

# The Effects of Vertical Arrangements in a Vertical Supply Chain\*

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## **Abstract**

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\*The analysis and conclusions set forth are those of the authors and do not indicate concurrence by other members of the Board research staff, by the Federal Reserve Board of Governors, by the Federal Trade Commission, or by its Commissioners.

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# 1 Introduction

## Data Generating Process

This section provides an overview of our methodology, with additional details appearing in the Appendix. We simulate markets by randomly sampling shares from a Dirichlet distribution for 2, 3, 4, or 5 retailers or wholesalers, respectively.<sup>1</sup> We also assume that in the pre-merger state, anywhere from 0 to 4 retailers are vertically integrated with a single wholesaler. We assume that vertically integrated wholesalers supply inputs to non-integrated retailers and that vertically integrated retailers purchase inputs from non-integrated wholesalers. The price coefficient  $\alpha$  is calibrated by assuming that in the pre-merger world, there is a vertically integrated outside option available to all customers. The other goods are differenced relative to this option, which maintains the outside good normalization. The market size is set to 1.

We specify values for the bargaining parameter ranging from 0.1 (wholesalers have the advantage) to 0.9 (retailers have the advantage). To better understand the relative bargaining strength of these parameter values, we report our results in terms of  $(1 - \lambda)/\lambda$ , which range from 9 (wholesaler power is nine times greater than retailer power) to 1/9 (retailer power is nine times greater than wholesaler power). The bargaining parameter is identical for all of the retailers in each simulation, unless noted otherwise.

For each combination of number of retailers, number of wholesalers, and bargaining parameter, we draw 1,000 different sets of market primitives. This results in 3.85 million merger simulations. We then eliminate mergers where the merger is unprofitable to the merging firms, as well as markets that do not pass the Hypothetical Monopolist Test, yielding 2.69 million markets.**discrepancy between res.nests dimension and ALL Counts in Table 1**<sup>2</sup> All 2.69 million markets treat as primitives the number of retailers, the number of

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<sup>1</sup>We parametrize the Dirichlet distribution so it is equivalent to a uniform distribution.

<sup>2</sup>The Hypothetical Monopolist Test requires that were a monopolist to jointly own all products in a

wholesalers, the bargaining parameter, and the wholesaler and retailer marginal costs, which we allow to be either constant or linear.

When simulating a horizontal merger, we assign the products produced by the two largest firms in the market to a single entity post-merger. Similarly, when simulating a vertical merger, we assign the products produced by the largest wholesaler and the largest retailer to a single entity post-merger. This assignment is purposefully skewed towards mergers that are more likely to have competitive effects and to come under agency review.

Table ?? provides summary statistics across our various simulations.<sup>3</sup> The median average wholesale pre-merger price is \$4.5, and the median average retail pre-merger price is \$13. Because the market size is set to 1, these average prices are equal to total pre-merger expenditures. Pre-merger HHIs range between 2,820 at the 25<sup>th</sup> percentile to 5,013 at the 75<sup>th</sup>, with a median of 3,689. HHIs for horizontal downstream mergers increase by 2,015 points at the median, resulting in a median post-merger HHI equal to 4,914. HHIs for upstream mergers increase by 2,063 points at the median, resulting in a median post-merger HHI equal to 5,238. HHIs for vertical mergers increase by 1,055 points at the median, resulting in a median post-merger HHI equal to 5,995.<sup>4</sup> HHIs for integrated mergers increase by 2,770 points at the median, resulting in a median post-merger HHI equal to 7,280. Many of these markets fall into the span designated by the DOJ/FTC Horizontal Merger Guidelines as “Highly Concentrated Markets,” with post-merger HHIs over 2,500 points and HHI Changes greater than 200 points.<sup>5</sup>

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candidate market, that firm would raise the price of at least one of the merging producers’ products by at least a “small but significant non-transitory increase in price” (SSNIP), which we take to be 5%.

<sup>3</sup>The `antitrust` R package contains the computer code needed to calibrate and simulate the effects of mergers in a range of competitive scenarios, including the ones described here.

<sup>4</sup>We compute the post-merger HHI for vertical mergers by calculating the merged firms’ market share as the sum of all the shares of downstream products that either incorporate the upstream partner’s input or are sold by the downstream partner.

<sup>5</sup>HHI thresholds are discussed in the 2010 Horizontal Merger Guidelines, Section 5.3.

## Results Overview

Our overall results are depicted in Figure 1, which is divided into four panels, each showing how the distribution of surplus changes for a particular set of agents (consumers, retailers, or wholesalers), as well as the net effect on the market as a whole. Surplus is presented as a percentage change relative to total pre-merger expenditure in the downstream market.

Each panel contains four pairs of box and whisker plots, with each pair corresponding to a different type of merger. The blue box and whisker plots (on the left in each pair) depict outcomes assuming that marginal costs are constant, and the orange box and whisker plots (on the right in each pair) show outcomes assuming that marginal costs are linear. The whiskers display the 5<sup>th</sup> and 95<sup>th</sup> percentiles of the outcome distribution, the boxes denote the 25<sup>th</sup> and 75<sup>th</sup> percentiles, and the solid horizontal line marks the median. Note that negative outcome values imply agent harm, and positive values imply agent benefits.

We focus first on the results for consumers in the left-most panel of Figure 1. The median change is negative, indicating harm, across all four types of mergers for both cost specifications. However, the distributions and magnitudes differ. In particular, there is only a partial rank-ordering of consumer harm across different types of mergers: consumer harm from integrated mergers first-order stochastically dominates consumer harm from all other merger types, while downstream and upstream mergers each first-order stochastically dominate consumer harm from vertical mergers, but do not stochastically dominate one other. Median consumer harm from integrated mergers is about 16% of pre-merger total expenditures, 1.37 times the magnitude of that from downstream mergers, 2.4 times the magnitude of that from upstream mergers, and more than 3.5 times the magnitude of vertical mergers.

Consumer harm is less prevalent for mergers where firms have constant marginal costs than when firms have linear costs. Vertical mergers when firms have constant marginal costs benefit consumers in about 30% of all simulations, but only in about 2.3% of simulations

when firms have linear costs. Upstream mergers with constant marginal cost firms benefit consumers in about 12% of simulations, but only 0.2% of simulations when firms have linear costs. Downstream mergers with constant marginal cost firms benefit consumers in about 11% of simulations, but only about 6% of simulations when firms have linear costs. Finally, integrated mergers benefit consumers in about 10% of all simulations when firms have constant costs, but less than 1% of simulations when firms have linear costs.

**Is it worth exploring which effect dominates: the lessening of EDM or the strengthening of RRC? Maybe do this by allowing assymetric cost structures between merging and non-merging parties?**

Turning to retailers in the second panel of Figure 1, we find that while downstream mergers, vertical mergers and integrated mergers always benefit retailers, upstream mergers harm retailers in about 70% of all simulations. Moreover, there is a partial rank-ordering across mergers: the retailer surplus distribution from integrated mergers first-order stochastically dominates the retailer surplus distribution from downstream mergers, which dominates the retailer surplus distribution from upstream mergers, but not the retailer surplus distribution from vertical mergers. We also find that for upstream, vertical, and integrated mergers, retailer surplus under constant marginal cost first-order stochastically dominates the retail surplus distribution under linear costs, again suggesting that the incentive to raise rivals' costs dominates the benefits from EDM. By contrast, for downstream mergers, there is no clear rank-ordering between markets with constant marginal costs and markets with linear costs.

As for wholesaler surplus, which appears in the third panel, the effects seen there are largely the reflection of those for retailers: wholesaler surplus increases in about 82% of all upstream simulated mergers, 28% of simulated vertical mergers, 20% of simulated downstream mergers, and 17% of simulated integrated mergers. However, only wholesaler surplus from upstream mergers first-order stochastically dominates the wholesaler surplus of the

other merger types.

In terms of total welfare, with the exception of the approximately 10% of vertical mergers and 8.5% of integrated mergers with constant costs that are beneficial, our simulated mergers are almost always net harmful. Moreover there is a complete rank ordering of mergers, with total harm from integrated mergers first-order stochastically dominating total harm from downstream mergers, which dominates total harm from upstream mergers, which dominates total harm from vertical mergers. Finally, for each merger type, total harm under linear costs first-order stochastically dominates total harm under constant marginal costs, with the greatest differences occurring for vertical and integrated mergers.

## Vertically Integrated Incumbent Firms

Here, we examine merger outcomes when a vertically integrated merges with either an un-integrated upstream or unintegrated downstream firm, or another integrated firm. We also examine merger outcomes for these integrated mergers as the number of integrated non-merging firms increases.

Figure 2 depicts box and whisker plots summarizing consumer harm (blue, left) and total harm (orange, right) as the number of incumbent integrated firms increases from 0 to 6 firms. The box and whisker plots when the number of incumbent integrated firms equals 0 correspond to the results depicted in Figure 1 of Sheu and Taragin (2017)<sup>6</sup>. For downstream and upstream mergers, the plots when the number of incumbent integrated firms equals 1 depict the outcome of a merger between an integrated firm and an unintegrated rival, and all 3rd parties are unintegrated. By contrast, for vertical mergers, the plots when the number of incumbent integrated firms equals 1 depict the outcome from an unintegrated wholesaler merging with an unintegrated retailer when a single 3rd party is integrated. Likewise, for

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<sup>6</sup>Important differences between the simulations depicted in Figure 2 and those in Figure 1 of Sheu and Taragin (2017) is that these results exclude downstream markets where prices are set according to a 2nd score auction, but include markets where costs are linear as well as constant.

integrated mergers, the plots when the number of incumbent integrated firms equals 2 depict a merger between two integrated firms, and all rivals are unintegrated.

Starting with downstream mergers (leftmost column), absent incumbent vertical integration (0 integrated firms), not only are downstream mergers rarely beneficial, but median consumer harm from downstream mergers is about 9% of pre-merger revenues while total harm is about 5% of pre-merger revenues. A merger between an incumbent integrated firm and an unintegrated retailer when all other market participants are unintegrated (1 integrated firm) increases the range of outcomes while also increasing median harm: consumer welfare is positive in more than 13% of mergers and total welfare is positive in 3.4%, but median consumer harm increases to 14% and median total harm increases to 7.6% of pre-merger revenues. Increasing the number of integrated 3rd parties to 1 (2 integrated firms) shrinks the inter-quartile range but has little impact on median harm. Adding additional integrated 3rd parties (3 integrated firms) further decreases the range of outcomes while also decreasing median harm. With 3 integrated 3rd parties (4 integrated firms), a downstream merger between an integrated and unintegrated firms benefits consumers in about 20% of markets and shrinks median consumer harm to about 6% of pre-merger revenues. By contrast, with 3 integrated 3rd parties, the inter-quartile range shrinks, and median total harm falls to about 3.7% of pre-merger revenues.

Like downstream mergers, not only are upstream mergers absent incumbent vertical integration rarely beneficial, but median consumer harm from upstream mergers is about 6% of pre-merger revenues and total harm is about 3% of pre-merger revenues. A merger between an incumbent integrated firm and an unintegrated retailer when all other market participants are unintegrated (1 integrated firm) increases the proportion of beneficial mergers but does little to change median harm: consumer welfare is positive in less than 8% of mergers and total welfare is positive in 2.3% of mergers, but median consumer harm increases to 7% and median total harm increases to 4.8% of pre-merger revenues. Increasing the number of integrated 3rd parties to 1 (2 integrated firms) shrinks the inter-quartile range but has little

impact on median harm. Adding additional integrated 3rd parties (3,4 integrated firms) further decreases the range of outcomes while leaving median harm largely unchanged.

Turning to vertical mergers, absent incumbent integration, about 22% of vertical mergers benefit consumers and about 14% of vertical mergers increase total surplus. The presence of a single 3rd party integrated firm (1 integrated firm) decreases the percentage of mergers that benefit consumers to 14.5% and the percentage of mergers that increase total surplus to 9.6%, but leads median harm largely unchanged. Interestingly, while adding a second integrated incumbent to the market also lowers the percentage of beneficial mergers, adding a third integrated firm increases the percentage of mergers that benefits consumers to about 15%, and the percentage of mergers that increase total surplus to 6.9%. Adding a fourth integrated incumbent has a similar effect to adding a third incumbent.

Finally, absent the presence of rival incumbent integrated firms, mergers between two integrated firms harm consumers in about 96% of simulated markets and lowers total surplus in more than 92% of simulated markets. while adding one additional rival incumbent integrated firm (3 integrated firms) has little effect on either the distribution of consumer or total surplus, additional integrated rivals eliminate the most harmful integrated mergers while also increasing median consumer harm by as much as 13.3% (5 integrated firms) and median total harm by as much as 8.4%.

## **Bargaining Power**

Sheu and Taragin (2017) show using numerical simulation that downstream and vertical mergers where wholesalers have relatively more bargaining power are less harmful than mergers where retailers have relatively more bargaining power. Here, we show that this result continues to hold when there are rival incumbent integrated firms. We also show that this relationship holds for integrated mergers as well as downstream and upstream mergers when one of the merging parties is vertically integrated.



Figure 3 depicts box and whisker plots summarizing the consumer (top) and total (bottom) welfare effects for downstream, upstream, and vertical mergers as the number of incumbent integrated firms increases from 0 to 1 and finally 4 incumbent vertically integrated firms. Plots when the number of integrated firms is 0 assume that pre-merger, no firms in the market are vertically integrated: these are comparable to those in Sheu and Taragin (2017). For downstream (left) and upstream (middle) mergers, the plots when the number of incumbent integrated firms equals 1 depict the outcome of a merger between an integrated firm and an unintegrated rival, and all 3rd parties are unintegrated. By contrast, for vertical mergers (right), the plots when the number of incumbent integrated firms equals 1 depict the outcome from an unintegrated wholesaler merging with an unintegrated retailer when a single 3rd party is integrated. Finally, plots with 4 integrated firms increases the number of rival incumbent integrated firms in upstream and downstream mergers to 3 and in vertical mergers to 4 .

For downstream mergers, when no incumbent firms are in the market (0 integrated firms), there is a positive relationship between bargaining power and both consumer and total harm. Median consumer harm decreases from about 18% of pre-merger expenditures when retailers have relatively more bargaining power to about 1% of pre-merger expenditures when wholesalers have relatively more bargaining power. Likewise, median total harm decreases from 7.5% of pre-merger expenditures when retailers have relatively more bargaining power to 2% when wholesalers have relatively more bargaining power. By contrast, mergers between an integrated and unintegrated upstream supplier (1 integrated firms), causes the box and whisker plots to rotate clockwise around equal bargaining power, strengthening the positive relationship between bargaining power and both consumer and total surplus. Increasing wholesaler bargaining power causes median consumer harm to fall from 25% of pre-merger revenues to -11% of pre-merger revenues, while median total harm falls from 12.5% to 2% of pre-merger revenues. Adding additional rival incumbents (4 integrated firms) has the reverse effect, rotating the box and whisker plots counter-clockwise and weakening the still

positive relationship between bargaining power and surplus. Here, increasing wholesaler bargaining power causes median consumer harm to fall from 14% of pre-merger revenues to -1.7% of pre-merger revenues, while median total harm falls from 5.3% to 1.9% of pre-merger revenues.

Turning to upstream mergers, when no incumbent firms are in the market (0 integrated firms), there is a negative relationship between bargaining power and both consumer and total harm. Median consumer harm increases from about 2% of pre-merger expenditures when retailers have relatively more bargaining power to about 31% of pre-merger expenditures when wholesalers have relatively more bargaining power. Likewise, median total harm increases from 0.7% of pre-merger expenditures when retailers have relatively more bargaining power to 14% when wholesalers have relatively more bargaining power. By contrast, for mergers between an integrated and unintegrated upstream supplier (1 integrated firms), there is a positive relationship between bargaining power and both consumer and total surplus. Median consumer harm increases from about 8.5% of pre-merger expenditures when retailers have relatively more bargaining power to about -20% of pre-merger expenditures when wholesalers have relatively more bargaining power. Likewise, median total harm increases from about 3.5% of pre-merger expenditures when retailers have relatively more bargaining power to -4.4% when wholesalers have relatively more bargaining power. Adding 2 additional incumbent integrated firms (4 integrated firms only strengthens the positive relationship between bargaining power and harm.

Unlike downstream or upstream mergers, where the presence of vertically integrated incumbent firms can affect either the magnitude or direction of the relationship between bargaining power and harm, the presence of integrated incumbents has little impact on the strong, positive relationship between bargaining power and harm for vertical mergers. Figure 3 shows that consumer harm when there are fewer incumbent integrated firms first-order stochastically dominates consumer harm when there are more incumbent integrated firms, the difference is smallest when wholesalers and retailers have equal bargaining power

and greatest as wholesaler power increases relative to retailer power.

Finally, Figure 4 depicts box and whisker plots summarizing consumer, retailer, wholesaler and total surplus for integrated mergers with 2, 4, or 6 integrated firms. When the number of incumbent integrated firms equals 2, Figure 4 depicts a merger between two integrated firms: all rivals are unintegrated. Plots with either 4 or 6 integrated firms depict mergers between integrated incumbents when there are either 2 or 4 rival integrated firms in the market.

In terms of the relationship between bargaining power and harm, integrated mergers are perhaps most similar to vertical mergers. Like vertical mergers, there is a strong monotonic relationship between bargaining power and harm. Median consumer harm increases from about 26% of pre-merger expenditures when retailers have relatively more bargaining power to about -1.4% of pre-merger expenditures when wholesalers have relatively more bargaining power. Likewise, median total harm increases from 16% of pre-merger expenditures when retailers have relatively more bargaining power to -13% when wholesalers have relatively more bargaining power.

A second similarity between vertical and integrated mergers is that the presence of integrated incumbents has little impact on the strong, monotonic relationship between bargaining power and harm. However, unlike vertical mergers, consumer harm from integrated mergers when there are fewer incumbent integrated firms does not first-order stochastically dominate consumer harm when there are more incumbent integrated firms.

An important difference between vertical and integrated mergers is that while vertical mergers are often beneficial when wholesalers have relatively more bargaining power, integrated mergers are often harmful unless wholesaler relative bargaining power exceeds  $7/3$ . In this way, integrated mergers are more similar to downstream mergers, or upstream mergers in markets with vertically integrated incumbents.

**Describe the counterintuitive result that increasing retailer bargaining power**

harms retailers but help wholesalers.

Costs

## References

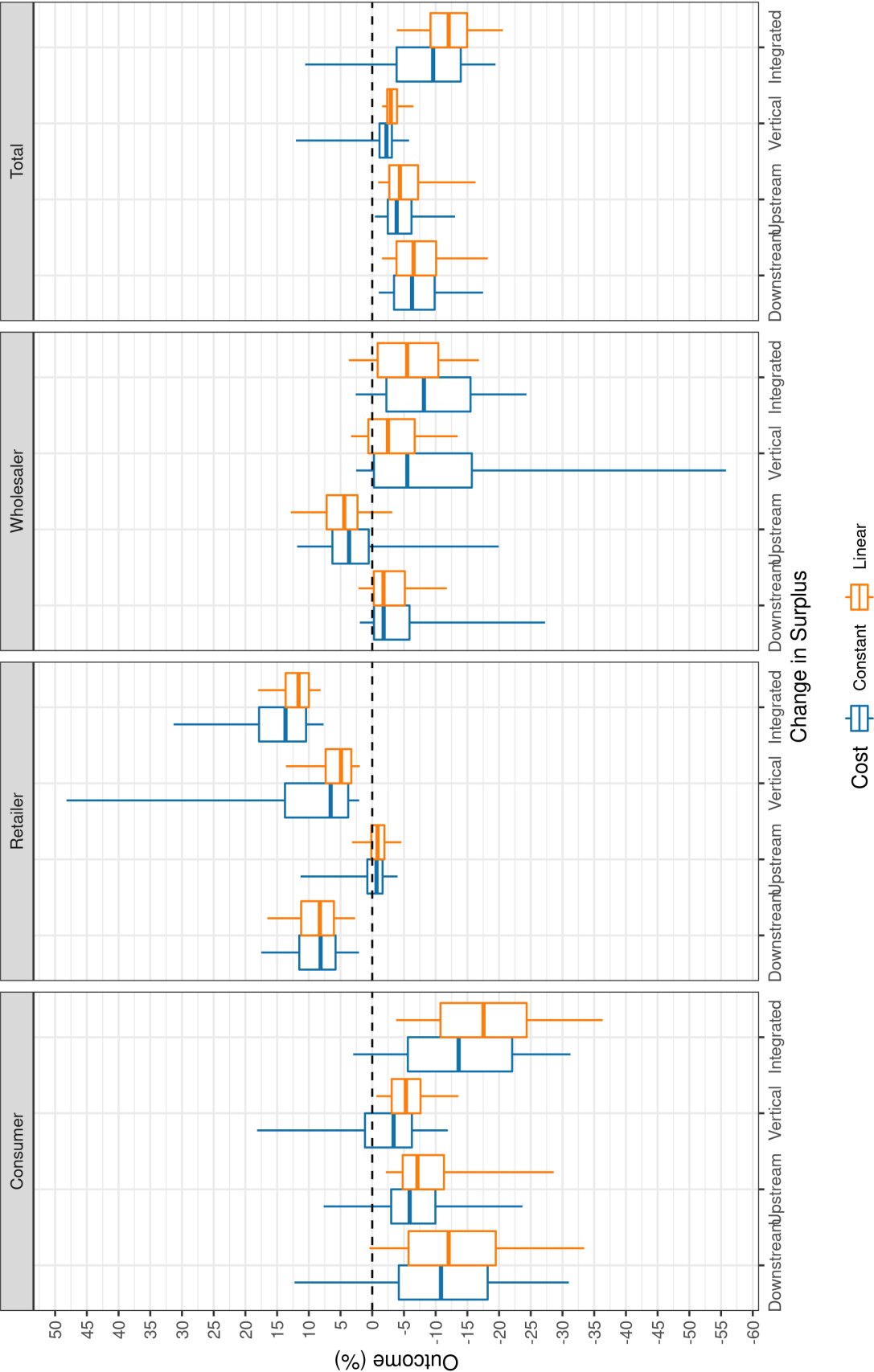
Sheu, G. and C. Taragin (2017). Simulating Mergers in a Vertical Supply Chain with Bargaining. EAG Discussion Papers 17-3, Economic Analysis Group.

Variable	Merger	Markets	Min	25th	50th	75th	Max
\# Retailers	All	2,687,297	2	3	4	5	5
\# Wholesalers			2	3	4	5	5
\# Integrated			0	0	1	3	6
Bargaining Power			0.1	0.4	0.6	0.8	0.9
Nesting Parameter			0	0	0	0	0
Avg. Upstream Price ()			0.19	2.3	4.5	9	253
Avg. Downstream Price ()			5.8	10	13	19	276
Market Elasticity			-61	-0.89	-0.52	-0.38	-0.23
Pre-Merger HHI	Integrated	679,620	2,178	3,620	4,298	5,515	9,996
	Upstream	756,570	2,010	2,574	3,171	4,236	10,000
	Downstream	745,941	2,010	2,374	2,852	3,733	10,000
	Vertical	505,166	2,118	3,620	4,386	5,554	9,970
Post-Merger HHI	Integrated	679,620	3,449	6,278	7,280	8,707	10,000
	Upstream	756,570	2,931	4,150	5,238	7,380	10,000
	Downstream	745,941	2,926	3,983	4,914	6,688	10,000
	Vertical	505,166	3,118	5,070	5,995	7,216	10,000
Delta HHI	Integrated	679,620	4	2,442	2,770	3,135	4,996
	Upstream	756,570	0	1,455	2,063	2,952	5,000
	Downstream	745,941	0	1,543	2,015	2,873	5,000
	Vertical	505,166	24	1,055	1,298	1,765	4,376

Table 1: Summary Statistics

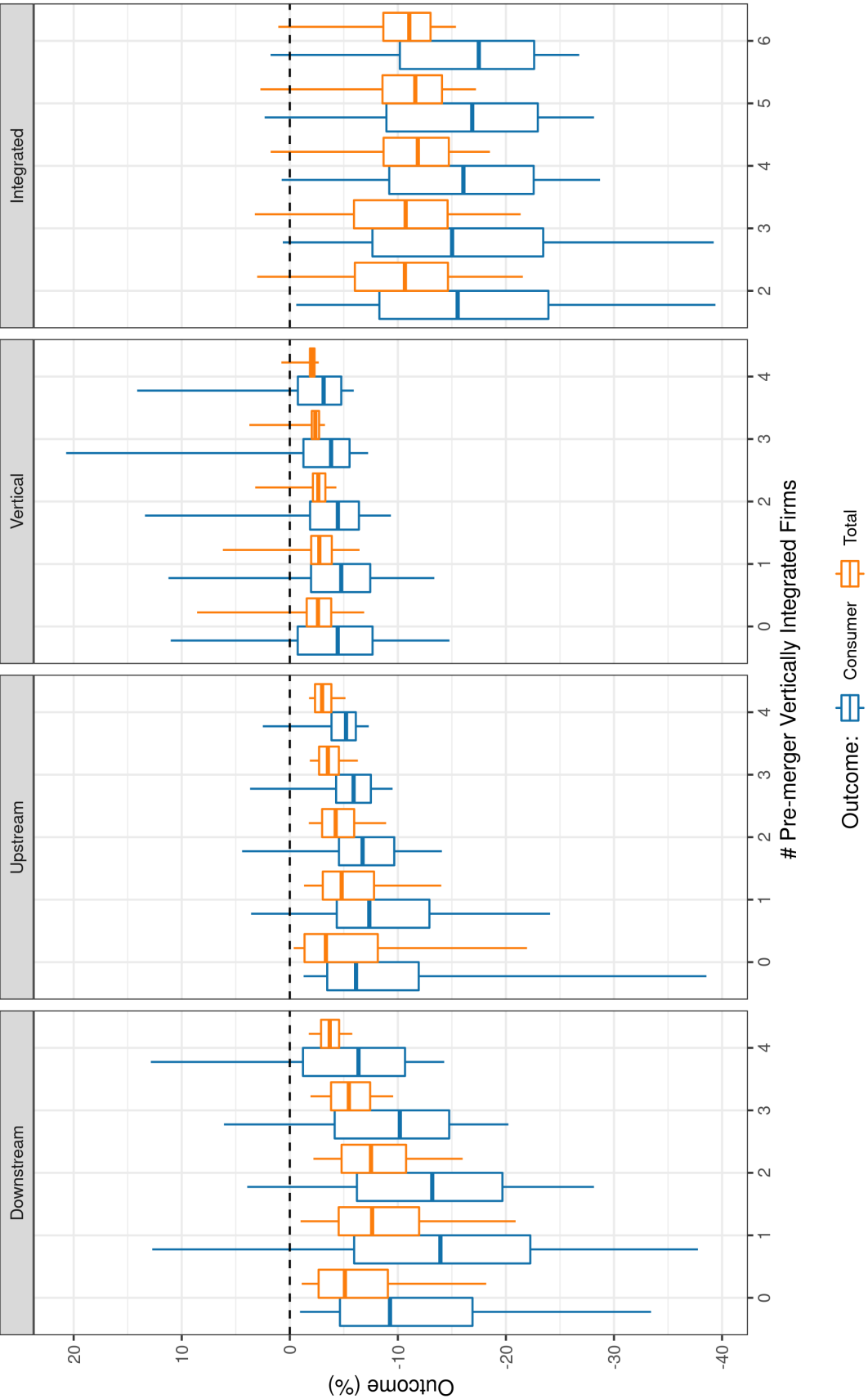
# The Distributions of Merger Outcomes

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



**Figure 1** The figure displays box and whisker plots summarizing the extent to which mergers affect consumer, retailer, wholesaler, and total surplus. Each blue box depicts the effects assuming that firms face constant marginal costs, while each orange box depicts the effects assuming that firms face linear marginal costs. Whiskers depict the 5<sup>th</sup> and 95<sup>th</sup> percentiles of a particular outcome, boxes depict the 25<sup>th</sup> and 75<sup>th</sup> percentiles, and the solid horizontal line depicts the median.

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.

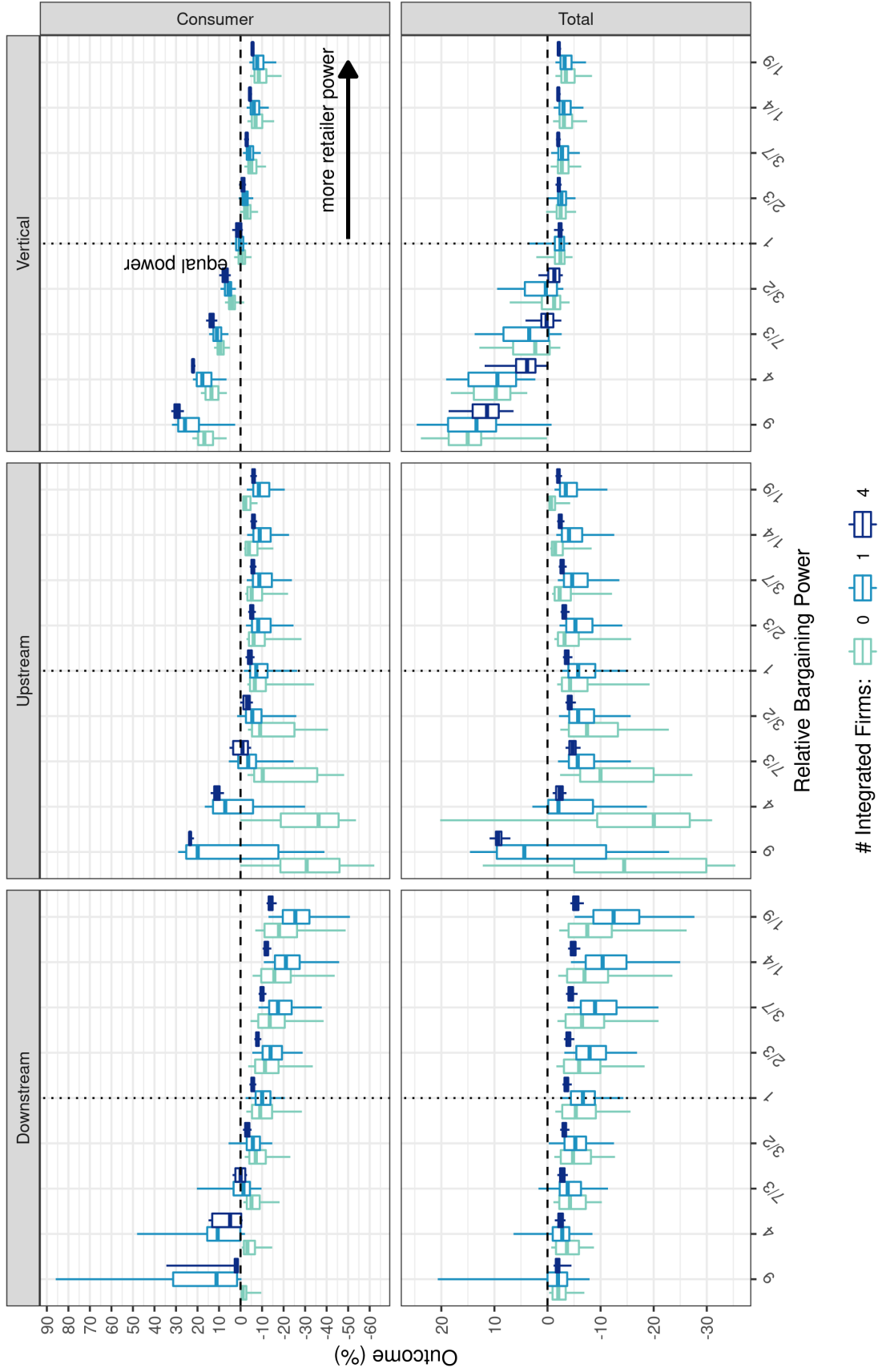


**Figure 2** The figure displays box and whisker plots summarizing the extent to which mergers affect consumer (blue, left) and total (orange, right) surplus as the number of vertically integrated firms present in a market change. Whiskers depict the 5<sup>th</sup> and 95<sup>th</sup> percentiles of a particular outcome, boxes depict the 25<sup>th</sup> and 75<sup>th</sup> percentiles, and the solid horizontal line depicts the median.



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

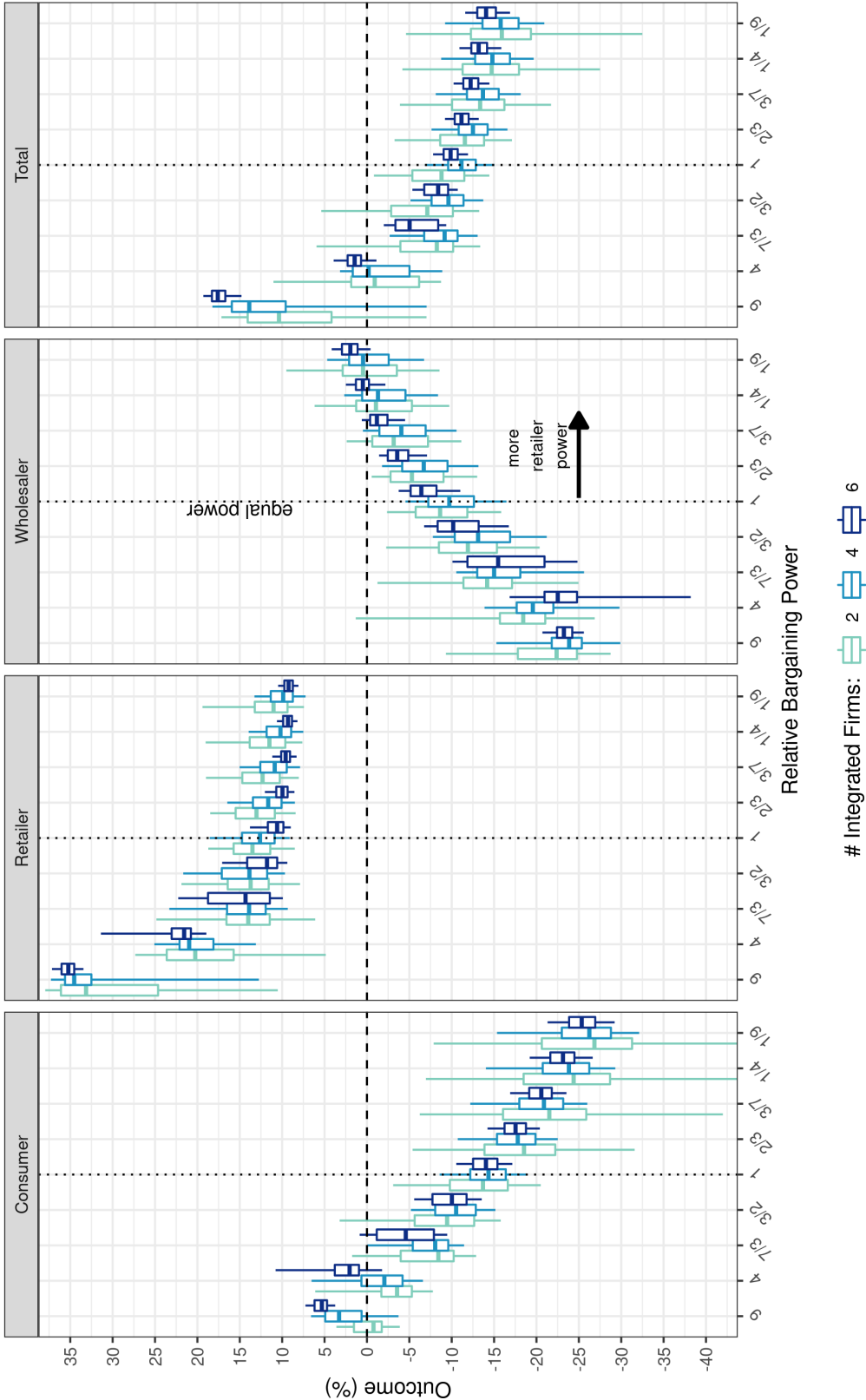
Outcomes are reported as a percentage of pre-merger total expenditures.



**Figure 3** The figure displays box and whisker plots summarizing the extent to which downstream, upstream, and vertical mergers affect consumer, and total surplus as the bargaining power of wholesalers relative to retailers changes. The different colored boxes display how outcomes change as the number of vertically integrated firms increases. Whiskers depict the 5<sup>th</sup> and 95<sup>th</sup> percentiles of a particular outcome, boxes depict the 25<sup>th</sup> and 75<sup>th</sup> percentiles, and the solid horizontal line depicts the median.

# How Changing Bargaining Strength Affects Surplus in an Integrated Merger

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



**Figure 4** The figure displays box and whisker plots summarizing the extent to which mergers among two integrated wholesalers and retailers affect consumer, retailer, wholesaler, and total surplus as the bargaining power of wholesalers relative to retailers changes. The different colored boxes display how outcomes change as the number of vertically integrated firms increases. Whiskers depict the 5<sup>th</sup> and 95<sup>th</sup> percentiles of a particular outcome, boxes depict the 25<sup>th</sup> and 75<sup>th</sup> percentiles, and the solid horizontal line depicts the median.