Countervailing Power in a Vertical Market Experiment

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Abstract

In a vertical market experiment featuring a wholesale market and a retail market we investigate the countervailing power hypothesis Galbraith (1952). Counter to standard models of imperfect competition this hypothesis proposes that increasing concentration of retail firms might actually be beneficial for consumers due to the retailers' increase in power vis-à-vis wholesalers. In the experiment we vary the number of retailers (4 retailers versus 2 retailers) and the outside option wholesale price (low versus high) to implement changes in retailer power. We show that reducing the number of retailers alone is insufficient to induce a lower retail price. It is feasible with an additional change in the outside option wholesale price. The countervailing power hypothesis in its narrow sense fails in our experiment for

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two reasons: The reduction in retailer number is insufficient to implement a strong wholesale price reduction, and in addition it increases collusion, which works against the countervailing power hypothesis. Thus, our experiment supports a critical view of Galbraith's theory.

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1 Introduction

High market concentration due to a low number of firms is disadvantageous for consumers. The firms have market power and compared to a perfectly competitive market they may sell a lower quantity at a higher price thereby reducing consumer surplus and total welfare. This is the standard view in economic theory, and a common understanding among policy makers. It has led to anti-trust legislation and legal institutions monitoring market developments.

In vertical markets, with wholesalers (producers), retailers and consumers, the effect of a changing number of firms is not so obvious. If the number of retailers decreases (increasing retail market concentration) the retailers gain market power vis-à-vis the consumers, but also vis-à-vis the wholesalers. If the wholesale market is non-competitive this change in market power might reduce the wholesale price giving retailers a possibility to pass on the received cost savings to the consumers.

This idea has been formulated by J. K. Galbraith, in his seminal book *American Capitalism: The Concept of Countervailing Power*, Galbraith (1952). The term "countervailing power" describes the fact that the increase in retailer market power may counterbalance the power of one or a few large wholesalers or producers. According to Galbraith regulation is unnecessary:[1] If market power exists on one side of the market due to a monopoly or oligopoly, countervailing power will arise on the other side of the market and restrain the exercise of market power. The rise of large retail firms is seen as an important manifestation of such countervailing power. They "are required by their situation to develop countervailing power on the consumer's behalf."[2] Large retailers compared to small retailers achieve lower wholesale prices and pass on those cost savings to their customers.

Galbraith's idea was perceived rather negatively by economists at the time. According to Stigler (1954) it was lacking theoretical foundation. Indeed, Galbraith did not provide a formal market model in support of the countervailing power effect. However, with the

[1] See Galbraith (1956), p. 112.
[2] Galbraith (1956), p.117

rise of non-cooperative game theory, especially with the introduction of the concept of subgame perfect equilibrium (Selten, 1965, 1975), modeling and analyzing vertical market structures became feasible. Starting with Von Ungern-Sternberg (1996) several authors have picked up the issue and determined theoretical conditions under which countervailing power might occur. We will discuss this literature in more detail in section 2.

Besides the theoretical question there is the empirical question: Under which conditions, if any, does countervailing power occur in real markets and is beneficial for consumers? – While this is obviously an important empirical question, it is rather difficult to investigate using field data. Changes in retail market concentration over time are usually accompanied by many other changes that potentially affect wholesale price or retail price or both: For example, if a wholesaler has fixed cost of selling to a retailer or non-constant marginal cost or both, selling larger quantities to fewer retailers will change the wholesale price. Similarly, depending on the retailer's cost structure, the cost per unit and consequently the retail price might change when the retail market share changes. Thus, using field data makes it difficult to disentangle the various sources for price changes. This is feasible, however, with experimental data. Experiments may achieve ceteris paribus manipulations that are difficult to find with field data.

In our experiment we rely on the vertical market structure in Von Ungern-Sternberg (1996). In his model the wholesale market featured a monopolist producer and several retailers with the wholesale price determined according to the Nash bargaining solution. The Nash bargaining solution responds to the number of retailers such that a reduction in the number of retailers decreases the wholesale price. The retail market featured several retailers and many consumers (with the latter modeled as a linear demand function). Retailer behavior was modeled in two variants, as Cournot behavior or competitive behavior. Von Ungern-Sternberg's conclusions were (1) that under Cournot behavior a decreased number of retailers is bad for consumers, but (2) that consumers might benefit under competitive retailer behavior. He wrote: "that countervailing power can have positive effects for the consumers only if competition at the retail level is very fierce".[3]

[3]Von Ungern-Sternberg (1996), p. 507.

The theoretical results of Von Ungern-Sternberg (1996) give important directions for empirical investigations of the countervailing power effect. Namely, it may be found more easily in a vertical market with relatively strong competition at the retail level (retail price is relatively insensitive to changes in the number of retailers) and a wholesale price which is relatively sensitive to changes in retailer number. In natural markets it is not clear how strong bargaining outcomes respond to the number of bargaining parties. Furthermore, it is open how competitive retailers behave. Similarly, in an experiment bargaining behavior should respond to the number of retailers and behavior at the retail market should be relatively competitive. We design the experiment such that we may expect this to hold. The retail market is organized as a double auction market which is known to bring out relatively competitive outcomes. The wholesale market is organized as an ultimatum game with the wholesaler offering a wholesale price which may be accepted or rejected by the retailers. It is known from many experiments that ultimatum offers are rejected if they are too greedy. Consequently, the wholesaler has to take the risk of rejection into account and this risk may depend on the number of retailers. This argument establishes a responsiveness of the wholesale price to the number of retailers which is necessary (but not sufficient) for the countervailing power effect.

In this paper we report an experiment on a vertical market structure comprising a wholesale market and a retail market. In our baseline treatment ("LOW" = low retailer power) there is a single wholesaler, four multi-unit retailers and four multi-unit buyers. The wholesaler announces an offered wholesale price. The retailers may agree to this offer or accept an outside option wholesale price instead. Thus, the wholesale market has the character of an ultimatum game. Afterwards the retail market starts. It is organized as a double auction. After bidding in the double auction has settled, we restart the game (wholesale market and retail market) for a second trading period. This continues for 15 periods to allow for learning.

In a second treatment ("MID" = intermediate retailer power) we increase retailer concentration by reducing the number of retailers to two. Everything else is kept the same as in LOW. In order to keep the aggregate retailer cost structure constant between treatments, each of the two retailers are modeled as a merger (or take-over) of two retailers of the LOW treatment. In addition, we apply a third treatment ("HIGH" = high retailer power) in which we reduce the outside option wholesale price and keep everything else the same as in MID. This treatment increases retailer power vis-à-vis the wholesaler keeping retail market power constant.

The countervailing power effect as hypothesized by Galbraith (1952) says that increasing concentration of retailers is beneficial for consumers in the sense that it may induce a decrease in retail price. This is our main hypothesis:

Hypothesis 1: Increasing countervailing power decreases the retail price.

The countervailing power effect hinges on three partial effects: That a power increase induces a reduction in wholesale price w, that a reduction in w is passed-through to consumers in the retail market, and that the decrease in the number of retailers does not increase collusion among retailers. We investigate these issues as well (Hypotheses 2, 3 and 4).

Our empirical findings are mixed: We find some evidence for the countervailing power effect, but only if we strongly increase the retailers' power by reducing the outside option wholesale price. Merely decreasing the number of retailers is not sufficient to reduce the offered wholesale price, and consequently it does not significantly reduce the retail price. Wholesale price and retail price are positively correlated but the pass-through rate of a wholesale price reduction is relatively small. Retail pricing is more collusive with 2 rather than 4 retailers. Overall our experiment supports a critical view of the countervailing power hypothesis.

The paper is organized as follows: Section 2 discusses related literature. Section 3 describes the experimental market structure, empirical hypotheses and theoretical benchmark solutions. Sections 4 and 5 describe experimental procedures and empirical results. Section 6 concludes.

2 Related Literature

2.1 Theoretical literature

The first game theoretical analysis investigating the countervailing power hypothesis in a vertical market structure that combines a wholesale (upstream) market and a retail (downstream) market is provided by Von Ungern-Sternberg (1996). His model relies on a quantity choice (Cournot) oligopoly at the retail stage of the game, and he concludes that countervailing power leads to lower consumer prices only if downstream competition is fierce. Dobson and Waterson (1997) find a similar result for price-choice (Bertrand) retailers when the degree of product differentiation is low. [4] Tyagi (1999) generalizes Greenhut and Ohta (1976) and establishes the independence between the supplier's optimal input price and the number of downstream competitors for a wide set of demand functions, including the linear one that we employ in our experiment.

The effects of downstream mergers on input or consumer prices have been analysed in the literature from different angles.

Due to a merger, input buyers can improve their bargaining position towards the input supplier, provided that the curvature of the supplier's surplus function is concave. This is shown in Chipty and Snyder (1999) and experimentally tested in Normann, Ruffle, and Snyder (2007). However, in these models input buyers do not compete with each other for consumers as they operate in segmented markets. Therefore any collusive effect due to higher concentration in the downstream markets cannot be investigated.

Iozzi and Valletti (2014) show that if supplier-retailer negotiation breakdowns are observable to rival retailers, input prices are higher under Cournot competition with differentiated products compared to non-observable breakdowns. The result is reversed for price competition.

Symeonidis (2010) shows that downstream mergers can lower input and consumer prices under decentralised bargaining, linear tariffs and Cournot competition with differentiated products. Lower input prices arise because the merged firm bargains with two

[4] Greenhut and Ohta (1976) have examined the relation between the structure of the downstream market and input prices without referring to buyer or countervailing power. See also Perry (1978).

input suppliers, introducing some rivalry among otherwise independent retailers.

Gaudin (2018) questions the robustness of countervailing power effects that rely on linear demand systems. He demonstrates that a necessary condition for countervailing buyer power to emerge is that the retail market displays an increasing pass-through rate of input prices to retail prices. If the manufacturer makes take-it-or-leave-it offers in the form of linear contracts, then an increasing pass-through rate is also sufficient to induce lower input prices for a broad range of demand systems. The explanation of this general result is described in Gaudin (2018): *An increase in retail market concentration induces an upward pricing pressure because of heightened market power. When the retail pass-through rate is increasing, this pricing pressure is amplified, for a given input price. As a response, in equilibrium, the manufacturer lowers the input price to alleviate the output reduction effect which results from this upward pricing pressure. By contrast, when the pass-through rate is decreasing, the manufacturer can raise its input price with limited effect on quantity. Moreover, a major determinant of the magnitude of input price changes is the reaction of competition intensity to a change in market concentration, which is roughly equivalent to the degree of product differentiation.*" Gaudin (2018) shows that even when an increase in downstream concentration causes a countervailing buyer power effect (input price falls), consumers are worse-off because the countervailing effect is in general not sufficient to offset the market power effect (consumer price rises). Our experimental study confirms this result.

If the pass-through rate of input prices to retail prices is the main driving force of countervailing power, then what determines the pass-through rate? Adachi and Ebina (2014); Bresnahan and Reiss (1985); Bulow and Pfleiderer (1983); Weyl and Fabinger (2013) attribute the pass-through rate on consumer demand curvature and furthermore Gaudin (2016) on the type of vertical contract and players' relative bargaining power. Under two-part tariffs, the pass-through rate is independent of the bargaining power while under revenue-sharing agreements, the retail pass-through rate increases in the manufacturer's bargaining power. This finding is in line with Chen (2003), Dobson and Waterson (2007) and Christou and Papadopoulos (2015) who provide a different interpretation of

Galbraith's concept namely that countervailing buyer power corresponds to an increase in a retailer's exogenously given bargaining power parameter.

2.2 Empirical Literature

While Galbraith's countervailing power hypothesis had no theoretical foundation until the 90's, it was studied empirically already in the 70's. The early studies of Gabel (1983); Guth, Schwartz, and Whitcomb (1976); Lustgarten (1975) and later Schumacher (1991) were in the Structure-Conduct-Performance tradition. They were in favor of the countervailing power argument mostly by showing significant statistical correlation between concentration indices on the seller's side and the buyer's side across industries and also concentration on the one side of the market and profitability on the other side.

Chipty and Snyder (1999) estimate the gross surplus function for suppliers of program services to be convex, and in line with theory a merger worsens the buyers' bargaining position. Dobson, Clarke, Davies, and Waterson (2001) document increasing concentration in the food retail distribution sector of the European Union and consider the impact of buyer power from a welfare point of view.

Regarding the US market, there is a series of studies on the so-called "Wal-Mart effect" on downstream competition, consumer prices and upstream profits, see for instance, Basker (2005); Bloom and Perry (2001); Mottner and Smith (2009) and the references therein. Sorensen (2003) empirically shows that large insurers obtain discounts for hospital services, because they are able to channel patients to lower-priced hospitals while the buyer size effect is small. Ellison and Snyder (2010) find that large drugstores in the U.S. pharmaceutical industry receive a modest discount for antibiotics produced by competing suppliers but no discount for antibiotics produced by monopolists. On the other hand, hospitals receive substantial discounts relative to drugstores. Both Sorensen (2003) and Ellison and Snyder (2010) emphasize supplier competition as a prerequisite for countervailing power. Beckert, Smith, and Takahashi (2020) find that in the UK brick industry there is bargaining over two-part tariffs and seller power is relatively stronger than buyer power. Countervailing power is modest and depends on the buyer's ability to switch suppliers.

Bonnet, Dubois, Boas, and Klapper (2013) show that the degree of pass-through from upstream cost shocks to downstream retail price of ground coffee is higher with vertical restraints and non-linear contracts. In other papers, Bonnet and Dubois (2015) and Bonnet and Dubois (2010) examine the market for bottled water in France. They conclude that manufacturers and retailers use two-part tariff contracts with or without resale price maintenance and identify the buyer power of retailers which stems endogenously from competing offers in the upstream level. An interpretation of these results provides insights on the type of contracts that may render countervailing power effective. Smith and Thanassoulis (2015) investigate prices and profits along the U.K. milk supply chain and show that any wholesale price increase that retailers concede in negotiations with processors is unlikely to have a direct effect on retail prices, while supermarkets enjoy the larger share in chain profits.

Concerning the relation between vertical bargaining and retail competition, Crawford and Yurukoglu (2012) showed that retail prices in the cable TV industry depend both on negotiated input prices at the wholesale level and competition at the retail level. Similar conclusions can be found in Draganska, Klapper, and Villas-Boas (2010) for the coffee industry and Ho and Lee (2017) for healthcare markets[5]. Craig, Grennan, and Swanson (2021) estimate that cost efficiencies and increased buyer power following a merger in the US hospital industry are modest. They lead to average input price savings of less than 3.1% for both target and acquirer firms. Barrette, Gowrisankaran, and Town (2021) empirically find that greater insurer concentration limits hospitals' exercise of market power and therefore countervailing power is important.

Last, Hollenbeck and Giroldo (2021) study lotteries on retail licences that feature exogenous variation in market concentration and find that more concentrated markets have significantly lower markups, retail and wholesale prices and thus provide evidence of countervailing buyer power by retailers.

[5] See also Gowrisankaran, Nevo, and Town (2015); Grennan (2013, 2014)

2.3 Experimental Literature

The experimental literature on countervailing buyer power is rather scarce.[6] Ruffle (2000) is the first experimental study to consider buyer concentration and its effect on price in a repeated posted-offer market. In a market with 2 sellers in Ruffle (2000), or one monopolist in Engle-Warnick and Ruffle (2005) reducing the number of buyers from 4 to 2 leads to significantly lower prices because of strategic demand withholding i.e. buyers refuse profitable trades at prices below their individual valuation levels. Buyers cannot negotiate the price in a posted-offer market, nevertheless in a repeated game they may strategically reject a profitable price offer in an attempt to force a lower price offer in the following rounds.[7] Lower prices in the two-buyers-one-seller experiment are attributed to the monopolist pricing more cautiously when there are fewer buyers in order to avoid foregone sales whereas in the two-buyers-two-sellers experiment, the two sellers are expected to compete more fiercely being afraid that if one buyer rejects, the market will transform to monopsony. Therefore, buyer concentration may be an effective source of countervailing power.

Davis and Wilson (2008) study the effect of a seller merger in experimental markets with simulated (passive) buyers compared to human (strategic) buyers and find lower prices in the latter treatment. Ruffle (2013) confirms experimentally the implications of Rotemberg and Saloner (1986) and Snyder (1998), where large buyers' ability to obtain price discounts depends on their relative size and the degree of seller competition (number of sellers).

Orland and Selten (2016) conduct experiments based on the oligopoly model by Kreps and Scheinkman (1983) to assess the impact of demand side concentration on market outcomes. By varying the number of buyers, they observe that firms set lower prices in markets with only one or two buyers. Aggregate demand withholding decreases with the number of buyers which leads to lower profits for sellers and higher profits for buyers in

[6]Ruffle (2005) provides a survey.

[7]Indeed, Engle-Warnick and Ruffle (2002) show that only one-quarter of the buyers in their experiments correspond to the game-theoretic prediction of passive price-taking, while three-quarters of the buyers adopt more sophisticated repeated-game strategies that can be inferred by a Bayesian method that best describes individuals' observed actions.

markets with few buyers.

The vertical market structure has at least three parties, wholesaler (or producer), retailer and consumer. All the abovementioned experimental studies do not rely on human participants for all parties but partially substitute them by parametric functions, e.g. a consumer demand function. Therefore, in the context of a vertical market, these studies cannot test the interaction between two consecutive markets, the wholesale market (supplier vs retailer) and the consumer market (retailer vs consumer) that is necessary to assess countervailing power and its price effects. Our experiment is the first one that goes all way. As Ruffle (2005), p.18, suggests "*One question left unanswered by most of this literature is whether the lower prices obtained by a large buyer or a highly concentrated buying side of the market are passed on to final consumers...These theoretical models beg experimental tests that include not only the usual negotiation between wholesalers and retailers, but an additional stage of competition between retailers for consumer demand*". Compared to previous experimental studies, the novelty of our vertical market experiment is that we introduce another stage of competition between retailers for consumer demand. Our experiment is the first to test directly how retail concentration affects price formation upstream, towards the supplier, and downstream, towards the consumers.

3 Experimental Market, Empirical Hypotheses and Theoretical Benchmark Predictions

3.1 Vertical Market Structure and Experimental Treatments

We investigate a vertical market structure that features a wholesale market (stages 1 and 2) and a retail market (stage 3) under 3 different experimental treatments. The baseline treatment LOW (low retailer power) has 4 retailers and a high outside option wholesale price. Treatment MID (intermediate retailer power) has 2 retailers and a high outside option wholesale price. Treatment HIGH (high retailer power) has 2 retailers and a low outside option wholesale price. The game runs as follows:

- At stage 1 a single wholesaler announces a wholesale price w for each unit sold.

- At stage 2 each retailer i, ($i = 1, 2, 3, 4$ in treatment LOW and $i = 1, 2$ in treatments MID and HIGH), either accepts the offered price ($w_i = w$) or rejects it in favor of an outside option[8] ($w_i = \bar{w}$). So together, stages 1 and 2, the wholesale market, comprise a variant of an ultimatum game to determine the wholesale price. The quantities sold by the wholesaler to each retailer is determined afterwards in the retail market.[9]

- At stage 3 the retailers and four consumers interact in a retail market that is organized as a double auction. Consumers are endowed with a scheme of reservation values implementing individual multi-unit demand. Retailers know their marginal cost schemes. According to the rules of a double auction retailers may submit ask prices or accept consumer bid prices, and consumers may submit bid prices or accept retailer ask prices.

In the experiment, quantities could be chosen only in discrete steps (see the Appendix). The discrete choice model is in line with the following continuous choice model which we rely on in describing the market and in determining theoretical benchmark solutions for ease of exposition:

Aggregate consumer demand is characterized by a linear (inverse) demand function $p(Q) = a - bQ$ with $a, b > 0$, $Q = \sum_i q_i$, where q_i represents the quantity sold by retailer i. In case of 4 retailers, retailer i's cost function is $C_i(q_i) = w_i q_i + c q_i^2$ where $w_i q_i$ is the cost for buying quantity q_i at the wholesale market and $c q_i^2$ represents any cost accruing at the retail market . Retailer i's profit function is

$$\pi_i = p(q_i, Q_{-i}) q_i - w_i q_i - c q_i^2$$

where $Q_{-i} = \sum_{j \neq i} q_j$. Let $k \geq 0$ be the wholesaler's marginal cost, then its profit function

[8] Allowing for an outside option implicitly assumes that there is another potential wholesaler. One may think of an outside seller who offers at price $\bar{w}$. Thus, the (inside) wholesaler has monopoly power as long as its offered price does not exceed $\bar{w}$. The existence of an outside option is quite reasonable in natural markets, and it is also reasonable in our experimental market. Namely, without an outside option a rejection of the wholesaler's offer would have meant that the retailer has nothing to sell in the retail market.

[9] I.e., retailers buy at orders: They first determine the quantity to be sold to consumers and then receive the respective quantity at the wholesale price w_i per unit.

is

$$\pi_0 = \sum_i \lambda_i (w_i - k) q_i,$$

where $\lambda_i = 1$ if retailer i accepted w, $\lambda_i = 0$ if retailer i rejected w.

The case of two retailers is modelled as if each two of the four retailers merged;[10] i.e., retailer 1 now owns two plants to produce q_1 and q_3 and retailer 2 owns two plants to produce q_2 and q_4. Everything else is the same as in the 4-retailers case. In the experiment the parameters were specified numerically as follows: $a = 36,000$, $b = 250$, $c = 875$ and $k = 10,000$.[11] Furthermore, $\bar{w} = 23,000$ in treatments LOW and MID, and $\bar{w} = 17,000$ in treatment HIGH.

3.2 Empirical Hypotheses

Reducing the number of retailers and the outside option wholesale price are two means of increasing retailer power vis-à-vis the wholesaler. Together this implements a comparison of low countervailing power versus intermediate or high countervailing power. In a narrow sense, the countervailing power effect only regards the reduction of the number of retailers (comparison of treatments LOW and MID). Since it was not clear a-priori how strongly experimental behavior responds to this power manipulation, we implemented the outside option variation in addition (comparison of treatments LOW and HIGH). We investigate our main hypothesis:

Hypothesis 1: Increasing countervailing power decreases the retail price. Specifically, the retail price decreases due to a decreasing number of retailers in treatment MID versus LOW (*Hypothesis 1.a*), and due to a decreasing outside option wholesale price in treatment HIGH versus LOW (*Hypothesis 1.b*).

The countervailing power effect hinges on three partial effects: That a power increase induces a reduction in wholesale price w, that a reduction in w is passed-through to

[10]Modelling the 2-retailer-case as mergers implies that the aggregate cost function stays constant between treatments LOW and MID.

[11]We chose 5- and 3-digit numbers in order to avoid decimal numbers in presenting the discrete structure of consumer valuations and cost values to experimental participants.

consumers in the retail market, and that the decrease in the number of retailers does not increase collusion among retailers. Namely, increasing collusion among retailers induces ceteris paribus an increase in retail price and works against the countervailing power effect. In the empirical analysis we will determine whether the three conditions are fulfilled or not. Therefore, in addition to our main hypothesis, we will assess the following hypotheses:

Hypothesis 2: The wholesale price w is lower in treatment MID than in LOW (Hyp. 2.a) and is lower in HIGH than in LOW (Hyp. 2.b).

Hypothesis 3: Wholesale price w and retail price p are positively correlated such that reductions in w are passed-through to consumers.

Hypothesis 4: Reducing the number of retailers increases collusion; i.e., collusion is higher in treatments MID and HIGH compared to treatment LOW.

Note that while we would like *Hyp. 4* to fail in order to support *Hyp. 1*, we formulate it such that it is ready for empirical testing. It may be seen as a classical effect of increasing market concentration.

3.3 Theoretical Benchmark Predictions

Before looking at empirically observed prices p and w it is instructive to determine what may be expected from a theoretical viewpoint. Therefore, we derive theoretical benchmark predictions in the Appendix and show the results here. In the experimental market like in natural markets it is not clear a-priori to what degree the market participants compete or collude and to what degree there is price discrimination. So we may consider different theoretical solutions.

Regarding retail price p, the double auction procedure allows for even the most extreme market outcomes of a perfect price-discriminating monopoly (retailer cartel) or monopsony (buyer cartel). It allows also for prices predicted by uniform-price theories like Nash equilibrium and competitive equilibrium. Table 1 displays retail price predictions implied by these theories. Column 2 shows the function $p(w)$ that determines the theoretical retail price for any given wholesale price. In case of price discrimination there is no unique retail price prediction so $p(w)$ is the predicted average retail price. For illustration, columns 3 and 4 evaluate $p(w)$ at both outside option wholesale prices. For $w = 23,000$ the predicted retail price ranges between 27,136 and 33,636. For $w = 17,000$ it ranges between 23,046 and 32,546.

Comparing $p(w)$ for the Nash equilibria with 2 and 4 retailers shows that *Hypothesis 1* (retail price reduction with 2 retailers compared to 4 retailers) will fail if there is only a small reduction in wholesale price w. E.g. If $w = 23,000$ with 4 retailers then the wholesale price would have to reduce to $w < 21,871$ with 2 retailers to induce a retail price reduction. On the contrary, if behavior is perfectly competitive any reduction in wholesale price will induce a retail price reduction. This is in line with von Ungern-Sternberg's (1996) conclusion that the countervailing power effect requires fierce competition at the retail stage. Assessing the degree of competition (collusion) may be based on the observed consumer surplus share. Theoretical values are shown in column 5 of Table 1. To

Table 1: Theoretical benchmark functions and values

Market	**Retail Price Function** $p(w)$	**Retail Price** p **for** $w = 23,000$	$w = 17,000$	**Consumer Surplus %**
Monopoly with P.D.	$29,455 + 0.182w$	$33,636$	$32,546$	0%
N.E. with 2 Retailers	$24,923 + 0.308w$	$32,000$	$30,154$	26.7%
N.E. with 4 Retailers	$24,000 + 0.333w$	$31,667$	$29,667$	30.8%
Perfect Competition	$22,909 + 0.364w$	$31,273$	$29,091$	36.4%
Monopsony with P.D.	$11,455 + 0.682w$	$27,136$	$23,046$	100%

N.E. = Nash Equilibrium, P.D. = Price Discrimination

determine a theoretical prediction for the wholesale price w note first that the wholesaler makes a take-it-or-leave offer simultaneously to 2 or 4 retailers. So price-discrimination is infeasible and any reasonable offer will obey $w \geq k = 10,000$ (wholesaler's reservation value) and $w \leq \bar{w}$ (retailer's reservation value). Varying w between these two boundaries serves to distribute earnings between wholesaler and retailers. As worked out in the Appendix assuming Nash equilibrium behavior both at the wholesale stage and the retail stage results in w equal to the respective outside option values. This is in line with the theoretical prediction in usual ultimatum games. However, this choice of w is risky. It has been found in ultimatum game experiments that responders reject offers that seem unfair, so one may expect an offered wholesale price below the outside option value. Furthermore, the payoff loss due to rejection may be small for the retailer (since the retailer may alternatively buy at $\bar{w}$) but large for the wholesaler since a large fraction of the wholesaler's demand is lost. With only 2 retailers a rejection means that the wholesaler loses about 50% of demand, whereas with 4 retailers the loss is about 25% which highlights[12] that asking for a high wholesale price is more risky with 2 retailers rather than 4. Following these considerations one may expect not only a wholesale price below outside option values but also a smaller one in treatment HIGH than in MID as well as a smaller one in MID than in LOW.

4 Experimental Procedures

The experiment was conducted with student participants in the experimental economics lab at the University of Erfurt using a computer network running the software z-Tree (Fischbacher, 2007). The participants were students from different fields, not necessarily economics or business which had signed-up for our experiment database. Recruiting was organized via ORSEE (Greiner, 2015). Each participant was involved only in a single treatment.

When the participants arrived at the lab they were assigned a player role (wholesaler, retailer or consumer) and seated at computer terminals in separate cabins. Role assignment was random and roles were kept for the entire experiment. Participants received printed instructions (see Appendix) for their respective role and read those at their own pace. Consumer valuations and seller cost were private information. The printed instructions had no information on the number of players in each role, however, participants received this information on screen in trial rounds and thereafter. Questions were answered privately. After two unpaid trial rounds the experiment proceeded over 15 paid rounds.

[12]These are just approximate losses in demand, since a rejection induces different wholesale prices between retailers which influences sales in the retail market.

The experimental implementation of stages 1 and 2 of the vertical market is straightforward. First, the wholesaler enters a wholesale price offer. Second, each retailer decides separately whether to accept or reject. Stage 3 features a multi-unit double auction: Retailers submit ask prices and consumers submit bid prices. Bids and asks are denoted in separate queues shown on the computer screen. A trade is concluded if a retailer accepts a bid or a consumer accepts an ask. Previous bids and asks of the two trading partners are erased from the price queues and the auction continues. A single consumer (seller) was allowed to buy (sell) up to 9 (36) units. Consumer valuations and cost schedules are provided in the Appendix. They implement the theoretical market structure described above. All entries of retail and wholesale prices were restricted to the range 8,000 to 36,000. This allows for unreasonable choices.

We ran 12, 12 and 13 sessions for treatments LOW, MID and HIGH respectively involving 283 participants in total.[13] A session took about 50 minutes including instruction phase and practice rounds. Earnings were denoted and collected over rounds in points and transferred into cash at the end of a session at a rate of 50,000 points = 1 EUR. Initially all subjects received 200,000 points. On average, wholesalers earned 46.92 EUR, while retailers and consumers earned 13.79 EUR and 8.42 EUR, respectively.

5 Data Analyses

Figures 1, 2 and 3 describe the development of observed retail prices and wholesale prices[14] over periods. More specifically, they show medians and 95%-confidence intervals of the median. Figure 1 shows all prices together, and Figure 2 (3) shows details on retail prices (wholesale prices).

[13]Initially we planned for 12 sessions each. However, in one of the HIGH sessions one retailer first received consumer instructions rather than retailer instructions. This was found out at the start of the first trial round and then corrected by providing retailer instructions. Routinely we ran another session but finally decided to keep all data, since we considered the mistake as inessential. In another HIGH session one of the two retailers persistently generated losses. We decided not to consider these data without further looking at details and rather ran another HIGH session as a substitute.

[14]Unless stated otherwise we display and analyze the wholesale price paid rather than the wholesale price offered. Actually, the difference between the two is negligible. If a retailer rejected an offered wholesale price for the outside option wholesale price, quantity sold shifted somewhat to the low cost retailer. Since the average paid wholesale price in a period is a quantity-weighted average and rejections occurred only rarely, offered and paid wholesale price don't differ much.

Retail prices are slightly increasing over periods and the variance is decreasing. In Figure 1 they seem almost indistinguishable between treatments LOW and MID, but seem somewhat lower in treatment HIGH. This impression is confirmed by Figure 2. While medians can be distinguished, the confidence intervals overlap. Since variance reduces over time, we will use average data of periods 11 to 15 for further statistical analyses and tests. Statistics using data of periods 1 to 15 are provided in the Appendix. Tests use sessions as units of analysis. Specifically, our data aggregation is as follows: In a first step we determine separately for each session and each period the mean retail price and mean wholesale price. Then we average across periods to get one data point for each session.[15]

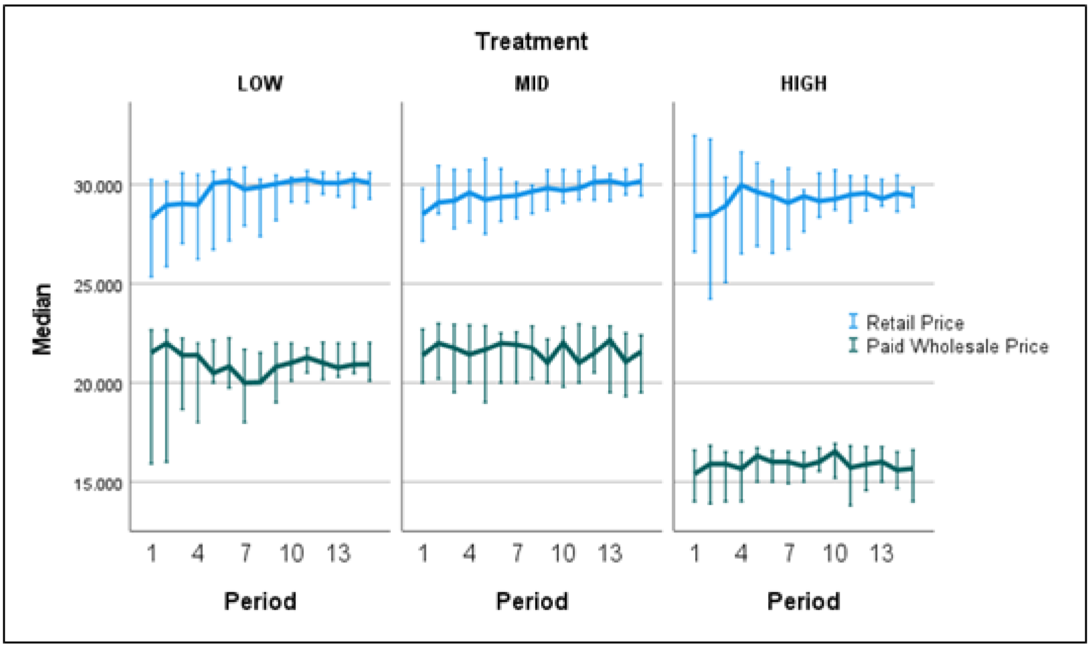

Figure 1: Time series of retail price and paid wholesale price by treatment (medians and 95% confidence intervals).

Table 2 provides descriptive statistics and tests. For retail price, paid wholesale price and consumer surplus share each cell shows quartile values (25, **50**, 75). Accordingly, the median retail price is 30,082 in treatment LOW, 30,018 in MID and 29,465 in HIGH. In line with *Hypothesis 1.b* the median retail price is lower in HIGH than in LOW and MID. The differences are marginally significant according to a one-tailed Mann-Whitney

[15]By this aggregation each period gets equal weight. If we aggregated prices for all trades in periods 11 to 15, periods would not be weighted equally,since in some periods more trades occurred than in others.

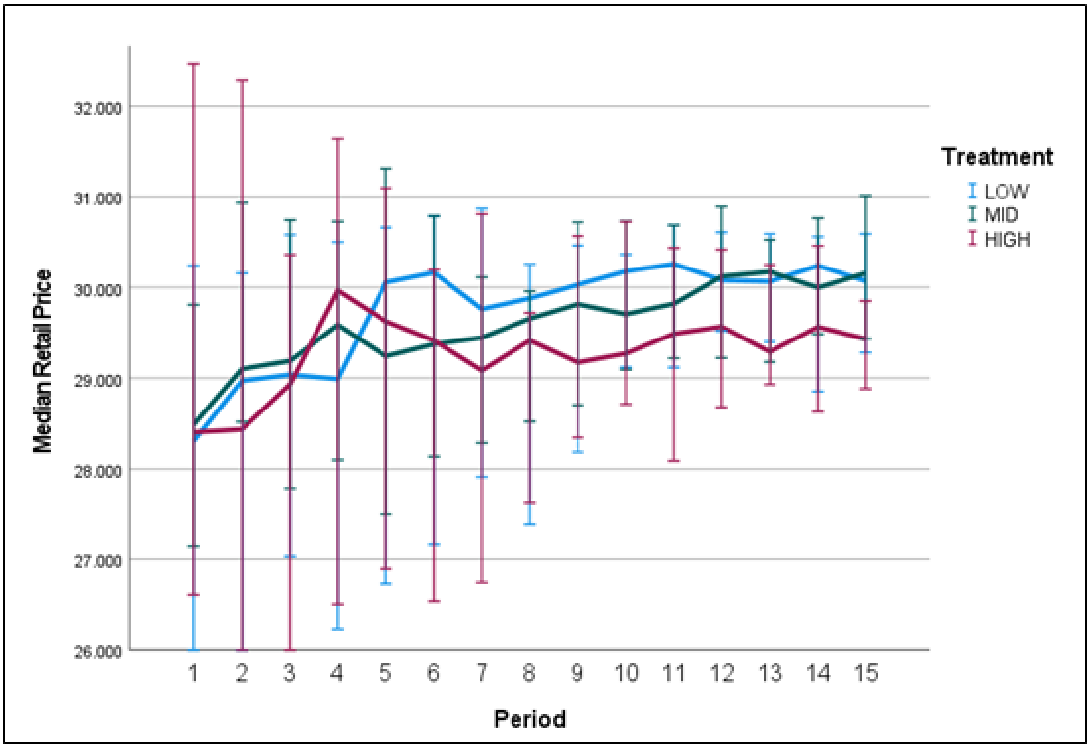

Figure 2: Detailed display of retail price (medians and 95% confidence intervals).

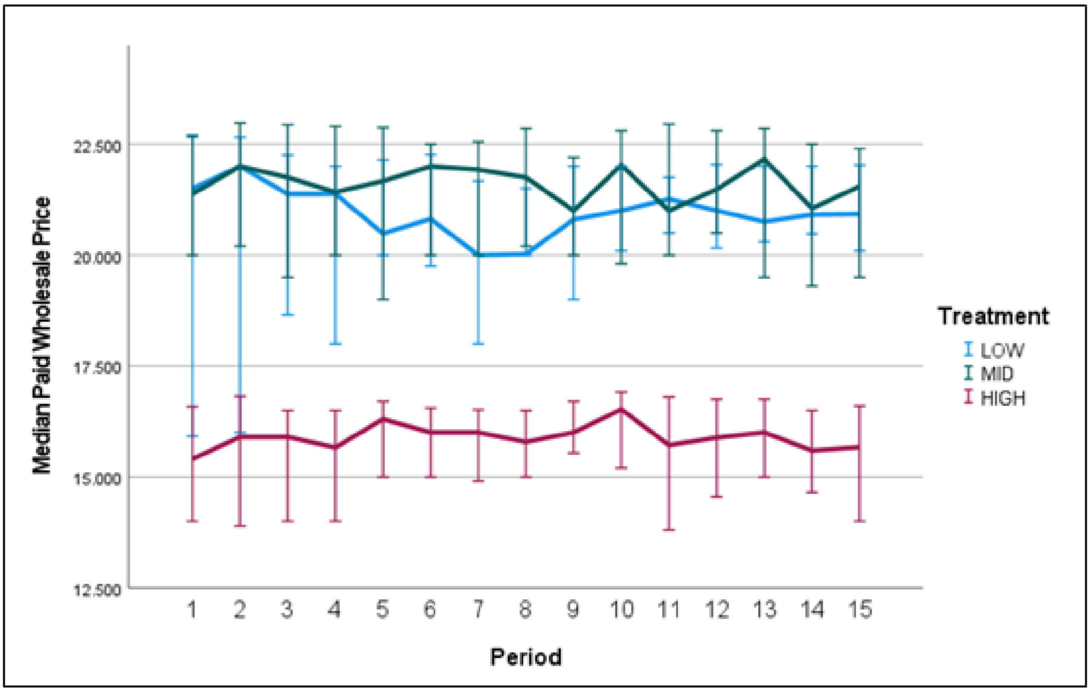

Figure 3: Detailed display of paid wholesale price (medians and 95% confidence intervals).

U-test.[16] *Hypothesis 1.a* fails since the difference is insignificant. Together this is only partial support for the countervailing power hypothesis since the variation in the number of retailers alone is insufficient to induce a retail price reduction. Only the additional increase in countervailing power due to a reduction of the outside option wholesale price leads to a significant retail price reduction.

Table 2: Quartiles (25, **50**, 75), correlations (ρ) and tests for retail price, paid wholesale price and consumer surplus share. P-Values are provided for two-tailed tests using session averages for periods 11-15 as units of analyses (N = 12, 12 and 13 for treatments LOW, MID and HIGH, respectively).

	LOW	MID	HIGH
	29,575	29,461	28,760
Retail Price	**30,082**	**30,018**	**29,465**
	30,509	30,717	30,175
	20,451	20,065	14,701
Paid Wholesale Price	**21,188**	**21,342**	**15,690**
	21,342	22,381	16,285
	0.34	0.28	0.20
Consumer Surplus %	**0.42**	**0.40**	**0.28**
	0.53	0.58	0.34
MWU-Test Retail Price			
LOW vs MID		$p = 0.887$	
LOW vs HIGH		$p = 0.168$	
MID vs HIGH		$p = 0.123$	
MWU-Test Paid Wholesale Price			
LOW vs MID		$p = 0.755$	
LOW vs HIGH		$p < 0.001$	
MID vs HIGH		$p < 0.001$	
MWU-Test Consumer Surplus Share			
LOW vs MID		$p = 0.799$	
LOW vs. HIGH		$p = 0.001$	
MID vs HIGH		$p = 0.052$	
LOW vs. Pooled MID and HIGH		$p = 0.038$	
Spearman Rank Correlation of Retail Price			
and Paid Wholesale Price Within Single Treatment	$\rho = 0.161$	$\rho = 0.056$	$\rho = 0.132$
	$p = 0.618$	$p = 0.863$	$p = 0.688$
Pooling LOW and MID		$\rho = 0.065, p = 0.762$	
Pooling LOW and HIGH		$\rho = 0.312, p = 0.130$	
Pooling MID and HIGH		$\rho = 0.322, p = 0.118$	

Comparing wholesale prices in Figure 1 and 3 shows a strong and highly statistically

[16] Table 2 reports two-tailed tests, but we use a directional interpretation wherever adequate.

significant difference between treatments HIGH and the other two treatments supporting *Hypothesis 2.b*. But there is no significant difference between LOW and MID such that *Hypothesis 2.a* fails. This in turn shows why Hypothesis 1.a fails: The mere reduction in the number of retailers is insufficient to reduce the wholesale price. And without such reduction there can be no countervailing power effect.[17]

To evaluate *Hypothesis 3*, we look at the empirical correlation of retail price and wholesale price. Table 2 reports Spearman rank correlations within each treatment. The coefficients are positive but not significantly different from zero. A reason for this result may be that the between-session variation of wholesale price within a single treatment is rather low as indicated by Figures 1 and 3. A comparison between treatments offers an alternative measure. Therefore, table 1 also reports correlations when data are pooled across treatments. The correlation coefficient is 0.322 (0.312) and is marginally significantly different from zero for a one-tailed test for the pooled data of MID and HIGH (LOW and HIGH) supporting *Hypothesis 3*. It is not significantly different from zero for the pooled data of LOW and MID which, again, might be due to the low between-session-variation of wholesale price even when these two treatments are pooled.

Even though retailers pass-on cost reductions reached in treatment HIGH to consumers, the pass-through rate is low: The wholesale price reduction of 5,652 (compared to MID) leads to a retail price reduction of only 553, which implies a pass-through rate of about 10%. It indicates that in HIGH the retailers capture a large share of the retail market surplus. This is confirmed by the statistics on consumer surplus shares. The consumer surplus share is 42% with four retailers (treatment LOW) and 40% (28%) with two retailers in treatment MID (HIGH). Testing LOW versus the pooled data of MID and HIGH shows a significant decrease in consumer surplus share if there are two retailers rather than four which supports *Hypothesis 4*. Thus, increasing retailer concentration leads to more collusive retail pricing. This is in line with the classical concentration effect.

[17]Also a test on the wholesale price offered rather than the wholesale price paid fails.

6 Discussion and Concluding Remarks

In our experiment we find only partial support for the countervailing power hypothesis. Retail price is lower in treatment HIGH than in LOW (*Hypothesis 1.b*). This is in line with Galbraith's idea that an increase in strategic power by retailers vis-à-vis a powerful wholesaler can be beneficial for consumers. However, the mere reduction in the number of retailers (treatment MID versus LOW) was insufficient to induce a significant reduction in wholesale price (*Hypothesis 2.a*) and therefore the countervailing power effect in its narrow sense failed (*Hypothesis 1.a*). Only the additional increase in retailer power by a reduction of the outside option wholesale price implemented a significant reduction in wholesale price (*Hypothesis 2.b*).

That reducing the number of retailers alone did not implement a wholesale price reduction could be a specific consequence of modelling wholesale pricing as an ultimatum game. As we expected a-priori, the offered wholesale price was occasionally rejected such that fear of rejection could be a reasonable concern in wholesale pricing. Furthermore, as expected, the offered wholesale price was substantially less than the theoretically predicted outside option value.[18] However, it was not significantly lower in MID than in LOW. Running experiments with alternative bargaining procedures could be a valuable robustness check of this finding. Also, it is an open question how strongly the wholesale price responds to a change in the number of retailers in natural markets.

As argued above, the countervailing power effect hinges not only on the change in wholesale price but on two more conditions which we evaluated as well: We found a positive correlation between wholesale price and retail price (*Hypothesis 3*) but a pass-through rate of a wholesale price reduction of only about 10%. The smaller this rate is the less likely one may observe the countervailing power effect. Finally, comparing surplus shares we found more collusion of retailers in the retail market when there are two retailers rather than four (*Hypothesis 4*). This is the classical concentration effect and it works against the countervailing power effect.

[18]Table A.1 in the Appendix reports median rejection rates between 5% and 10%. It also reports statistics on offered wholesale price.

In our experiment we modelled the retail market as a double auction. The double auction is flexible in the sense that it allows for the full range of competitive versus collusive behavior. It is known to bring out competitive pricing when there are many experimental participants on each side of the market. In our case we implemented the double auction with only four consumers and four (two) retailers. Thus, varying the retail market size and/or institution could also be a valuable experimental robustness check.

The theoretical result of von Ungern-Sternberg (1996) relied on specific modelling assumptions, the combination of the Nash bargaining solution at the wholesale stage and competitive behavior at the retail stage. Accordingly, the wholesale price responds to the number of retailers and any variation in wholesale price induces a corresponding change in retail price. Our experiment indicates that such conditions may be difficult to find empirically. Substantial strategic power of retailers vis-à-vis a monopoly wholesaler requires a rather small number of retailers, but this at the same time may lead to collusive retail pricing. The latter works against the countervailing power hypothesis. Overall we therefore conclude that our experiment supports a critical view on Galbraith's countervailing power hypothesis. While the rise of large retail firms may lead to decreasing retail price this might be driven by economies of scale rather than changes in strategic power.

References

Adachi, T., & Ebina, T. (2014). Cost pass-through and inverse demand curvature in vertical relationships with upstream and downstream competition. *Economics Letters*, *124*(3), 465–468. doi: doi:10.1016/j.econlet.2014.07.008

Barrette, E., Gowrisankaran, G., & Town, R. (2021). Countervailing market power and hospital competition. *The Review of Economics and Statistics*, 1–33. doi: doi:10.1162/rest_a_01020

Basker, E. (2005). Selling a cheaper mousetrap: Wal-mart's effect on retail prices. *Journal of Urban Economics*, *58*(2), 203–229. doi: doi:10.1016/j.jue.2005.03.005

Beckert, W., Smith, H. W., & Takahashi, Y. (2020). Competition in a spatiallydifferentiated product market with negotiated prices. *CEPR Discussion Paper No. DP15379*. Retrieved from https://ssrn.com/abstract=3723569

Bloom, P. N., & Perry, V. G. (2001). Retailer power and supplier welfare: The case of walmart. *Journal of Retailing*, *77*(3), 379–396. doi: doi:10.1016/S0022-4359(01)00048-3

Bonnet, C., & Dubois, P. (2010). Non linear contracting and endogenous buyer power between manufacturers and retailers: Empirical evidence on food retailing in france. *CEPR Discussion Papers*(DP8029). Retrieved from https://ssrn.com/abstract=1711042

Bonnet, C., & Dubois, P. (2015). Identifying two part tariff contracts with buyer power: empirical estimation on food retailing. *CEPR Discussion Paper No. DP10623*. Retrieved from https://ssrn.com/abstract=2610758

Bonnet, C., Dubois, P., Boas, S. B., & Klapper, D. (2013). Empirical evidence on the role of nonlinear wholesale pricing and vertical restraints on cost pass-through. *Review of Economics and Statistics*, *95*(2), 500–515. doi: doi:10.1162/REST_a_00267

Bresnahan, T. F., & Reiss, P. C. (1985). Dealer and manufacturer margins. *The RAND Journal of Economics*, 253–268. doi: doi:10.2307/2555413

Bulow, J. I., & Pfleiderer, P. (1983). A note on the effect of cost changes on prices. *Journal of Political Economy*, *91*(1), 182–185. doi: doi:10.1086/261135

Chen, Z. (2003). Dominant retailers and the countervailing-power hypothesis. *RAND journal of Economics*, 612–625. doi: doi:10.2307/1593779

Chipty, T., & Snyder, C. M. (1999). The role of firm size in bilateral bargaining: A study of the cable television industry. *Review of Economics and Statistics*, *81*(2), 326–340. doi: doi:10.1162/003465399558111

Christou, C., & Papadopoulos, K. G. (2015). The countervailing power hypothesis in the dominant firm-competitive fringe model. *Economics Letters*, *126*, 110–113. doi: doi:10.1016/j.econlet.2014.11.022

Craig, S. V., Grennan, M., & Swanson, A. (2021). Mergers and marginal costs: New evidence on hospital buyer power. *The RAND Journal of Economics*, *52*(1), 151–

178. doi: doi:10.1111/1756-2171.12365

Crawford, G. S., & Yurukoglu, A. (2012). The welfare effects of bundling in multi-channel television markets. *American Economic Review*, *102*(2), 643–85. doi: doi:10.1257/aer.102.2.643

Davis, D. D., & Wilson, B. J. (2008). Strategic buyers, horizontal mergers and synergies: An experimental investigation. *International Journal of Industrial Organization*, *26*(3), 643–661. doi: doi:10.1016/j.ijindorg.2006.12.004

Dobson, P., Clarke, R., Davies, S., & Waterson, M. (2001). Buyer power and its impact on competition in the food retail distribution sector of the european union. *Journal of Industry Competition and Trade*, *1*(3), 247–281. doi: doi:10.1023/A:1015268420311

Dobson, P., & Waterson, M. (1997). Countervailing power and consumer prices. *The Economic Journal*, *107*(441), 418–430. doi: doi:10.1111/j.0013-0133.1997.167.x

Dobson, P., & Waterson, M. (2007). The competition effects of industry-wide vertical price fixing in bilateral oligopoly. *International Journal of Industrial Organization*, *25*(5), 935–962. doi: doi:10.1016/j.ijindorg.2007.04.004

Draganska, M., Klapper, D., & Villas-Boas, S. B. (2010). A larger slice or a larger pie? an empirical investigation of bargaining power in the distribution channel. *Marketing Science*, *29*(1), 57–74. doi: doi:10.1287/mksc.1080.0472

Ellison, S. F., & Snyder, C. M. (2010). Countervailing power in wholesale pharmaceuticals. *Journal of Industrial Economics*, *58*(1), 32–53. doi: doi:10.1111/j.1467-6451.2010.00408.x

Engle-Warnick, J., & Ruffle, B. J. (2002). Buyer Concentration as a Source of Countervailing Power: Evidence from Experimental Posted-Offer Markets. *Ssrn*. doi: doi:10.2139/ssrn.310339

Engle-Warnick, J., & Ruffle, B. J. (2005). The Strategies Behind their Actions: A New Method to Infer Repeated-Game Strategies and an Application to Buyer Behavior. *SSRN Electronic Journal*. doi: doi:10.2139/ssrn.300500

Fischbacher, U. (2007). Z-Tree: Zurich toolbox for ready-made economic experiments.

Experimental Economics, *10*, 171–178. doi: doi:10.1007/s10683-006-9159-4

Gabel, H. L. (1983). The role of buyer power in oligopoly models: an empirical study. *Journal of Economics and Business*, *35*(1), 95–108. doi: doi:10.1016/0148-6195(83)90033-4

Galbraith, J. K. (1952). *American capitalism: The concept of countervailing power.* Boston: Houghton Mifflin.

Galbraith, J. K. (1956). *American capitalism: The concept of countervailing power.* New York: Houghton Mifflin. Revised Edition.

Gaudin, G. (2016). Pass-through, vertical contracts, and bargains. *Economics Letters*, *139*, 1–4. doi: doi:10.1016/j.econlet.2015.11.043

Gaudin, G. (2018). Vertical Bargaining and Retail Competition: What Drives Countervailing Power? *Economic Journal*, *128*(614), 2380–2413. doi: doi:10.1111/ecoj.12506

Gowrisankaran, G., Nevo, A., & Town, R. (2015). Mergers when prices are negotiated: Evidence from the hospital industry. *American Economic Review*, *105*(1), 172–203. doi: doi:10.1257/aer.20130223

Greenhut, M. L., & Ohta, H. (1976). Related market conditions and interindustrial mergers. *The American Economic Review*, *66*(3), 267–277. Retrieved from http://www.jstor.org/stable/1828161

Greiner, B. (2015). Subject pool recruitment procedures: organizing experiments with ORSEE. *Journal of the Economic Science Association*, *1*(1), 114–125. doi: doi:10.1007/s40881-015-0004-4

Grennan, M. (2013). Price discrimination and bargaining: Empirical evidence from medical devices. *American Economic Review*, *103*(1), 145–77. doi: doi:10.1257/aer.103.1.145

Grennan, M. (2014). Bargaining ability and competitive advantage: Empirical evidence from medical devices. *Management Science*, *60*(12), 3011–3025. doi: doi:10.1287/mnsc.2014.2006

Guth, L. A., Schwartz, R. A., & Whitcomb, D. K. (1976). The use of buyer concentration ratios in tests of oligopoly models. *The Review of Economics and Statistics*, 488–492. doi: doi:1935883

Ho, K., & Lee, R. S. (2017). Insurer competition in health care markets. *Econometrica*, *85*(2), 379–417. doi: doi:10.3982/ECTA13570

Hollenbeck, B., & Giroldo, R. Z. (2021). Winning big: Scale and success in retail entrepreneurship. *Marketing Science*. doi: doi:10.1287/mksc.2021.1316

Iozzi, A., & Valletti, T. (2014). Vertical bargaining and countervailing power. *American Economic Journal: Microeconomics*, *6*(3), 106–135. doi: doi:10.1257/mic.6.3.106

Kreps, D. M., & Scheinkman, J. A. (1983). Quantity precommitment and bertrand competition yield cournot outcomes. *The Bell Journal of Economics*, 326–337. Retrieved from https://www.jstor.org/stable/3003636

Lustgarten, S. H. (1975). The impact of buyer concentration in manufacturing industries. *The Review of Economics and Statistics*, 125–132. doi: doi:10.2307/1923993

Mottner, S., & Smith, S. (2009). Wal-mart: Supplier performance and market power. *Journal of Business Research*, *62*(5), 535–541. doi: doi:10.1016/j.jbusres.2008.06.012

Normann, H. T., Ruffle, B. J., & Snyder, C. M. (2007). Do buyer-size discounts depend on the curvature of the surplus function? Experimental tests of bargaining models. *RAND Journal of Economics*, *38*(3), 747–767. doi: doi:10.1111/j.0741-6261.2007.00110.x

Orland, A., & Selten, R. (2016). Buyer power in bilateral oligopolies with advance production: Experimental evidence. *Journal of Economic Behavior and Organization*, *122*, 31–42. doi: doi:10.1016/j.jebo.2015.11.016

Perry, M. K. (1978). Related market conditions and interindustrial mergers: Comment. *The American Economic Review*, *68*(1), 221–224. Retrieved from https://www.jstor.org/stable/1809702

Rotemberg, J. J., & Saloner, G. (1986). A supergame-theoretic model of price wars during booms. *The American economic review*, *76*(3), 390–407. Retrieved from https://www.jstor.org/stable/1813358

Ruffle, B. J. (2000). Some factors affecting demand withholding in posted-offer markets. *Economic Theory*, *16*(3), 529–544. doi: doi:10.1007/978-3-642-56448-2_3

Ruffle, B. J. (2005). Buyer countervailing power: a survey of the theory and experimental evidence. *Available at SSRN 894664*. doi: doi:10.2139/ssrn.894664

Ruffle, B. J. (2013). When Do Large Buyers Pay Less? Experimental Evidence. *Journal of Industrial Economics*, *61*(1), 108–137. doi: doi:10.1111/joie.12008

Schumacher, U. (1991). Buyer structure and seller performance in us manufacturing industries. *The Review of Economics and Statistics*, 277–284. doi: doi:10.2307/2109518

Selten, R. (1965). Spieltheoretische behandlung eines oligopolmodells mit nachfrageträgheit: Teil i: Bestimmung des dynamischen preisgleichgewichts. *Zeitschrift für die gesamte Staatswissenschaft/Journal of Institutional and Theoretical Economics*(H. 2), 301–324.

Selten, R. (1975). Reexamination of the perfectness concept for equilibrium points in extensive games. *International Journal of Game Theory*(4), 25–55. doi: doi:10.1007/BF01766400

Smith, H., & Thanassoulis, J. (2015). Prices, profits, and pass-through of costs along a supermarket supply chain: Bargaining and competition. *Oxford Review of Economic Policy*, *31*(1), 64–89. doi: doi:10.1093/oxrep/grv007

Snyder, C. M. (1998). Why do larger buyers pay lower prices? intense supplier competition. *Economics Letters*, *58*(2), 205–209. doi: doi:10.1016/S0165-1765(97)00279-6

Sorensen, A. T. (2003). Insurer-hospital bargaining: negotiated discounts in post-deregulation connecticut. *The Journal of Industrial Economics*, *51*(4), 469–490. doi: doi:10.1111/j.0022-1821.2003.00211.x

Stigler, G. J. (1954). The economist plays with blocs. *The American Economic Review*, *44*(2), 7–14. Retrieved from `https://www.jstor.org/stable/1818318`

Symeonidis, G. (2010). Downstream merger and welfare in a bilateral oligopoly. *International Journal of Industrial Organization*, *28*(3), 230–243. doi: doi:10.1016/j.ijindorg.2009.08.004

Tyagi, R. K. (1999). On the effects of downstream entry. *Management Science*, *45*(1), 59–73. doi: doi:10.1287/mnsc.45.1.59

Von Ungern-Sternberg, T. (1996). Countervailing power revisited. *International Journal of Industrial Organization*, *14*(4), 507–519. doi: doi:10.1016/0167-7187(95)00488-2

Weyl, E. G., & Fabinger, M. (2013). Pass-through as an economic tool: Principles of incidence under imperfect competition. *Journal of Political Economy*, *121*(3), 528–583. doi: doi:10.1086/670401

Appendices

A Descriptive Statistics

Table 3: Descriptive statistics based on session-average data for periods 1 to 15. Each cell shows quartile values (25, **50**, 75).

	Treatment		
	LOW	MID	HIGH
	28,214	28,844	28,119
Retail Price	**29,676**	**29,628**	**29,206**
	30,390	30,111	29,957
	19,542	19,788	14,767
Paid Wholesale Price	**21,105**	**21,576**	**15,640**
	21,333	22,419	16,273
	19,963	19,732	14,602
Offered Wholesale Price	**21,000**	**21,220**	**15,469**
	21,200	22,419	16,052
	0.05	0.03	0.07
Rejection Rate	**0.10**	**0.05**	**0.10**
	0.13	0.13	0.23
	0.37	0.32	0.22
Consumer Surplus Share	**0.49**	**0.47**	**0.32**
	0.60	0.67	0.43

B Theoretical Benchmark Solutions

B.1 The model

In the upstream level there exists a unique supplier denoted by s who produces and sells a product to N retailers, $i = 1, 2, 3..., N$. The supplier's unit cost is constant and equal to k. The supplier sets unilaterally a wholesale uniform price w and retailers decide whether to buy or not. In the downstream level, retailers sell the product to consumers.

The retailer's i cost function is $TC(q_i) = wq_i + cq_i^2$ where q_i is the quantity of the good purchased from the supplier and cq_i^2 is the retail cost of selling q_i units. Consumers are represented by the following inverse demand function $p(Q) = a - bQ$ where Q is the total quantity.

The timing of the game is the following:

At $t = 1$, the supplier makes a simultaneous common take-it-or-leave-it offer to each one of the retailers. The offer is a linear contract, that is, a wholesale price w for a unit of the good.

At $t = 2$, each retailer accepts or rejects the supplier's offer taking into account an exogenously given alternative market price $\bar{w}$.

At $t = 3$, The retail price p is set either according to the following market structures:

A) A monopolistic retailer who owns four production plants

B) Oligopolistically through Cournot competition (retailers choose how much quantity q_i to buy from the supplier or the alternative source and sell that quantity at the retail price p to the consumer)

C) Competitively through market clearing and price taking (at the market clearing p retailers chooses how much quantity of the good q_i to buy at w and sell at price p)

D) Monopsony?? (The monopsonist is the consumer?)

B.2 Monopoly at the retail level with uniform consumer price (1 monopolistic retailer with N production plants)

At $t = 3$, the monopolistic retailer owns N plants chooses $q_i, i = 1, 2, 3, ..., N$ so as to maximize $\Pi(q_1, q_2, ..., q_N) = (a - b\sum_i q_i)\sum_i q_i - w\sum_i q_i - c\sum_i q_i^2$. The first order conditions (focs) give the profit maximizing quantity for each plant as a function of the quantities chosen for the other plants, $d\Pi/dq_i = -b\sum_i q_i + (a - b\sum_i q_i) - w - 2cq_i = 0$ or $q_i(q_{-i}) = (a - w - 2bq_{-i})/(2b + 2c)$. Solving the system of focs where by symmetry $q_{-i} = \sum_i q_i - q_i = (N-1)q_i$, therefore $q_i(w) = (a-w)/(2bN+2c)$ and the total quantity is $Q_{mon}(w) = Nq_i(w)$. Consequently the consumer price is

$$p_{mon}(w) = a - b\frac{N(a-w)}{2(bN+c)}.$$

At $t = 2$, retailer accepts the supplier's offer as long as $\Pi(w) \geq \Pi(\bar{w}) \geq 0$ or $w < \bar{w}$.

At $t = 1$, the supplier chooses w so as to maximize $\Pi_s(w) = (w-k)Q_{mon}(w)$ and the first order necessary conditions reduce to $w^* = (a+k)/2$. If $w^* > \bar{w}$, the supplier chooses $\bar{w}$.

At $w = w^*$ each retailer produces $q_i^* = (a-k)/[4bN+4c]$, therefore total supply of the final good is $Q^* = Nq_i^*$ and the equilibrium consumer price is

$$p_{mon}(Q^*) = a - bN\frac{a-k}{4(bN+4c)}.$$

For $N = 4, a = 36000, b = 250, c = 875, k = 10000$, we have $p_{mon}(w) = 26400{+}0.267w$, $w^* = 23000$, $p^* = 32533.33$, $CS = 24035.56$, $\Pi = 90133.33$, $CS/(CS+\Pi) = 21.05\%$. For $w = 17000$, $p = 30933.33$, $CS = 51342.22$, $\Pi = 192533$, $CS/(CS+\Pi) = 21.05\%$

B.3 Monopoly at the retail level with perfect price discrimination (1 monopolistic retailer with N production plants)

In case of perfect price discrimination, the average consumer price is calculated as the mean of the maximum reservation price a and the minimum price a monopolist can charge. The latter is the marginal cost evaluated at Q^* such that $MC(Q^*) = p$ or $w+2cQ = a-bQ$ or $Q^*(w) = (a-w)/(b+2c)$. Then, the consumer price as a function of w is $p(w) = (2ac+bw)/(b+2c)$. So for $w^* = (a+k)/2$, the quantity is $Q^* = (a-k)/(2b+4c)$ and $MC(Q^*) = (ab+4ac+bk)/(2b+4c)$. So the average price under perfect price discrimination is

$$\bar{p} = \frac{a+MC(Q^*)}{2} = \frac{3ab+8ac+bk}{4b+8c}.$$

For $N = 4, a = 36000, b = 250, c = 875, k = 10000$, we have $p(w) = 31500 + 0.125w$, $w^* = 23000$, $p^* = 34375$, $CS = 0$, $\Pi = [a - MC(Q^*)]Q^*/2 = \frac{(a-w^*)Q^*(w)}{2} = 42250$, $CS/(CS+\Pi) = 0\%$. For $w = 17000$, $p =$????, $CS = 0$, $\Pi =$????, $CS/(CS+\Pi) = 0\%$

B.4 Cournot competition at the retail level (N retailers)

We solve the game using the equilibrium concept of subgame perfection.

At $t = 3$, each retailer chooses q_i so as to maximize $\Pi_i(q_i, q_{-i}) = (a - bq_i - bq_{-i})q_i - wq_i - cq_i^2$ where $q_{-i} = \sum_{j\neq i} q_j$, is the sum of the quantities of all retailers excluding i.The first order necessary conditions give the best reply function, $d\Pi_i/dq_i = -bq_i + (a - bq_i - bq_{-i}) - w - 2cq_i = 0$ or $q_i(q_{-i}) = (a - w - bq_{-i})/(2b+2c)$. At the Cournot equilibrium with N retailers, by symmetry $q_{-i} = (N-1)q_i$, so $q_i(w) = (a-w)/[(N+1)b+2c]$ and the total quantity is $Q(w) = Nq_i(w)$.Consequently the consumer price is

$$p(w) = a - b\frac{N(a-w)}{(N+1)b+2c}.$$

At $t = 2$, retailer accepts the supplier's offer as long as $\Pi_i(w) \geq \Pi_i(\bar{w}) \geq 0$.

At $t = 1$, the supplier chooses w so as to maximize $\Pi_s(w) = (w-k)Q(w)$ and the first order necessary conditions reduce to

$$\begin{aligned} \frac{d\Pi_s(w)}{dw} &= \frac{N}{(N+1)b+2c}(a-2w+k) = 0 \\ &\Rightarrow \quad w^* = \frac{a+k}{2}. \end{aligned} \tag{1}$$

Note the optimal wholesale price does not depend on the number of downstream Cournot competitiors and hence the intensity of downstream competition. At $w = w^*$ each retailer produces $q_i^* = (a-k)/[2b(N+1)+4c]$, therefore total supply of the final good is $Q^* = Nq_i^*$and the equilibrium consumer price is

$$p_{Cournot}(Q^*) = a - bN\frac{a-k}{2b(N+1)+4c}$$

B.5 Perfect competition at the retail level

Again, we solve the game using the notion of subgame perfection.

At $t = 3$, each retailer chooses q_i so as to maximize $\Pi_i(q_i) = pq_i - wq_i - cq_i^2$ taking as given the retail price p. The first order necessary conditions give the individual supply function, $d\Pi_i/dq_i = p - w - 2cq_i = 0$ or $q_i(p) = (p-w)/2c$, so the total supply is $Q(p) = Nq_i(p)$. The consumer price is given by the market clearing condition $Q^d = Q^s$ or

$$\begin{aligned} \frac{a-p}{b} &= \frac{N(p-w)}{2c} \Rightarrow \\ p(w) &= \frac{2ac+bwN}{2c+bN} \end{aligned} \tag{2}$$

Replacing (2) in $Q(p)$ the supplier faces the following demand

$$Q(w) = \frac{N(a-w)}{2c+bN}$$

At $t = 2$, retailer accepts the supplier's offer as long as $\Pi_i(w) \geq \Pi_i(\bar{w}) \geq 0$.

At $t = 1$, the supplier chooses w so as to maximize $\Pi_s(w) = (w-k)Q(w)$ and the first order necessary conditions reduce to

$$\begin{aligned} \frac{d\Pi_s(w)}{dw} &= \frac{N}{2c+bN}(a-2w+k) = 0 \\ &\Rightarrow \quad w^* = \frac{a+k}{2}. \end{aligned} \tag{3}$$

Again, the optimal wholesale price does not depend on the number of retailers.

At $w = w^*$, the individual quantity produced and sold is $q_i^* = (a-k)/(4c+2bN)$, the total supply is $Q^*_{comp} = Nq_i^*$ and the equilibrium price is

$$p_{comp}(Q^*) = \frac{4ac + b(a+k)N}{4c+2bN},$$

B.6 Merger of Cournot retailers

Suppose that $N = 4$ and that retailer 1 acquires firm 3 and retailer 2 acquires 4.

At $t = 3$, each retailer operates as a firm with two production plans, in particular retailers 1&3 and 2&4 maximize respectively

$$\begin{aligned} \Pi_1(q_1, q_3; q_{24}) &= (p(Q) - w)(q_1 + q_3) - cq_1^2 - cq_3^2 \\ \Pi_2(q_2, q_4; q_{13}) &= (p(Q) - w)(q_2 + q_4) - cq_2^2 - cq_4^2 \end{aligned}$$

where $q_{24} = q_2 + q_4$ is the total quantity produced by merged retailer 2&4 and $q_{13} = q_1 + q_3$ is the total quantity produced by merged retailer 1&3.

The first order necessary conditions give the best reply functions,

$$q_1(q_{24}) = q_3(q_{24}) = \frac{a - w - b(q_2 + q_4)}{2(b + c)}$$
$$q_2(q_{13}) = q_4(q_{13}) = \frac{a - w - b(q_1 + q_3)}{2(b + c)}$$

and the Cournot equilibrium with N retailers, each plant $i = 1, 2, 3, 4$ is producing $q_i(w) = (a - w)/(6b + 2c)$, or each retail firm produces $q_{13}(w) = q_{24}(w) = (a - w)/(3b + c)$ and $Q(w) = 2(a - w)/(3b + c)$. Consequently the consumer price is

$$p(w) = a - b\frac{2(a - w)}{3b + c}.$$

At $t = 2$, retailer accepts the supplier's offer as long as $\Pi_i(w) \geq \Pi_i(\bar{w}) \geq 0$

At $t = 1$, the supplier chooses w so as to maximize $\Pi_s(w) = (w - k)Q(w)$ and the first order necessary conditions reduce to $w^* = (a + k)/2$.

At $w = w^*$ each plant produces $q_i = (a - k)/(12b + 4c)$ and each retail firm produces $q^*_{13} = q^*_{24} = (a - k)/(6b + 2c)$. The equilibrium total supply of the good is $Q^* = (a - k)/(3b + c)$ and the equilibrium consumer price is

$$p(Q^*) = a - b\left(\frac{a - k}{3b + c}\right).$$

B.7 Merger of competitive retailers

Suppose that $N = 4$ and that retailer 1 acquires firm 3 and retailer 2 acquires 4.

At $t = 3$, each retailer operates as a firm with two production plans, in particular retailers 1&2 and 3&4 take as given the retail price p and maximize respectively

$$\Pi_{12}(q_1, q_2, q_{34}) = (p - w)(q_1 + q_3) - cq_1^2 - cq_3^2$$
$$\Pi_{34}(q_3, q_4, q_{12}) = (p - w)(q_2 + q_4) - cq_2^2 - cq_4^2$$

The first order necessary conditions give the individual supply function of each plant $i = 1, 2, 3, 4$, $d\Pi_i/dq_i = p - w - 2cq_i = 0$ or $q_i(p) = (p - w)/2c$ and the supply of each firm is $q_{13}(p) = q_{24}(p) = (p - w)/c$. The consumer price is given by the market clearing condition $Q^d = Q^s$ or $(a-p)/b = 2(p-w)/c$, so $p(w) = (ac+2bw)/(2b+c)$ and the total demand the supplier faces is $Q(w) = 2(a-w)/(2b+c)$

At $t = 2$, retailer accepts the supplier's offer as long as $\Pi_i(w) \geq \Pi_i(\bar{w}) \geq 0$.

At $t = 1$, the supplier chooses w so as to maximize $\Pi_s(w) = (w-k)Q(w)$ and again $w^* = (a+k)/2$. At $w = w^*$ the equilibrium price is

$$p_{comp}(w^*) = \frac{ac + b(a+k)}{2b+c},$$

the quantity produced at each plant is s $q_i^* = (a-k)/(8b+4c)$ and so the total supply of the good is $Q^*_{comp} = (a-k)/(2b+c)$.

C Instructions

- Instructions in English
- Instructions in original language (german)

D Induced Demand and Supply Parameters

D.1 Consumer Values

Table 4: Consumer Values

Unit	1	2	3	4	5	6	7	8	9
Buyer 1	36000	35000	34000	33000	32000	31000	30000	29000	28000
Buyer 2	35750	34750	33750	32750	31750	30750	29750	28750	27750
Buyer 3	35500	34500	33500	32500	31500	30500	29500	28500	27500
Buyer 4	35250	34250	33250	32250	31250	30250	29250	28250	27250

D.2 Suplier's Marginal Cost

$k = 10000$

D.3 Retailers' Marginal Cost

The retailer's i cost function is $TC(q_i) = wq_i + cq_i^2$ where q_i is the quantity of the good purchased from the supplier and $875q_i^2$ is the retail cost of selling q_i units. The marginal cost function is $MC(q_i) = w + 1750q_i$, while for a merged firm with two production plants (treatment MED and HIGH), the marginal cost increases after every second unit because production is allocated between two plants.

Table 5: Retailers' Marginal Cost

Unit	Low	Med	High	Unit	Low	Med	High
1	24750	24750	18750	19	56250	40500	34500
2	26500	24750	18750	20	58000	40500	34500
3	28250	26500	20500	21	59750	42250	36250
4	30000	26500	20500	22	61500	42250	36250
5	31750	28250	22250	23	63250	44000	40500
6	33500	28250	22250	24	65000	44000	40500
7	35250	30000	24000	25	66750	47500	42250
8	37000	30000	24000	26	68500	47500	42250
9	38750	31750	25750	27	70250	49250	44000
10	40500	31750	25750	28	72000	49250	44000
11	42250	33500	27500	29	73750	51000	45750
12	44000	33500	27500	30	75500	51000	45750
13	45750	35250	29250	31	77250	52750	47500
14	47500	35250	29250	32	79000	52750	47500
15	49250	37000	31000	33	80750	54500	49250
16	51000	37000	31000	34	82500	54500	49250
17	52750	38750	32750	35	84250	56250	51000
18	54500	38750	32750	36	86000	56250	51000

D.4 Aggregate Supply and Demand in the Consumer Market

Table 6: Aggregate Supply and Demand in the Consumer Market

Unit	D	S_{M-L}	S_H	Unit	D	S_{M-L}	S_H
1	36000	24750	18750	19	31500	31750	25750
2	35750	24750	18750	20	31250	31750	25750
3	35500	24750	18750	21	31000	33500	27500
4	35250	24750	18750	22	30750	33500	27500
5	35000	26500	20500	23	30500	33500	27500
6	34750	26500	20500	24	30250	33500	27500
7	34500	26500	20500	25	30000	35250	29250
8	34250	26500	20500	26	29750	35250	29250
9	34000	28250	22250	27	29500	35250	29250
10	33750	28250	22250	28	29250	35250	29250
11	33500	28250	22250	29	29000	37000	31000
12	33250	28250	22250	30	28750	37000	31000
13	33000	30000	24000	31	28500	37000	31000
14	32750	30000	24000	32	28250	37000	31000
15	32500	30000	24000	33	28000	38750	32750
16	32250	30000	24000	34	27750	38750	32750
17	32000	31750	25750	35	27500	38750	32750
18	31750	31750	25750	36	27250	38750	32750

D: Aggregate Demand, S_{M-L}: Aggregate Supply in treatment MED and LOW, S_H: Aggregate Supply in treatment HIGH.

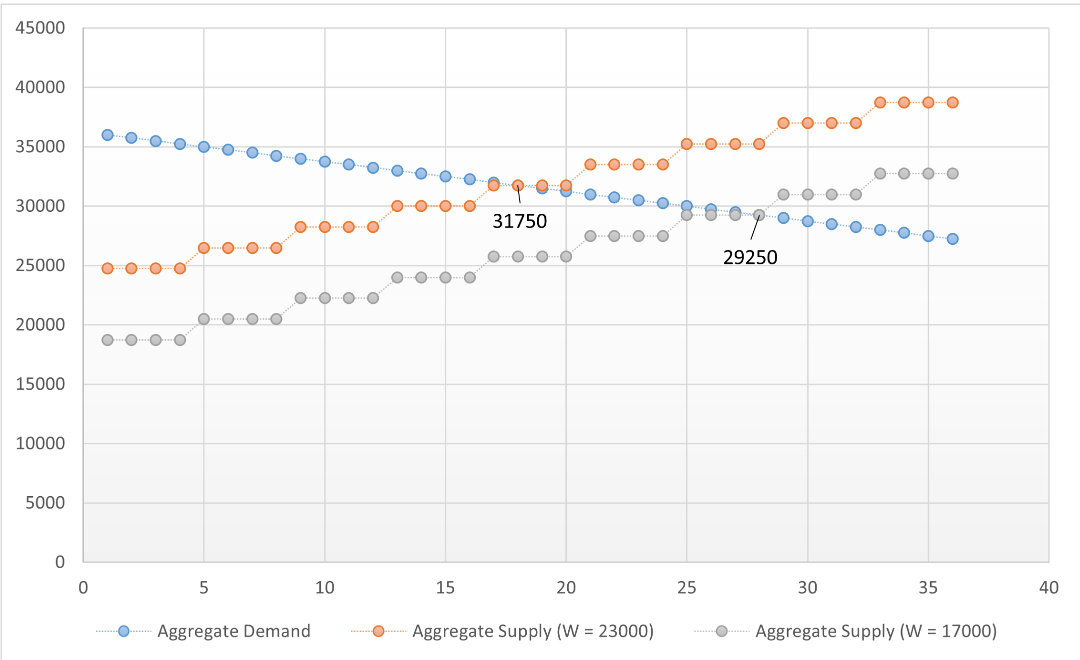

Figure 4: Aggregate Demand and Supplies