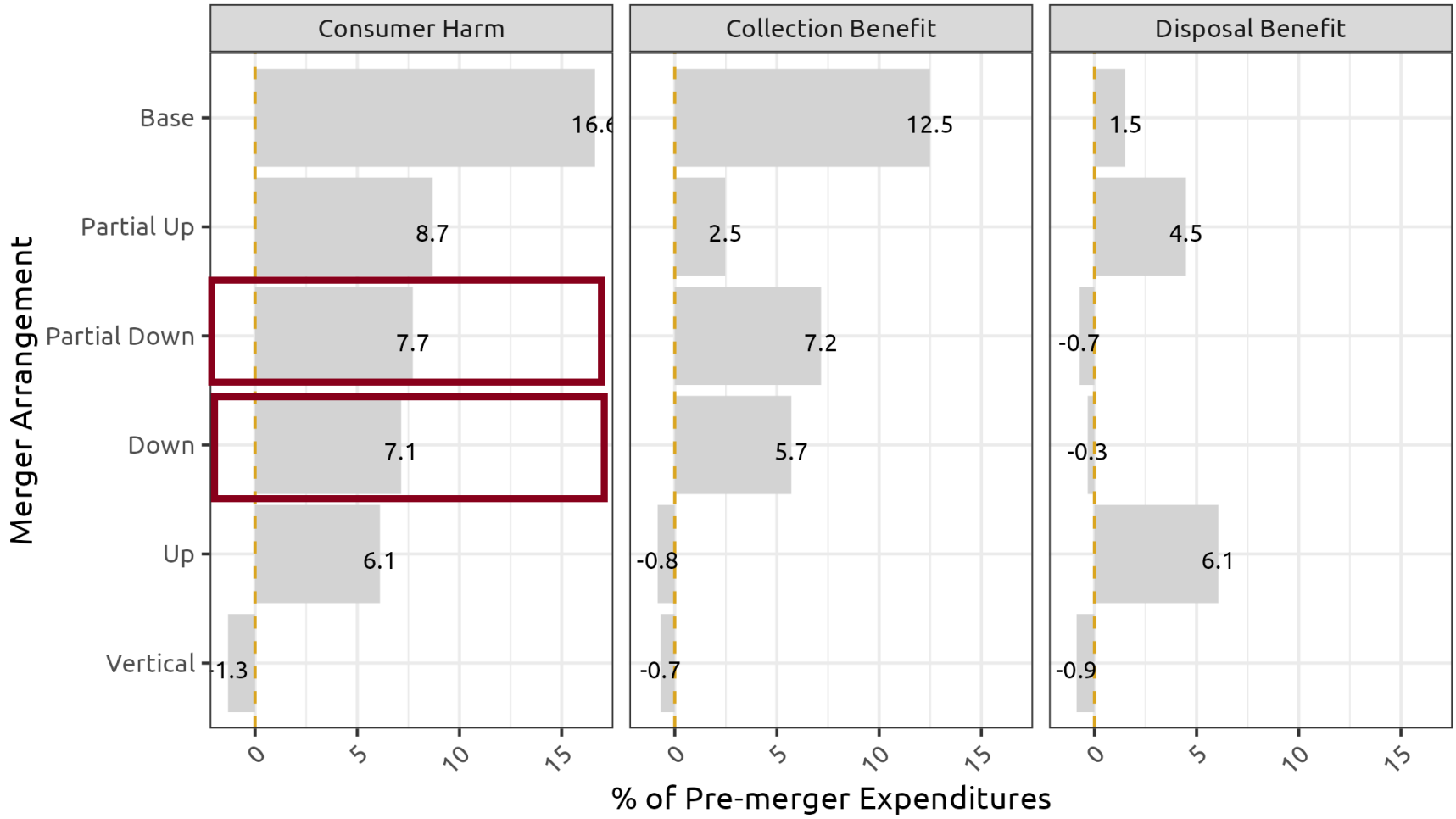


Results for Counterfactual Mergers

- Republic/Santek as proposed appears to have been one of the most harmful possiblities, due to the popularity of the Republic-Republic and Santek-Santek products
- Any gains from EDM are outweighed by RRC and loss of horizontal competition.
  - Despite EDM decreases in upstream prices of over 60%
  - Pure vertical merger between Santek disposal and Republic collection is the exception
- The complex options tend to result in more consumer harm

Outline

1. Theory
2. Republic/Santek Application
3. **Conclusion**

Summary

- We study the impacts of additional vertical integration on the welfare effects of mergers
- Model shows the effects of EDM and RRC in Republic/Santek
  - Partial model can understate or overstate effects
  - Despite substantial input price decreases from EDM, hard to find instances where consumers gain on net

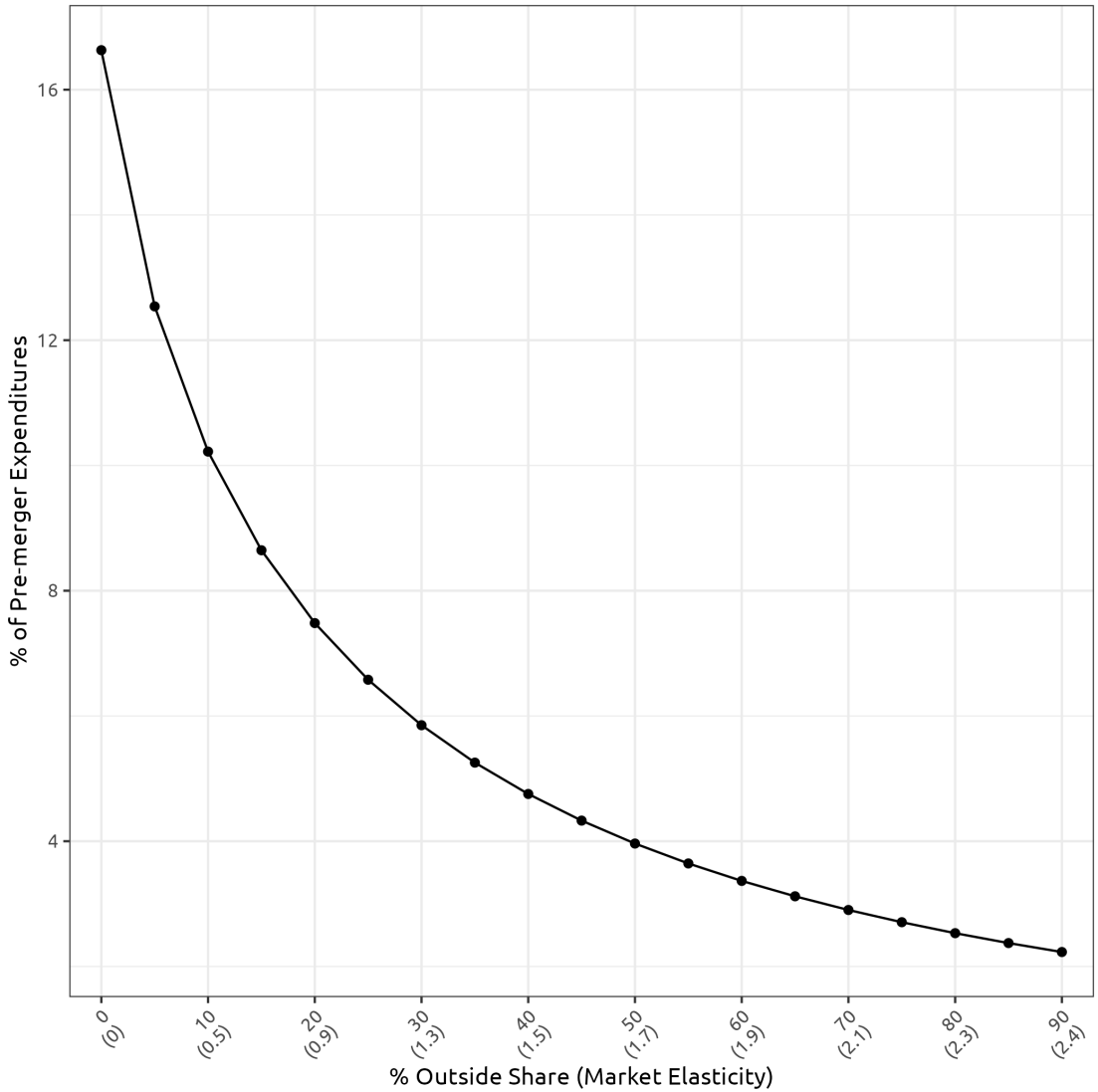
Thank You!

Sensitivity Analysis

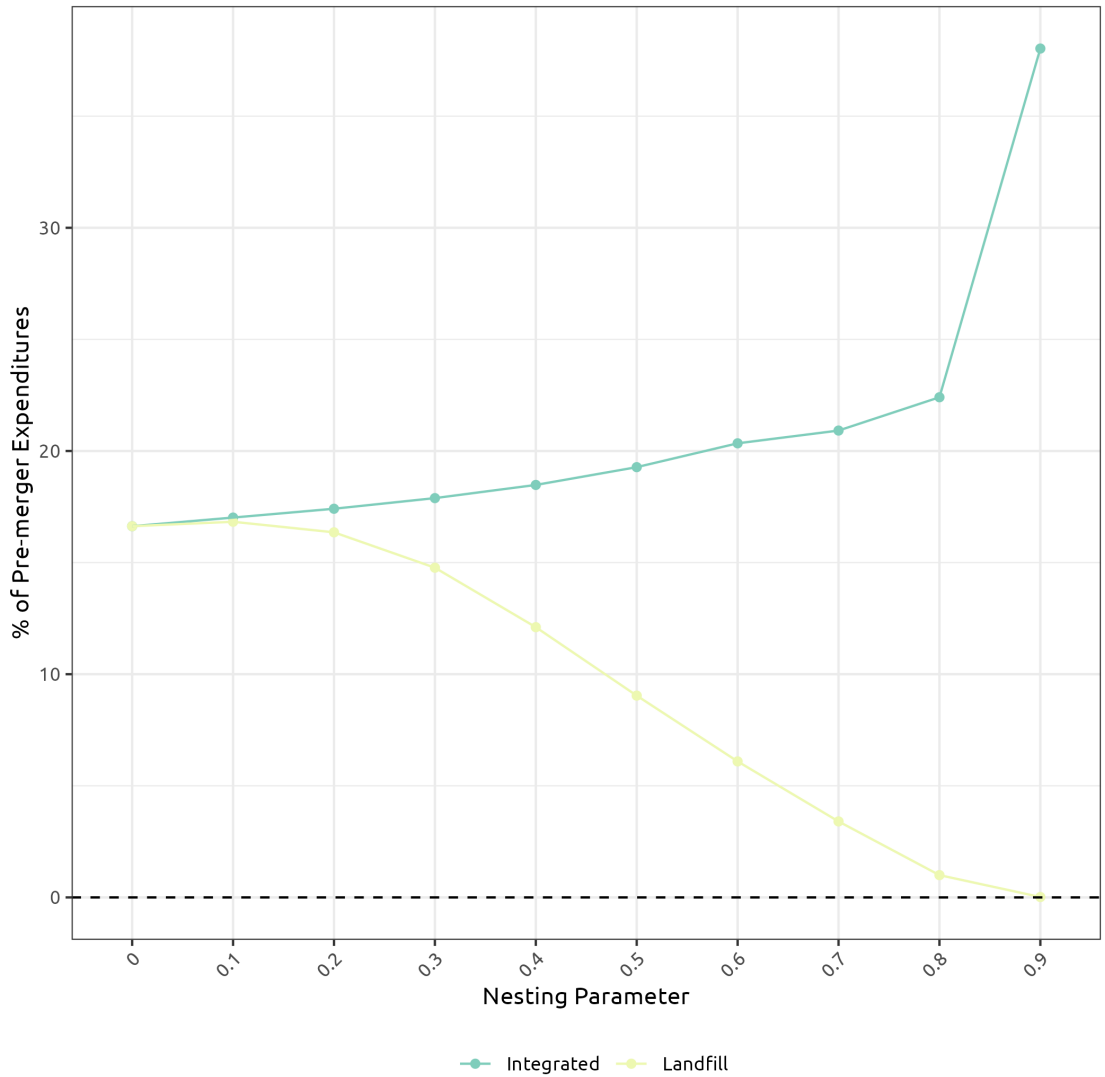
We consider the way our results change in three sensitivity exercises

1. Extent of substitution outside the market: vary share of outside good/market elasticity
2. Assumed demand substitution: switch to nested logit and vary nesting parameter
   - Option 1: nest products by integrated vs. not
   - Option 2: nest products by disposal landfill provider
3. Bargaining power: vary λ
   - Baseline calibration results in $\lambda_{Santek} = 1$ and $\lambda_{WasteConn} = 0.73$, so retailers have substantial advantage

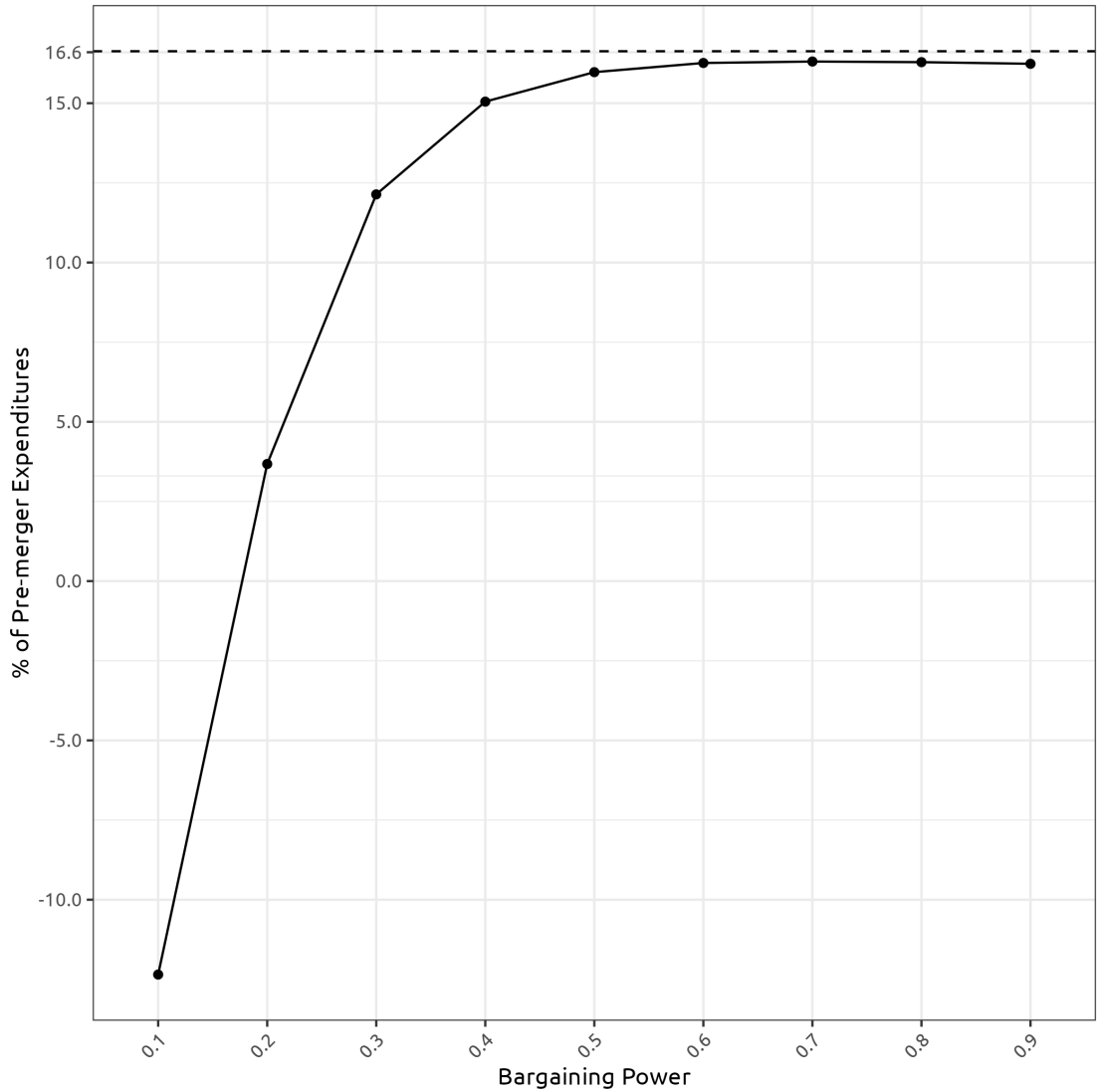
Consumer Harm and Outside Good Share



Consumer Harm and Nested Logit



Consumer Harm and Bargaining Power



Sensitivity Analysis Results

1. Consumer harm falls as substitution outside market increases. Harm still above 5% when market is unit elastic.
2. Consumer harm rises as preferences for integrated products increases, falls as preferences for landfills increases. Harm still above 5% when landfill nesting parameter is as high as 0.6.
3. Consumer harm falls as retailer bargaining power decreases. Harm similar to baseline when bargaining power is as low as 0.4.