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Abstract

Cutting out the intermediary and selling directly to consumers is an increasingly common strategy by manufacturers. We develop a structural model of vertical relations where manufacturers bargain with retailers and sell their products directly to consumers. Direct sales generate potential consumer gains due to additional competition and product variety but also increase manufacturers' bargaining leverage, thereby increasing upstream and downstream prices and potentially reducing consumer welfare. We estimate the model using data from the outdoor advertising industry to quantify the bargaining-leverage and welfare effects of direct sales. We discuss the relevance of the bargaining-leverage effect for vertical merger evaluation.

JEL Codes: D43, L13, L42, L51, L81, M37.

Keywords: Direct-to-consumer sales, bargaining, vertical mergers, double marginalization, advertising.

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1 Introduction

When analyzing the negotiation of wholesale prices, most of the literature assumes that manufacturers cannot sell directly to consumers. In recent years there has been an increase in these type of direct sales to consumers. Such increase has motivated a number of recent studies investigating the competitive effects of direct-to-consumer sales by manufacturers. Most of these articles are theoretical. At the same time, competition authorities have emphasized the importance of allowing consumers to choose between manufacturers and retailers, and the anticompetitive impact of prohibiting direct-to-consumer sales by manufacturers. Yet there are remarkably few empirical studies investigating the impact of direct-to-consumer sales on welfare and its implications for market power and merger evaluation. We develop a structural model where manufacturers bargain with retailers over wholesale prices and can sell directly to consumers, estimates the model using a rich dataset from the outdoor advertising industry, and uses the estimated model to quantify the effects of direct-to-consumer sales by manufacturers on welfare, bargaining outcomes, and to evaluate policy interventions in the industry.

Direct sales to consumers by manufacturers have increased across a wide range of industries. Examples include Apple and Microsoft, selling their products directly in their stores in addition to using retailers such as Best Buy and Walmart; Nike and Adidas, selling their products directly online in addition to using retailers such as Foot Locker and Macy's; and television networks, like HBO and ESPN, selling their content directly through their online platforms, HBO Now and ESPN+, in addition of selling their content to cable companies such as Comcast and Time Warner Cable. The increase in direct sales to consumers has been facilitated by the internet through own-developed online platforms; trading platforms like Amazon, eBay, or Taobao; social media like Facebook, Twitter, and Instagram; and the internet search advertising market, where online publishers sell their inventory to advertisers either directly or through advertising marketplaces, and where large companies like Google have recently been subject of antitrust lawsuits.[1]

Concurrently, competition authorities at the Federal Trade Commission (FTC) and the Department of Justice (DOJ) have urged legislators against prohibitions of direct-to-consumer sales by manufacturers. For example, regarding the prohibitions in the U.S. on direct sales to consumers by auto manufacturers—and Tesla Motors in particular—, the FTC's Office of Policy Planning argued: "FTC staff[s] offer no opinion on whether automobile distribution through independent dealerships is superior or inferior to direct distribution by manufacturers. [...] [C]onsumers are the ones best situated to choose for themselves both the cars they want to buy and how they want to buy them." (Federal Trade Commission, Press Release 2014). On the same subject, the following quotation from the DOJ website reads: "Just as Dell has altered its distribution model in the personal computer industry to better meet evolving consumer preferences, car customers would benefit from [the] elimination of state bans on

[1] See, *e.g.*, United States of America et al. v. Google LLC (2020) and Texas et al. v. Google LLC (2020).

auto manufacturers' [...] direct sales to consumers." (Bodisch 2009, p. 11).[2] The fundamental principle that consumers should be allowed to choose between manufacturers and retailers has been used beyond Tesla's case.[3]

Allowing direct-to-consumer sales by manufacturers (direct sales, henceforth) juxtaposes potential gains to consumers related to additional competition/variety downstream and potential increases in the costs of retailers arising from the additional *bargaining leverage* of manufacturers.[4] These two channels affect prices paid by consumers in opposite directions. First, direct sales by the manufacturer increase competition in the market for final products, thereby exerting downward pressure on the prices paid by consumers. Direct sales also generate additional product variety for consumers.[5] When products are differentiated, additional variety potentially increases consumer welfare through better segmentation, as documented in the related literature. Second, direct sales increase the bargaining leverage of manufacturers when negotiating with retailers. This effect increases retailers' costs by increasing negotiated wholesale prices and exerts upward pressure on the prices paid by consumers. The net effect on the prices paid by consumers is ambiguous, as we show in Section 3. Estimating a structural model is essential to quantify the magnitude of these effects.

We develop a structural equilibrium model of a vertical industry, where manufacturers have a dual channel to the consumer. The supply side features bargaining between manufacturers and retailers, and direct sales. Manufacturers and retailers bargain over wholesale prices through Nash bargaining. We incorporate direct sales to the workhorse bargaining model used for applied work (*e.g.*, Collard-Wexler *et al.* 2019). The outside option of a manufacturer improves with direct sales: if negotiations fail, a manufacturer is better off with direct sales than without them. This feature is the main difference between our model and others in the applied literature on bargaining.[6] Final prices to consumers are determined through Bertrand competition. The demand side is a standard discrete choice model of differentiated products. Consumers have idiosyncratic preferences for prices and distribution channels; that is, we allow for unobserved heterogeneity in the form of random coefficients for the price paid by consumers and whether the product is sold directly by a manufacturer or with the intermediation of a retailer.

To illustrate our approach to investigating the welfare effects of direct sales, we estimate our

[2] Lafontaine and Scott Morton (2010) discuss state franchise laws in the context of automobile distribution and their implications for the profits of car manufacturers and dealers. They conclude that (p. 248): "consumers would benefit if manufacturers could have much more leeway in experimenting with alternative distribution models than the web of franchise laws currently in place allow them to do." A direct-sale channel is one of such alternative distribution models.

[3] See, *e.g.*, Bodisch (2009), Lafontaine and Scott Morton (2010), and Lao *et al.* (2015).

[4] In the context of direct sales of this article, the bargaining leverage of a manufacturer is defined as the increase in the bargaining power of the manufacturer negotiating with a retailer due to the presence of direct sales. See Section 5 for details.

[5] We define product variety as the number of products available to consumers in the market. See Section 2 for details.

[6] *E.g.*, see Crawford and Yurukoglu (2012), Grennan (2013), Crawford *et al.* (2018), and the references therein.

model using a unique dataset from the Portuguese outdoor advertising industry. We exploit three features of the industry/data for the estimation. First, direct sales have been a regular feature of this industry over the last decade. Second, we collected market-level data directly from all the meaningful manufactures and retailers in the industry. The data encompass more than 95 percent of the industry's transaction volume. Finally, we observe both final prices paid by consumers and wholesale prices negotiated between manufacturers and retailers.

We separately estimate the demand- and supply-side parameters by GMM. The demand estimation is standard and relies on a set of moment conditions and an adequate set of instruments. We estimate the supply-side parameters conditional on the demand estimates. For the supply estimation, we use the optimality of the pricing decisions upstream and downstream. Specifically, the first-order conditions from the bargaining game between manufacturers and retailers determine the bargaining parameters and marginal costs, conditional on prices and demand estimates. The first-order conditions from the Bertrand-competition game for the final products determine the marginal costs, conditional on prices and demand estimates. Identification of supply relies on a set of instruments and the restrictions that marginal costs for a given manufacturer do not vary across retailers and bargaining weights for a given retailer do not vary across manufacturers, as discussed in Section 4.

We use the estimated model to simulate three counterfactual scenarios assessing the role of direct sales on prices and welfare in the industry. The first scenario simulates a situation where direct sales are present, but manufacturers cannot use them to increase their bargaining leverage. The second scenario considers a situation where direct sales are prohibited. In the final scenario, the vertically integrated manufacturers spin off their retail operations as separately owned companies, divesting their direct-sale operations. We show how the simulated counterfactual scenarios can isolate manufacturers' bargaining leverage due to direct sales, quantify the welfare effects of direct sales, and evaluate the magnitude of the welfare loss resulting from the decrease in product variety relative to the double marginalization.

Our empirical analysis quantifies the three main effects discussed: the extent to which direct sales increase wholesale prices due to the additional leverage of manufacturers and the welfare effects due to a direct-sale prohibition and their divestiture. First, direct sales increase manufacturers' bargaining leverage allowing them to charge wholesale prices that are 4 percent higher. The additional bargaining leverage decreases the profits of the retailers substantially, 9 percent. Consumer welfare is reduced due to the resulting increase in downstream prices. Second, prohibiting direct sales decreases consumer welfare significantly, 81 percent. Manufacturers' profits decrease by 3 percent. Retail prices increase substantially by 51 percent as a consequence of the prohibition. There is yet an increase in retail market shares, reflecting that consumers divert from direct to retail products. Retailers are the conspicuous winners from the direct-sale prohibition; their profits increase by 184 percent. In the third scenario, the divestiture of direct sales, wholesale prices tend to decrease due to the reduced manufacturers' bargaining leverage, but they tend to increase due to the reverse elimination of double marginalization (reverse EDM). The reverse EDM dominates the bargaining-leverage effect, resulting in a net increase in wholesale prices by 4 percent, and upward pressure on downstream prices, which increase by 8 percent. Consumer welfare decreases by 5 percent in the divestiture scenario; the net effect on total welfare is negligible. There is no loss of product variety in this scenario; therefore, it highlights how much of the welfare loss from prohibiting direct sales results from the loss of product variety, about 20 percent, rather than from the reverse EDM that occurs in this alternate scenario.

In summary, we make two main contributions. First, it develops a supply model featuring bargaining and direct sales to show that direct sales increase the bargaining power of manufacturers and have ambiguous effects on final prices paid by consumers and welfare. Second, we apply our model to the outdoor advertising industry to illustrate how the estimated model can be used to quantify these effects and discuss the implications for merger evaluation.

Related Literature

Since the work by McGuire and Staelin (1983), Choi (1991), and Lee and Staelin (1997), the theoretical implications of direct-to-consumer sales by manufacturers have been studied extensively in the marketing literature.[7] In an influential article, McGuire and Staelin (1983) find that, in a duopoly setting, vertical integration is more profitable than non-integration when consumers' preferences for the manufacturer's products are sufficiently differentiated. Chiang, Chhajed, and Hess (2003) study a Stackelberg game, where a manufacturer distributes its product through a retailer and opening a direct-sale channel (direct marketing) makes the manufacturer more profitable even if no sales occur by reducing inefficiencies due to double marginalization, similar to our case. Arya, Mittendorf, and Sappington (2007) show that retailers may benefit from direct sales from an encroaching supplier when the latter does not facilitate product differentiation. Cai (2010) studies the impact of channel selection on the supply chain with dual channels (*i.e.*, with direct sales) with and without coordination.

Our article is related to the raising rivals' costs (RRC) theory by Salop and Scheffman (1983).[8] The RRC theory proposes a model to explain why vertical integration raises input prices to downstream rivals and may foreclose product-market competition, thus decreasing consumer welfare.[9] The original RRC theory assumes that manufacturers upstream have all the bargaining power. Rogerson (2020, 2021) incorporate bargaining between upstream and downstream firms to investigate the competitive effect of vertical mergers. Closest to our article, Rogerson (2020) shows that a vertical merger allows the merged firm to increase the price it charges rival downstream firms for inputs by increasing its bargaining leverage over these downstream rivals. He calls it the bargaining leverage over rivals (BLR) effect. The

[7] There is also a large literature on the theoretical effects of supply chain competition. See Cachon (2002) and Ingene and Parry (2004) for surveys of the models used by the literature. See Tsay, Nahmias, and Agrawal (1999) for a review of the literature on supply chain contracts. See Cattani, Gilland, and Swaminathan (2004) for a survey of models used in internet supply chains.

[8] See also Krattenmaker and Salop (1986) and Salop and Scheffman (1987).

[9] See Riordan (2008) for a survey about the economics literature on the competitive effects of vertical integration. See also the discussions by Salop and Culley (2016) and Salop (2018).

BLR effect has a similar economic interpretation to the bargaining-leverage effect analyzed in our article. There are two main differences between the article by Rogerson and ours. First, the main focus of Rogerson (2020) is the evaluation of vertical mergers. Our main focus in this article is the evaluation of direct sales. A vertical merger and the creation of a direct-to-consumer channel give rise to similar economic principles. They are, however, different strategies. The magnitude of the bargaining leverage and double marginalization effects may differ across these two strategies, as discussed in Section 6. Furthermore, the creation of a direct-to-consumer channel involves an additional effect: the creation of a new downstream brand, thus increasing competition and product variety downstream and benefiting consumers. Second, the models developed are different. Rogerson (2020) develops a theory that can be used to derive an intuitive formula to measure the upward pricing pressure caused by a vertical merger due to changes in bargaining leverage. We develop a structural model injecting bargaining theory into the evaluation of direct sales that can be used to quantify the bargaining leverage and welfare effects of direct sales. Rogerson (2021) investigates the extent to which vertical integration raises input prices to downstream rivals when input prices are determined by Nash bargaining, both for the case where upstream and downstream prices are set sequentially and for the case where they are set simultaneously. Our contributions to the literature strands mentioned in this and the previous paragraphs are twofold. First, to provide an empirical framework to study direct sales when manufacturers and retailers bargain over wholesale prices. Second, to quantify the impact of direct sales on (wholesale and final) prices and welfare to consumers in a real-world setting.

Our article is also related to the literature studying online sales (*e.g.*, Anderson and Coughlan 1987; Pozzi 2013; Duch-Brown, Grzybowski, Romahn, and Verboven 2017; Quan and Williams 2018; Cazaubiel, Cure, Johansen, and Vergé 2018) and channel interactions in marketing (*e.g.*, Kadiyali, Chintagunta, and Vilcassim 2000; Sudhir 2001; Cotterill and Putsis 2001; Villas-Boas and Zhao 2005). Our contribution to these literature is to investigate the effect of direct sales on retailers and bargaining.

Draganska, Klapper, and Villas-Boas (2010) develop a bargaining model to investigate the determinants of bargaining in channel profitability. Our bargaining model is also similar to, *e.g.*, Crawford and Yurukoglu (2012) and Grennan (2013), and the literature that followed. In our model, manufacturers also sell directly to consumers, which is not modeled by any of these articles. Similar to our article, manufacturers also sell directly to the consumers in Donna, Pereira, Pires, and Trindade (2022). That article is, to the best of our knowledge, the only empirical article where manufacturers sell directly to consumers and manufacturers bargain with retailers. The main focus of Donna, Pereira, Pires, and Trindade (2022) is, however, the demand side. Donna, Pereira, Pires, and Trindade (2022) investigate the welfare effects to consumers of the services provided by the intermediaries. They use their supply model only to compute counterfactual prices. Donna, Pereira, Pires, and Trindade (2022) do not account for the central feature in our model: that a direct-to-consumer channel enhances manufacturer bargaining power, which can harm retail consumers. In contrast, our main focus here is the supply side. We do this to investigate the impact of direct sales on manufacturers' bargaining power which is not studied by Donna, Pereira, Pires, and Trindade (2022). Ellickson, Kong, and Lovett (2018) study how private labels improve the retailer's bargaining position. They find that direct sales by the retailer generate a bargaining benefit through more favorable margins on the competing branded products, analog to the increase in bargaining power to manufacturers in our case. While they study the effect of direct sales by a retailer (private labels), we study the effect of direct sales by a manufacturer. In addition, the supply side models are different. While they assume that retailers are monopolists (supermarkets), we allow Bertrand competition among multiple retailers in the final product market. They use the monopoly assumption to infer wholesale prices which are unobserved in their data. In contrast, we do observe wholesale prices in our data. We use the observed wholesale prices and the restrictions from the Bertrand equilibrium to estimate retailers' marginal costs. For these reasons, the supply-side identifying assumptions are different.

Our article is also related to the literature that studies the vertical relationships between manufacturers and retailers, and vertical integration. In our article, the two layers of activity are related vertically as in, *e.g.*, Brenkers and Verboven (2006), Mortimer (2008), Bonnet and Dubois (2010), Villas-Boas (2007), Dubois and Sæthre (2016). The main difference between these articles and ours is that in our model manufacturers and retailers bargain over wholesale prices. Bargaining models similar to the one in our article have been used in studies investigating vertical integration (*e.g.*, Crawford, Lee, Whinston, and Yurukoglu 2018; Luco and Marshall 2020).

Finally, our article is related to the literature studying outdoor advertising. This literature is quite small due to data limitations. We are only aware of two articles. Pereira and Ribeiro (2018) study capacity divestitures and Donna, Pereira, Pires, and Trindade (2022) study intermediation in this industry. These articles do not study how direct sales affect bargaining.

The rest of the article is organized as follows. Section 2 describes the industry and the data. Section 3 presents the model. Section 4 discusses identification and estimation. We quantify the welfare effects of direct sales in Section 5. Section 6 discusses the implications for vertical mergers. Section 7 concludes.

2 Industry and Data

2.1 Industry

For the empirical analysis, we focus on the outdoor advertising industry in Portugal. This industry has three main economic agents: manufacturers, retailers, and consumers. A manufacturer is a firm that installs and commercially exploits equipment to display outdoor advertising. Examples include J.C. Decaux Group, Cemusa, and Mop. A retailer is an intermediary that buys advertising from the manufacturer on behalf of the consumer. Retailers offer consumers additional services such as consulting services and planning advertising campaigns, which are charged in the retail price. Examples include Omnicom Media Group, WPP Plc., and Power Media Group Inc. Finally, a consumer, or advertiser, is a firm that demands advertising to promote its products. Consumers in this industry are firms that buy exposure in the manufacturer's advertisement network.[10] For example, consumers buy 200 panels of 2 m^2 panels (called faces) distributed in the national network of J.C. Decaux Group. They cannot choose, however, specific 2 m^2 panels located at a particular place. Most of the purchases are in the national network, which is the focus of this article. The exposition is similar across manufacturers.

Vertical Structure. In terms of vertical relations, consumers make 85 percent of their purchases from the retailers and the remaining 15 percent directly from the manufacturers (Table 1). There are two distribution channels in the industry: retailing and direct sales. Consumers use retailers as intermediaries in the retailing channel to purchase manufacturers' display formats. In the direct-sale channel, consumers purchase directly from the manufacturers. Consumers' choice of the distribution channel is determined by their advertising needs, which may or may not be related to the size of their firm. The two channels offer different services. The direct-sale channel offers a basic service. The retailing channel offers the basic service plus additional services, such as consulting. Firms that advertise occasionally or make simple campaigns typically use the direct-sale channel. Firms that advertise frequently or make elaborate campaigns that require complex planning use the retailing channel.

Physical Products. Display formats are the physical products in the industry. There are three main display formats: 2 m^2 panels,[11] Seniors, and Others. Panels of 2 m^2 are relatively small panels that appear on city information panels, bus shelters, kiosks, *etc.* A Senior is an advertising panel with an area between 8 and 24 m^2. The last category, "Others," encompasses Transports and Special Formats. A Transport includes panels on moving vehicles (*e.g.*, buses, trains, taxis, *etc.*) or transport hubs (*e.g.*, airports, railway's stations, subways' stations, *etc.*). A Special Format is a large panel typically made by special request to be displayed, *e.g.*, on buildings' gables.

Marginal costs refer to marginal production costs. Consider the case of 2 m^2 panels. Marginal costs consist of two parts: the marginal cost of the physical panel on the streets (billboard) and the marginal costs of the posters inside the billboard. The physical panels last for a while and can be used for several campaigns. However, they need maintenance, which is costly, and, eventually, they need to be replaced. Posters have to be designed, printed, and installed, which are costly activities.

Generally, one can think of marginal costs as having an industry-wide component common to all firms and a firm-specific component. A campaign involves variable costs associated with three activities: producing, installing, and maintaining the posters and physical displays.

[10] The advertisement network refers to the location of the display formats of the manufacturers.

[11] In the setting studied m^2 refers to square meters.

Poster production is typically subcontracted and includes the cost of the paper, paint, electricity, labor, and printing equipment. The costs associated with this activity are similar across firms. They are the common, industry-wide component of the marginal costs. Poster installation and maintenance are typically performed directly by the firms. Installation costs include labor, gasoline, and the cost of transportation vehicles. Maintenance costs include labor, specialized tools, and physical parts. Some components for the last two activities, like gasoline, are common across firms, but others differ. The latter is the idiosyncratic, firm-specific component of the marginal costs.

Differentiation. Retailers sell advertising space and other services, such as consulting. Display formats from a given, specific manufacturer sold through different retailers are differentiated products. Manufacturers are not necessarily present at the same locations at all times. They do not have identical networks. Manufacturers also offer differentiated products. Finally, some combinations of display formats, manufacturers, and retailers may not be available at a given time. Consumers ought to consider not only the attributes of the advertising space they require but also the characteristics of the retailers and manufacturers.

Payment Schedules. Contracts and payment schedules between manufacturers and retailers are negotiated because all participants in the industry are firms. Manufacturers charge a price schedule that consists of a linear price and quantity discounts as a function of the total sales. Both retailers and consumers have access to quantity discounts. In practice, however, quantity discounts are only observed in the retailer channel. This feature is because the retailers aggregate the purchases from multiple consumers when buying from the manufacturers. Although consumers could negotiate directly with the manufacturer, the individual quantity purchased by a given consumer is substantially lower than the total quantity purchased by the retailers. So the purchases made by consumers in the direct-sale channel exhibit no quantity discounts. From the consumers' perspective, the payment schedules between manufacturers and consumers, and between retailers and consumers are posted prices.

Productive Capacity. In the short run, the productive capacity of each manufacturer and, thus, of the industry is fixed. The capacity is measured by the installed equipment available for outdoor advertising. To operate, manufacturers must first obtain the right to use the space where the display equipment is installed, either through a public tender or direct contracting. This right is obtained from the site owners, the landlords of the physical space where the display equipment is installed. Site owners include transit authorities, airports, supermarkets, malls, and other public/private landlords. The rights between manufacturers and site owners are set by long-run contracts that last up to 20 years. In this article, we focus on the year 2013. The productive capacity is, therefore, fixed. Inspection of our data on manufacturers' installed capacity and monthly usage indicates that capacity limits are never attained in our sample for any of the manufacturers; manufacturers always operate below capacity.

Market Concentration. The Portuguese outdoor advertising market is quite concentrated at the manufacturer and retail levels. At the manufacturer level, the three largest firms are responsible for 77.6 percent of the sales in the market, with the largest manufacturer encompassing 47.6 percent of the sales. At the retail level, the five largest retailers are responsible for 48.2 percent of the sales, with 21.2 percent of the sales made by the largest retailer, which is larger than the direct sales by the manufacturers. The most popular display formats are 2 m^2 panels; they encompass 55.8 percent of the sales. The largest manufacturer is responsible for 56.5 percent of the sales of 2 m^2 panels in the market; the largest retailer is responsible for 10.4 percent of the sales of 2 m^2 panels. There is no cross-ownership between manufacturers, nor between retailers, nor between manufacturers and retailers.

2.2 Data

The data are administrative, encompassing all the meaningful manufacturers and retailers in the industry for 2013, aggregated at the monthly market level. By *meaningful* we mean that the data encompass more than 95 percent of the volume of transactions in the industry.

We consider three display formats: 2 m^2 panel, senior, and an additional category aggregating the remaining formats that have very small market shares individually. We consider four manufacturers: the three main manufacturers in the industry (J.C. Decaux Group, Cemusa, and Mop) and an additional manufacturer aggregating the smaller ones. Finally, we consider nine retailers: the five main retailers in the industry (Omnicom Media Group, WPP Plc., Power Media Group Inc., Havas Media Group, and Interpublic Group of Companies), one additional retailer that aggregates the smaller retailers, and the three manufacturers selling directly to consumers (J.C. Decaux Group, Cemusa, and Mop). The smaller manufacturers do not sell directly to consumers. Henceforth, for confidentiality reasons, we refer to the three main manufacturers as m_1, m_2, and m_3, not necessarily in the order above, to the additional manufacturer as m_4, to the retailers that sell directly to the consumers as r_1^d, r_2^d, r_3^d, by the same order as the three main manufacturers, to the five main retailers as $r_4^v, \ldots, r_8^v$, not necessarily in the order above, and to the additional retailer as r_9^v. Characteristics of the manufacturers and retailers were collected by inspecting the websites of the retailers and manufacturers. The appendix in Donna, Pereira, Pires, and Trindade (2022) describes the procedure to clean the data.

In each month and for each triplet of display format, manufacturer, and retailer, we observe: the total sales, measured in Euros; the total quantity of advertising sold, measured in advertising faces and square meters; the wholesale prices charged from the manufacturers to the retailers, measured in Euros; the commissions, fees, and quantity discounts paid to the manufacturers, measured in Euros; and the installed capacity, measured in advertising faces. We also observe characteristics for each manufacturer and retailer, such as the number of offices.

We use the data described above to build a data set of products sold for each month of the year 2013 and their characteristics.

Product definition. We define a product as a combination of display format, manufacturer, and retailer (including direct sales and retailers).

Market definition. A market is defined as a month. Geographically, all manufacturers and retailers operate in the same market. This feature follows from Portugal being a small country with a concentrated population along the coast. For the definition of the geographic market, we follow the Portuguese Competition Authority, which considered that the geographic market for this industry is Portugal in the merger review for the outdoor advertising industry, case Ccent. 15/2014 JCDecaux/Cemusa.

Market shares. Market shares are defined by dividing volume sales by the total potential sales in a given month (*i.e.*, market size). These potential sales (or market size) is assumed to be twenty percent greater than the maximum observed total monthly sales of the year 2013.[12] The market share of the outside good was defined as the difference between one and the sum of the market shares of the inside goods in each month. The outside good can be conceptualized as including products outside the sample (*e.g.*, special request panels), outdoor advertising sold by other manufacturers and retailers (*e.g.*, small manufacturers and retailers that operate locally), and not buying outdoor advertising. An observation in this data set represents a market share of a product as defined above in a given month. We consider 12 markets, one for each month of the year, and a continuum of heterogeneous consumers in each market.

2.3 Summary statistics

We provide summary statistics of the market shares and prices in tables 1 and 2, respectively. Table 1 shows the market shares of each product in the sample. All of the retailers contract with the three largest manufacturers.

Table 2 reports summary statistics on wholesale and retail prices for each display format. Mean retail prices are only slightly higher than the corresponding wholesale prices. That is, retailers have low margins indicating they have low bargaining power. Table 2 shows large differences in prices across both manufacturers and retailers holding constant the display format. These price differences and the differences in the observed market shares indicate that differentiation is important in this industry, as mentioned above.

[12]For robustness, we tested increasing/decreasing the market size to, respectively, 50 and 10 percent greater than the maximum observed total monthly sales, and obtained very similar results.

3 Model

In this section we present the model, discuss the economic forces at play, and show the effects of direct sales on wholesale and final prices to consumers.

3.1 Demand Model

We use a standard random coefficients logit model for individual demand similar to Berry (1994), Berry, Levinsohn, and Pakes (1995), and Nevo (2001). Assume there are $t = 1, \ldots, T$ markets, each with a continuum of rational, utility-maximizing consumers indexed by i. In each market t there are J_t horizontally differentiated inside products indexed by $j = 1, 2, ..., J_t$. We index by $j = 0$ the outside product. The indirect utility of consumer i from buying product j in market t is:

$$u_{ijt} = -\alpha_i p_{jt} + x_{jt}\beta + \tau_f + \tau_m + \tau_r + \tau_t + \xi_{jt} + \hat{\varepsilon}_{ijt},$$

where p_{jt} denotes the price of product j in market t; x_{jt} is a S-dimensional (row) vector of observable characteristics of product j in market t; τ_f, τ_m, τ_r, and τ_t capture the preferences for type of good f,[13] manufacturer m, retailer r, and monthly seasonal effects in market t, using fixed dummy variables for type of good, manufacturer, retailer, and monthly seasonal effects, respectively; ξ_{jt} is the valuation of unobserved (by the econometrician) characteristics of product j in market t; $\hat{\varepsilon}_{ijt}$ is a stochastic term described below;[14] α_i are individual-specific parameters that capture consumers' preferences for price as described below; and β is a S-dimensional vector of parameters. In each market t we normalize the characteristics of the outside product, $j = 0$, such that $u_{i0t} = \epsilon_{i0t}$ for all t.

We model the distribution of consumers' preferences for price as $\alpha_i = \alpha + \sigma\nu_i$, where α and σ are parameters, ν_i captures unobserved (by the econometrician) individual characteristics, and $P_\nu(\nu_i)$ is a parametric distribution assumed to be a standardized Normal, $\mathcal{N}(0, 1)$, for the estimation.[15]

Consumers have preferences specific to each distribution channel (or retailer type) and the outside product. We capture it by decomposing the stochastic term, $\hat{\varepsilon}_{ijt}$, using the distributional assumptions of the nested-logit with a factor structure: $\hat{\varepsilon}_{ijt} = \zeta_{igt} + (1 - \lambda)\varepsilon_{ijt}$. The subindex $g \in \{0, 1, 2\}$ defines three groups (or nests) of nonoverlapping products for the outside product (denoted by $g = 0$, with only one product), the products sold in the retailing channel (denoted by $g = 1$), and the products sold in the direct-sale channel (denoted by $g = 2$). The random variable ζ_{igt} has a unique distribution such that $\hat{\varepsilon}_{ijt}$ is extreme value (Cardell 1997). The parameter λ is a nesting parameter such that $0 \leq \lambda < 1$. A larger value

[13] Display format in the application studied.

[14] Heterogeneity in the value to consumers within product (for example, due to the specific location of the billboard) is of horizontal nature (for example, some consumers may prefer space near a school while others may prefer it close to a highway). This feature is captured in our model by $\hat{\varepsilon}_{ijt}$.

[15] We have also estimated demand using lognormally distributed random coefficients for price. The results are available in Appendix B.2.

of λ corresponds to a greater correlation in preferences for products in the same distribution channel and the outside product. A larger value of λ is therefore associated with less substitution between products in different distribution channels and the outside product. When $\lambda = 0$ the model in the second step collapses to a standard random-coefficient mixed-logit model (*e.g.*, Berry, Levinsohn, and Pakes 1995; Nevo 2001) with no preference heterogeneity for distribution channels or the outside product.

The computation of the market share function follows the standard derivations. See Appendix A.1 for details.

Given our focus on the supply side, we purposely posit a simple specification of the demand system. It allows to keep the notation compact and highlights the main economic forces at play on the supply side. The demand- and supply-side parameters are estimated separately, as we explain below. It is thus straightforward to apply the supply-side analysis to a different specification of the demand system. For example, Donna, Pereira, Pires, and Trindade (2022) allow for correlation in the unobserved shocks between channels and costly search. To keep the demand side simple, we allow consumers to self-select into the distribution channels based on their preferences but do not engage in costly search. See Donna, Pereira, Pires, and Trindade (2022) for generalizations of the demand system.[16]

3.2 Supply Model

There are two types of multi-product firms, manufacturers and retailers. Manufacturers produce basic production factors, called display formats, that they sell directly to retailers or consumers. A production factor (display format) from a manufacturer sold to different retailers generates different products. Retailers combine manufacturer factors with their own retail production factors to produce retail products, also called display formats, that they sell to consumers. There are $m = 1, \dots, M$ manufacturers and $r = 1, \dots, R$ retailers. Let $\mathcal{J}$ be the set of differentiated products. Denote by Ω_m^R the set of products that manufacturer m sells to retailers, Ω_m^D the set of products that manufacturer m sells directly to the consumers, and Ω_r the set of products that retailer r sells to the consumers. The timing is as follows:

(1a) Manufacturers and retailers bargain over wholesale prices, $w \equiv \{w_j\}_{j \in \mathcal{J}}$, where w_j represents the wholesale price paid by a retailer to the manufacturer of product j.

(1b) Simultaneously with the bargaining over wholesale prices, retailers and manufacturers set retail prices, $p \equiv \{p_j\}_{j \in \mathcal{J}}$ to the consumers through a Nash Bertrand game. The vector p includes products from retailers and direct sales.

(2) Consumers observe all prices, p, and choose the product that maximizes their utility, thus determining the market shares, $\{s_j(p)\}_{j \in \mathcal{J}}$. Profits are realized.

[16] The results discussed in Section 4 are robust to demand specifications using costly search.

Firms maximize profits when bargaining over wholesale prices and setting retail prices. The profit of retailer r is:[17]

$$\Pi_r = \sum_{j \in \Omega_r} (p_j^R - w_j) M s_j^R(p), \tag{1}$$

where M denotes market size; p_j^R denotes the price of product j sold to consumers by the retailer; and $s_j^R(p)$ denotes the market share of product j sold to consumers by the retailer.

The profit of manufacturer m is:

$$\Pi_m = \sum_{j \in \Omega_m^R} (w_j - c_j^m) M s_j^R(p) + \sum_{j \in \Omega_m^D} (p_j^D - c_j^m) M s_j^D(p), \tag{2}$$

where c_j^m denotes the manufacturer's marginal cost of product j; p_j^D denotes the price of product j sold to consumers directly by the manufacturer; and $s_j^D(p)$ denotes the market share of product j sold to consumers by the manufacturer directly.

Four comments are in order. First, we have explicitly distinguished with superscripts the market share of display format j sold to retailers, denoted by $s_j^R(p)$, and the market share of display format j sold directly to consumers, denoted by $s_j^D(p)$. Similarly, for the prices of products sold to consumers by retailers, p_j^R, and by manufacturers directly, p_j^D. This notation eases the discussion of the examples in the next subsection. Second, we assume retailers' only marginal cost is the wholesale price. We make this assumption because the observed retail margins in our data are positive but very small. Thus retailers' marginal costs would have to be very small.[18] Third, we assume that upstream and downstream prices are set simultaneously. This assumption simplifies the estimation of the model by allowing us to obtain a more tractable solution of the upstream first-order condition, as shown below.It is a common assumption in the vertical bargaining literature (*e.g.*, see Draganska, Klapper, and Villas-Boas 2010, Ho and Lee 2017, and Crawford, Lee, Whinston, and Yurukoglu 2018, among others). It can be interpreted as the retailers choosing the retail prices without observing the bargaining process's outcome. While this assumption limits how upstream and downstream prices interact, retail prices still affect wholesale prices in equilibrium, as shown below. We believe this assumption is appealing in our setting because manufacturers do not have an obvious first-order-mover advantage. An alternative assumption would be to use a sequential-timing assumption, first, wholesale prices are negotiated, then, downstream prices are set. See Donna, Pereira, Pires, and Trindade (2022) for details about the estimation of such a model. Finally, the profit function of manufacturers contains two terms: the profits from selling the products to the retailers and directly to the consumers. In the subsequent analysis of this section, we take the demand system as a primitive and analyze each of the following in turn: equilibrium determination of retail prices, bargaining over wholesale prices, and the leverage effect obtained by a manufacturer with direct sales.

[17] We omit the market subscript, t, for the variables in this subsection to simplify the notation.

[18] We obtain similar results using additional retailers' marginal costs.

Retail price setting. Retail prices are given by the Nash-Bertrand equilibrium. The necessary first-order conditions for the retailers are:

$$s_j^R + \sum_{k\in\Omega_r} (p_k^R - w_k)\frac{\partial s_k^R(p)}{\partial p_j^R} = 0, \qquad \forall j \in \Omega_r, \quad r = 1,\ldots,R. \tag{3}$$

The necessary first-order conditions for manufacturers from their direct sales are:

$$s_j^D + \sum_{k\in\Omega_m^R} (w_k - c_k^m)\frac{\partial s_k^R(p)}{\partial p_j^D} + \sum_{k\in\Omega_m^D} (p_k^D - c_k^m)\frac{\partial s_k^D(p)}{\partial p_j^D} = 0, \quad \forall j \in \Omega_m^f,\ f \in \{\text{R},\text{D}\},\ m = 1,\ldots,M. \tag{4}$$

The system of equations in (3) and (4) defines the vector of prices to consumers set by the retailers and by the manufacturers directly, p^R and p^D.

Wholesale price setting. The equilibrium concept for the determination of negotiated wholesale prices is Nash equilibrium in Nash bargains (Nash-in-Nash, henceforth), first proposed by Horn and Wolinsky (1988). Each negotiated wholesale price is the solution of a Nash bargain. All negotiated wholesale prices form a Nash equilibrium, *i.e.*, no manufacturer-retailer pair would like to change their negotiated wholesale price given all other agreements. We assume that firms do not expect the other contracts to be renegotiated in case negotiation fails. This assumption is standard and has been used in applied work by Draganska, Klapper, and Villas-Boas (2010) and Crawford, Lee, Whinston, and Yurukoglu (2018), among others.

In the Nash-in-Nash framework, the disagreement payoff of a firm in the negotiation of the wholesale price of a given product is defined as the profit this firm would earn if that product was not offered keeping the other wholesale prices fixed. The disagreement payoffs for each retailer r and each manufacturer m are, respectively:

$$\Pi_{r,-j} \equiv \sum_{k\in\Omega_r|\{j\}} (p_k^R - w_k) M s_{k,-j}^R(p_{-j}),$$

and

$$\Pi_{m,-j} \equiv \sum_{k\in\Omega_m^R|\{j\}} (w_k - c_k^m) M s_{k,-j}^R(p_{-j}) + \sum_{k\in\Omega_m^D} (p_k^D - c_k^m) M s_{k,-j}^D(p_{-j}),$$

where the terms $s_{k,-j}^R(p_{-j})$ and $s_{k,-j}^D(p_{-j})$ represent the market shares of product k if product j is not offered.

The wholesale price for product j sold by retailer r solves:

$$\max_w \left(\underbrace{\Pi_r(w, w_{-j}) - \Pi_{r,-j}(w_{-j})}_{GFT_r^j}\right)^{\lambda_j} \left(\underbrace{\Pi_m(w, w_{-j}) - \Pi_{m,-j}(w_{-j})}_{GFT_m^j}\right)^{1-\lambda_j}, \ \forall j \in \Omega_r, \quad r = 1,\ldots,R.$$

where $\lambda_j \in (0,1)$ for all j is the retailer's bargaining weight *vis-à-vis* manufacturers; and the terms GFT_r^j and GFT_m^j stand for gains-from-trade from product j for retailer r and manufacturer m, respectively.

The necessary first-order conditions are given by:

$$\frac{\Pi_r(w, w_{-j}) - \Pi_{r,-j}(w_{-j})}{\Pi_m(w, w_{-j}) - \Pi_{m,-j}(w_{-j})} = \frac{\lambda_j}{1-\lambda_j}, \qquad \forall j \in \Omega_r, \quad r = 1, \ldots, R. \tag{5}$$

In words, equation (5) says that the ratio of gains over the corresponding disagreement profits is equal to the ratio of bargaining weights. Rewrite equation (5) as:[19]

$$\begin{aligned} w_j s_j^R(p) = (1-\lambda_j)\left[p_j^R s_j^R(p) - \sum_{k \in \Omega_r|\{j\}} (p_k^R - w_k)\Delta s_{k,-j}^R(p)\right] + \\ + \lambda_j \left[c_j^m s_j^R(p) + \underbrace{\sum_{k \in \Omega_m^R|\{j\}} (w_k - c_k^m)\Delta s_{k,-j}^R(p)}_{\equiv d_j^R} + \underbrace{\sum_{k \in \Omega_m^D} (p_k^D - c_k^m)\Delta s_{k,-j}^D(p)}_{\equiv d_j^D}\right], \quad \forall j \in \Omega_r, \quad r = 1, \ldots, R. \end{aligned} \tag{6}$$

where $\Delta s_{k,-j}^f(p) \equiv s_{k,-j}^f(p_{-j}) - s_k^f(p)$, with $f \in \{\text{R}, \text{D}\}$.

In the last equation, we expressed the manufacturer's gains-from-trade as $GFT_m^j = (w_j - c_j^m)s_j^R - d_j^R - d_j^D$, where d_j^R and d_j^D are non-negative terms representing the additional profits the firm obtains from its other products (from the retailing and direct-sale channels, respectively) when product j stops being offered. The term $d_j^R + d_j^D$ represents manufacturer m's opportunity cost or shadow price from dealing with retailer r. The presence of direct sales increases this opportunity cost.

The system of equations in (6) defines wholesale prices as a function of demand primitives and the vector of prices to consumers set by the retailers and by the manufacturers directly, p^R and p^D. For the manufacturers that do not sell directly to consumers, the problem and optimality conditions are analogous, with the only difference being that d_j^D is zero.

Equilibrium. Using the notation for the firms in this subsection rewrite the market share function for product j sold by firm $f \in \{\text{R}, \text{D}\}$ in equation (A.3) as:

$$s_j^f(\cdot) = \int_{A_j} \mathbb{P}_{ij} \, \mathrm{d}P_\nu(\nu_i), \qquad \forall j \in \mathcal{J}. \tag{7}$$

The market share function in (7), and the equilibrium prices of the industry in (3), (4), and (6) characterize the equilibrium behavior in the industry.

3.3 Economic Intuition

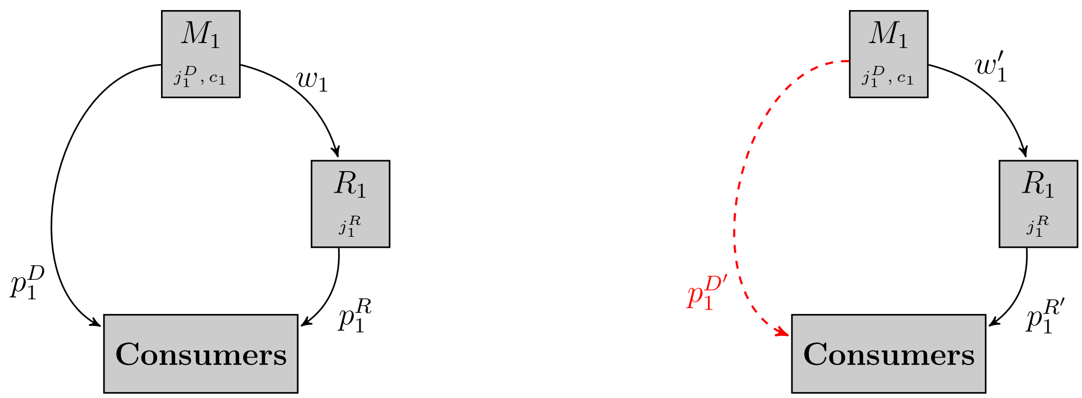
In this subsection, we present three examples to discuss the main economic forces at play and how the existence of a direct-sale channel may affect the negotiated wholesale prices and the prices paid by consumers. In the first example, there is a single manufacturer interacting

[19] See Appendix A.2 for details about the derivations of equations (5) and (6).

with a single retailer. It shows that the negotiated wholesale price and the final price to consumers decrease unambiguously when the manufacturer does not leverage its direct sales in the negotiation. In the second example, there are two manufacturers interacting with a single retailer. It shows the same results from Example 1 when both manufacturers do not use the leverage of direct sales. In the third example, we show that there are ambiguous effects on prices upstream and downstream when only one manufacturer does not leverage its direct sales in the negotiation. Throughout the rest of this subsection, we assume that downstream products are substitutes.[20]

Example 1. No leverage with one manufacturer and one retailer.

Figure 1: No leverage with one manufacturer and one retailer.



(a) M_1 uses leverage from direct sales. (b) M_1 does not use leverage from direct sales.

Notes: The figure illustrates the leverage effect with one manufacturer and one retailer from Example 1. Panel a. In the upstream manufacturer M_1 produces input 1 at marginal cost c_1. This input is sold to retailer R_1 at the negotiated wholesale price w_1, and used to manufacture product j_1^D. In the downstream there are two competing firms, M_1 and R_1. Manufacturer M_1 sells product j_1^D directly to consumers at price p_1^D. Retailer R_1 sells product j_1^R at price p_1^R. Panel b. The dotted red line denotes that the manufacturer M_1 does not use the leverage from direct sales when negotiating with retailer R_1. Not using the leverage results in a lower (relative to panel a) negotiated wholesale price, $w_1' < w_1$. Holding constant product competition and product variety downstream, the decrease in the wholesale price to w_1' creates downward pressure on downstream prices, $p_1^{D'}$ and $p_1^{R'}$.

There is one manufacturer, M_1 and one retailer, R_1. In the upstream manufacturer M_1 produces input 1 at marginal cost c_1. This input is sold to retailer R_1 at the negotiated wholesale price w_1, and used to manufacture product j_1^D. In the downstream there are two competing firms, M_1 and R_1. Manufacturer M_1 sells product j_1^D directly to consumers at price p_1^D. Retailer R_1 sells product j_1^R at price p_1^R. There are three prices, w_1, p_1^D, and p_1^R, characterized by the system in equations (3), (4), and (5). Figure 1a depicts the situation. The downstream first-order conditions (3) and (4) become:

[20] The discussion about the opening of a direct-to-consumer channel also involves the elimination of double marginalization. We omit the double-marginalization effect in this subsection because it is not relevant for the trade-off emphasized in these examples. See Section 6 for a discussion about the elimination of double marginalization in the context of direct sales.

$$(p_1^R): \qquad s_1^R(p) + (p_1^R - w_1)\frac{\partial s_1^R}{\partial p_1^R}(p) = 0,$$

$$(p_1^D): \qquad s_1^D + (w_1 - c_1)\frac{\partial s_1^R}{\partial p_1^D}(p) + (p_1^D - c_1)\frac{\partial s_1^D}{\partial p_1^D}(p) = 0.$$

Similarly, the upstream first-order condition (5) can be written as:

$$(w_1): \quad \left[w_1 - (\lambda_1 c_1 + (1-\lambda_1)p_1^R)\right] s_1^R(p) = \underbrace{\lambda_1(p_1^D - c_1)\underbrace{\left(s_{1,-j}^D(p) - s_1^D(p)\right)}_{>0}}_{\equiv \text{DSE}>0},$$

where the term on the right-hand side represents the direct sales effect denoted by DSE.

Now consider the same setting without the leverage of the manufacturer from direct sales. Figure 1b depicts the situation. The dotted red line denotes that the manufacturer M_1 does not use the leverage from direct sales when negotiating with retailer R_1. To keep product variety and downstream competition constant, we maintain that direct sales are still an option for consumers. It allows us to isolate the leverage effect due to direct sales.[21] Without the leverage of the manufacturer, the term DSE in the last equation is zero. Then:

$$\underbrace{w_1 = \lambda c_1 + (1-\lambda)p_1^R + \text{DSE}/s_1^R(p)}_{\text{with direct sales}} > \underbrace{w_1' = \lambda c_1 + (1-\lambda)p_1^{R'}}_{\text{without direct sales}},$$

where the inequality follows because a change in $\Delta_{w_1} > 0$ in w_1 generates a change in the same direction but lower in magnitude in p_1^R because the pass-through from w_1 to p_1^R does not exceed one and $0 < \lambda < 1$.[22]

Thus, $w_1 > w_1'$. The decrease in wholesale prices without leverage creates a downward pressure on downstream prices, $p_1^{D'}$ and $p_1^{R'}$.

In sum, when the manufacturer starts using the leverage from direct sales: (i) wholesale prices increase upstream allowing it to extract a higher fraction of the retailing channel surplus; and (ii) prices to consumers increase downstream.

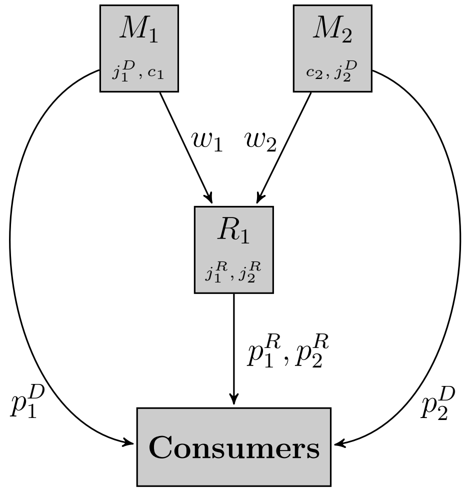
Example 2. No leverage effect from two manufacturers.

Now there are two manufactures and one retailer. In the upstream manufacturers M_1 and M_2 produce, respectively, inputs 1 and 2 at costs c_1 and c_2. These inputs are sold to retailer R_1 at, respectively, the negotiated wholesale prices w_1 and w_2, and used to manufacture products j_1^D and j_2^D. In the downstream there are three competing firms, M_1, M_2, and R_1. Manufacturers M_1 and M_2 sell, respectively, products j_1^D and j_2^D directly to consumers at prices p_1^D and p_2^D. Retailer R_1 sells products j_1^R and j_2^R at prices p_1^R and p_2^R, respectively. Now there are 6 prices, w_1, w_2, p_1^D, p_2^D, p_1^R, and p_2^R. Figure 3a

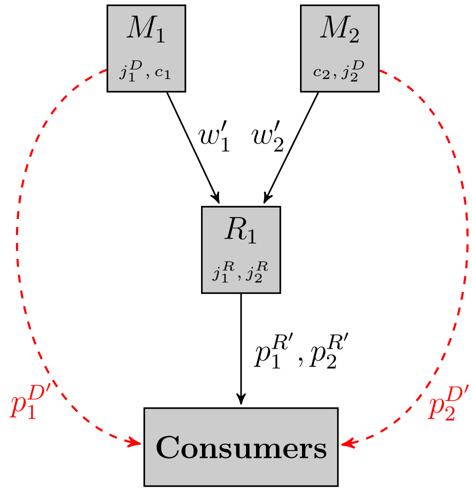
[21] Alternatively, one can think about a manufacturer with two separate divisions/managers, one for direct sales to consumers and the other for wholesales to retailers. These managers/divisions do not internalize the profits from the other managers/divisions.

[22] That is, let $\Delta_{w_1} \equiv |w_1' - w_1|$ and $\Delta_{p_1^R} \equiv |p_1^{R'} - p_1^R|$, where the prime superscripts refer to the situation without the leverage of the manufacturer from direct sales as depicted in Figure 1b. Then, $\Delta_{w_1} > \Delta_{p_1^R}$.

Figure 2: No leverage effect from two manufacturers.



(a) M_1 and M_2 use leverage from direct sales.



(b) Neither M_1 nor M_2 use leverage from direct sales.

Notes: The figure illustrates the leverage effect of one manufacturer with two manufacturers and one retailer from Example 2. Panel a. In the upstream manufacturers M_1 and M_2 produce, respectively, inputs 1 and 2 at costs c_1 and c_2. These inputs are sold to retailer R_1 at, respectively, the negotiated wholesale prices w_1 and w_2, and used to manufacture products j_1^D and j_2^D. In the downstream there are three competing firms, M_1, M_2, and R_1. Manufacturers M_1 and M_2 sell, respectively, products j_1^D and j_2^D directly to consumers at prices p_1^D and p_2^D. Retailer R_1 sells products j_1^R and j_2^R at prices p_1^R and p_2^R, respectively.
Panel b. The dotted red lines denote that the manufacturers M_1 and M_2 do not use the leverage from direct sales when negotiating with retailer R_1. Not using the leverage results in a lower (relative to panel a) negotiated wholesale prices: $w_1' < w_1$ and $w_2' < w_2$. Holding constant product competition and product variety downstream, the decrease in the wholesale prices create an imbalance in the first-order conditions of the retailer. The change of w_1' relative to w_2' will determine how retailer R_1 will adjust its prices. For example, if w_2' decreases more than w_1', it is relatively more profitable for R_1 to sell product j_2^R, thus creating an incentive to increase $p_1^{R'}$ and decrease $p_2^{R'}$ to divert demand to product j_2^R.

depicts the situation. The downstream first-order conditions in equations (3) and (4) become:

$$(p_1^R): \qquad s_1^R(p) + (p_1^R - w_1)\frac{\partial s_1^R}{\partial p_1^R}(p) + (p_2^R - w_2)\frac{\partial s_2^R}{\partial p_1^R}(p) = 0, \tag{8}$$

$$(p_2^R): \qquad s_2^R(p) + (p_2^R - w_2)\frac{\partial s_2^R}{\partial p_2^R}(p) + (p_1^R - w_1)\frac{\partial s_1^R}{\partial p_2^R}(p) = 0, \tag{9}$$

$$(p_1^D): \qquad (w_1 - c_1)\frac{\partial s_1^R}{\partial p_1^D}(p) + s_1^D + (p_1^D - c_1)\frac{\partial s_1^D}{\partial p_1^D}(p) = 0, \tag{10}$$

$$(p_2^D): \qquad (w_2 - c_2)\frac{\partial s_2^R}{\partial p_2^D}(p) + s_2^D + (p_2^D - c_2)\frac{\partial s_2^D}{\partial p_2^D}(p) = 0. \tag{11}$$

Upstream, first-order condition (5) for manufacturer M_1 becomes:

$$(w_1): \qquad \lambda_1 \left[(w_1 - c_1) s_1^R(p) + (p_1^D - c_1) \underbrace{\left(s_1^D(p) - s_{1,-j}^D(p) \right)}_{<0} \right]$$
$$= (1-\lambda_1) \left[(p_1^R - w_1) s_1^R(p) + (p_2^R - w_2) \underbrace{\left(s_2^R(p) - s_{2,-j}^R(p) \right)}_{<0} \right].$$

The main difference relative to Example 1 is on the right-hand side: in the downstream firms now have to take into account the profits from product 2. The above condition can be rewritten as:

$$(w_1): \qquad \left[w_1 - (\lambda_1 c_1 + (1-\lambda_1) p_1^R) \right] s_1^R(p) = \underbrace{\lambda_1 (p_1^D - c_1) \underbrace{\left(s_{1,-j}^D(p) - s_1^D(p) \right)}_{>0}}_{\text{Direct sales term}} + (1-\lambda_1)(p_2^R - w_2) \underbrace{\left(s_2^R(p) - s_{2,-j}^R(p) \right)}_{<0}. \tag{12}$$

Similarly, for manufacturer M_2:

$$(w_2): \qquad \left[w_2 - (\lambda_2 c_2 + (1-\lambda_2) p_2^R) \right] s_2^R(p) = \underbrace{\lambda_2 (p_2^D - c_2) \underbrace{\left(s_{2,-j}^D(p) - s_2^D(p) \right)}_{>0}}_{\text{Direct sales term}} + (1-\lambda_2)(p_1^R - w_1) \underbrace{\left(s_1^R(p) - s_{1,-j}^R(p) \right)}_{<0}. \tag{13}$$

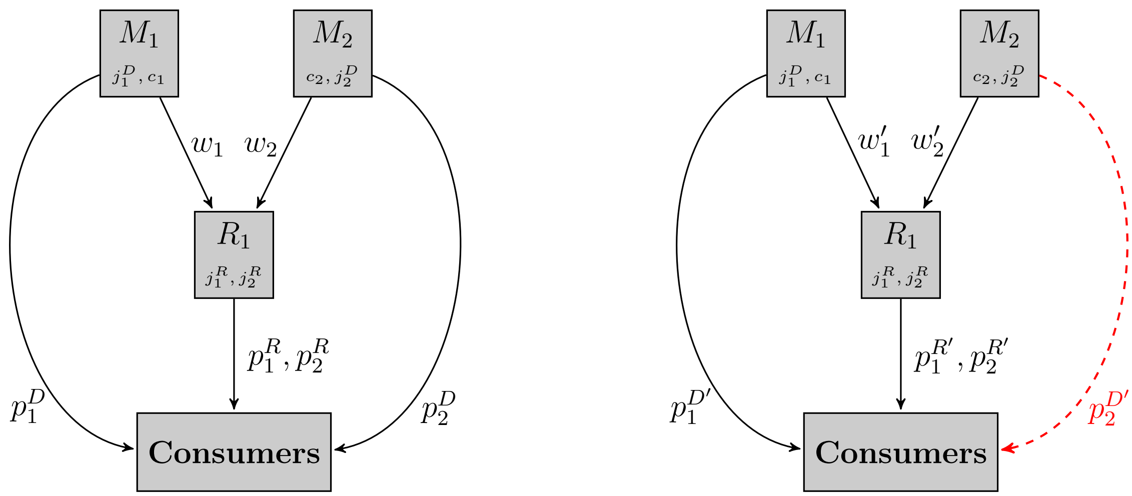
Now consider the situation in Figure 2b where neither M_1 nor M_2 use leverage from direct sales. Using the last equations one can see that both wholesale prices decrease to w_1' and w_2'. This generates an imbalance in the first-order conditions (8) to (11). Prices from the retailer downstream, p_1^R and p_2^R, may increase or decrease depending on the relative change of wholesale prices and the demand system. To see this consider the first-order conditions of the multi-product retailer, (8) and (9). For example, if w_1 decreases substantially more than w_2, R_1 may have an incentive to decrease p_1^R and to increase p_2^R to divert demand towards the cheaper product upstream. Alternatively, (8) and (9) may generate an incentive to decrease both prices, p_1^R and p_2^R. The manufacturers' first-order conditions, (10) and (11), reflect an incentive to decrease prices of direct sales downstream to $p_1^{D'} < p_1^D$ and $p_2^{D'} < p_2^D$, respectively.

In sum, when both manufacturers start using leverage from direct sales: (i) wholesale prices increase upstream; and (ii) some prices to consumers increase, while others may decline.

Example 3. Two manufacturers, no leverage from one of them.

Consider now the same situation as in Example 2 where equilibrium prices are characterized by first-order conditions (8) to (13). Now, however, consider a situation where only M_1 uses the leverage from direct sales as depicted in Figure 3b. As before when M_2 does not use the leverage of direct sales the negotiated wholesale price decreases, $w_2' < w_2$ relative to Figure 3a. The effect upon w_1 is less clear because the final prices to consumers move in different directions. To see this, consider retailer first-order conditions.

Figure 3: No leverage from one manufacturer.



(a) M_1 and M_2 use leverage from direct sales.

(b) M_2 does not use leverage from direct sales.

Notes: The figure illustrates the leverage effect of one manufacturer with two manufacturers and one retailer from Example 3.
Panel a. In the upstream, manufacturers M_1 and M_2 produce, respectively, inputs 1 and 2 at costs c_1 and c_2. These inputs are sold to retailer R_1 at, respectively, the negotiated wholesale prices w_1 and w_2, and used to manufacture products j_1^D and j_2^D. In the downstream, there are three competing firms, M_1, M_2, and R_1. Manufacturers M_1 and M_2 sell, respectively, products j_1^D and j_2^D directly to consumers at prices p_1^D and p_2^D. Retailer R_1 sells products j_1^R and j_2^R at prices p_1^R and p_2^R, respectively.
Panel b. The dotted red line denotes that the manufacturer M_2 does not use the leverage from direct sales when negotiating with retailer R_1. Not using the leverage results in a lower (relative to panel a) negotiated wholesale price for M_2, $w_2' < w_2$. Holding constant product competition and product variety downstream, the decrease in the wholesale price to w_2' creates an imbalance in the first-order conditions of the retailer. Now is relatively more profitable for retailer R_1 to sell product j_2^R, thus creating an incentive to increase $p_1^{R'}$ and decrease $p_2^{R'}$ to divert demand to product j_2^R.

The decrease in the wholesale price to w_2' creates an imbalance:

$$(p_1^R): \qquad s_1^R + (p_1^R - w_1)\frac{\partial s_1^R}{\partial p_1^R}(p) + (p_2^R - w_2')\frac{\partial s_2^R}{\partial p_1^R}(p) > 0,$$

$$(p_2^R): \qquad s_2^R + (p_2^R - w_2')\frac{\partial s_2^R}{\partial p_2^R}(p) + (p_1^R - w_1)\frac{\partial s_1^R}{\partial p_2^R}(p) < 0.$$

Now it is relatively more profitable for retailer R_1 to sell product j_2^R. There is an incentive to increase p_1^R relative to p_2^R to divert demand to product j_2^R. This effect is documented by Luco and Marshall (2020) for the carbonated beverage industry.[23] Thus, in the upstream the net effect upon w_1 is ambiguous. In the downstream prices move in different directions: p_2^D and p_2^R decrease, the effects on p_1^R and p_1^D are ambiguous.

In sum, Example 3 shows that when one manufacturer starts using the leverage from direct sales, it is relatively more profitable for the retailer to sell the product of the manufacturer without direct sales. This feature creates an incentive for the retailer to increase the price of the product from the manufacturer with direct sales. In turn, this creates an ambiguous effect on final prices to consumers. There is also an ambiguous effect on the negotiated price of the other manufacturer.

In Appendix B we provide three examples with the graphic representation of the industry

[23]They call it the Edgeworth-Salinger effect.

for the following cases: (i) no direct sales from one manufacturer; (ii) no direct sales from both manufacturers; and (iii) direct sales *vs.* vertical integration. In Section 5 we investigate counterfactual outcomes similar to the ones in the examples above but using a more general setting with multiple manufacturers, multiple retailers, and multiple display formats applied to the outdoor advertising industry.

4 Identification and Estimation

4.1 Identification and Estimation

Below, we discuss identification and estimation of the demand- and supply-side parameters using aggregate-level data. We devote more space to supply side, which is the focus of the article.

Demand

Identification of demand. Identification of the price coefficient, α, and the heterogeneity parameters, σ and λ, requires at least one instrument for each of these parameters. We rely on instruments with exclusion restrictions.

As regards the price coefficient, we assume that firms observe ξ_{jt} in the supply model. Thus, it enters in the markup term of the pricing equation and introduces a bias to the estimate of α. We use prices of the same product in other markets as instruments for the price of the product in the current market, as in Hausman (1996) and Nevo (2001). The identifying assumption is that month-specific valuations for a product are independent across time after accounting for display format, manufacturer, retailer, and month fixed effects. The prices of the same product are correlated across months because of the common component of the marginal costs.

As regards the heterogeneity parameter, σ, there is an endogeneity problem due to the parameter σ interacting with the endogenous variables, (s_{jp}, p_{jt}). We use a variation of the differentiation instruments proposed by Gandhi and Houde (2019). We construct instruments defined by a proximity measure counting the number of competitors located within one standard deviation of product j. Specifically, we use the count of other products whose predicted prices lie within five Euros of the own price and the interaction of this variable with product and manufacturer dummy variables. Following Donna, Pereira, Pires, and Trindade (2022), we use predicted prices instead of the potentially endogenous prices. To that end, to construct the differentiation instruments, we run a preliminary regression of prices on characteristics, predict prices from this regression, and use the predicted prices to count the number of products within the 5-Euro band. Using such predicted prices generates a valid instrument (even if prices are endogenous) because the characteristics used in the preliminary regression are exogenous. Such regression generates an unbiased estimate of prices in which structural shocks are removed. The characteristics included in the preliminary regression explain over 90 percent of the price variation in the data.[24]

Finally, the nested-logit heterogeneity parameter, λ, governs the substitution within and between subgroups of products (or nests) sold in the retailing and direct-sale channel, and the outside product. An instrument is needed due to the unknown parameter, λ, interacting with the endogenous within-group share. We use the number of products in the market within each distribution channel as an instrument. The identifying assumption is that the error term is uncorrelated with the number of products in the market within each distribution channel. The instrument's power comes from the number of products in the market within each distribution channel being negatively correlated with the share of the products within that distribution channel.

Estimation of demand. We estimate the parameters that characterize demand without using the supply-side model. We estimate the model by GMM by relying on the moment condition $\mathbb{E}[Z'\omega(\theta^*)] = 0$, where Z is the matrix of instruments obtained by stacking the instruments described in the previous paragraph, $\omega(\cdot)$ is a vector with the structural error term defined below, and $\theta^* = (\alpha, \beta, \sigma)$ is the true value of the parameters. The GMM estimate is:

$$\hat{\theta} = \arg\min_{\theta} \left[\omega(\theta)' Z A^{-1} Z' \omega(\theta)\right],$$

where A is a consistent estimate of $\mathbb{E}(Z'\omega\omega'Z)$; for the estimation we use the inverse of the sample variance of the empirical moments as the weighting matrix.

For each candidate parameter vector, we use equation (A.3) to compute the market share function, $s_{jt}(p_{jt}, x_{jt}, \delta_{jt}; \sigma)$. Then, we find the mean utility level, δ_{jt}, that equates:

$$s_{jt}(p_{jt}, x_{jt}, \delta_{jt}; \sigma) = S_{jt}, \tag{14}$$

where S_{jt} are the observed market shares obtained from the data. We use the contraction mapping by Berry, Levinsohn, and Pakes (1995) to solve for the system of equations in (14). Then, we define the structural error term as $\omega_{jt} \equiv \delta_{jt}(p, x, S; \sigma) + \alpha p_{jt}$.

Supply

We discuss next identification of the supply model in Section 3. We then present the estimation procedure. For general supply identification and estimation arguments, see Donna, Pereira, Pires, and Trindade (2022) (Section 5 and Appendix D).

Identification of supply. The supply is characterized by the equations in (3), (4), and (6). A necessary and sufficient condition for identification of the supply-side parameters is that the marginal cost of a given display format in a given month is the same whether the display

[24]We have also experimented with a band of ten Euros and obtained similar results.

format is sold directly to the consumer or to a retailer (Donna, Pereira, Pires, and Trindade (2022)). Under that assumption, equations in (3), (4), and (6) jointly identify the vectors of retail marginal costs, manufacturer marginal costs, and bargaining weights.

The following assumptions, discussed below, simplify the supply model. They provide sufficient conditions for identification. We later used them in the estimation routine.

Assumption 1. *For each retailer, the retail marginal cost is zero. That is, let* c_j^r *be the retailer marginal cost of product* j*. Then,* $c_j^r = 0$ *for all* $j \in \Omega_r$ *and for all* $r = 1, \ldots, R$*.*[25]

Assumption 2. *For a given manufacturer, marginal costs of a display format do not vary across retailers or direct sales. That is, call* c_{fj}^m *the marginal cost of display format* f *sold by manufacturer* m *to retailer* j *and* c_{fm}^m *the marginal cost of display format* f *sold directly by manufacturer* m*; then,* $c_{fj}^m = c_{fk}^m = c_{fm}^m$ *for all* $(j, k) \in \Omega_m^R$ *and* $m \in \Omega_m^D$*.*

Assumption 3. *For a given retailer, bargaining weights do not vary across manufacturers. That is,* $\lambda_j = \lambda_k$ *for all* $(j, k) \in \Omega_r$*.*

These assumptions merit further discussion. The first assumption is reasonable in our setting given the small retail margins observed in the data (Table 2).[26] The assumption allows us to omit the vector of retailer marginal costs in the supply-side analysis (estimation and counterfactual analysis). Regarding assumption 2, for a manufacturer, the physical display formats and services offered in both channels are the same. Any potential cost difference is due to fixed costs. Assumption 3 is related to the nature of the data in the empirical setting studied, as explained below. Assumptions 2 and 3 reduce, respectively, the dimension of the vectors of manufacturer marginal costs and bargaining weights. Assumptions 1 to 3 have implications for identification (discussed next) and for estimation (discussed in the next subsection). For identification, they allow to identify the supply-side parameters using equation (6) alone (instead of using equations 3, 4, and 6 as in Donna, Pereira, Pires, and Trindade (2022)). First, one can omit equation (3) to compute the structural error term (equation 15 below; equation 18 in Donna, Pereira, Pires, and Trindade (2022)). Intuitively, assumption 1 (zero retail costs) allows to omit equation (3), defining the necessary first-order conditions of the retailers. Alternatively, equation (3) can be used jointly with equation (6) to recover the retailer marginal costs (see footnote 26). Second, assumptions 2 allow us to omit equation (4) defining the necessary first-order conditions of the manufacturers for their direct sales. The reason is twofold. On the one hand, the manufacturer marginal costs in the second and third terms in equation (4) are, respectively, the ones in the last two terms in equation (6) due to assumption 2. On the other, the system in (6) defines a system of $M \times R$ equations for each market t and display format. This system "just identifies" the vectors of manufacturer marginal costs and bargaining weights. The vector of manufacturer marginal

[25] This assumption is implicit in the formulation of the profit of the retailers, as noted in footnote 18.

[26] We have performed the estimation without this assumption and obtained retailers' marginal costs that were very close to zero.

costs has dimension $1 \times M$ (assumption 2), while the vector of bargaining parameters has dimension $1 \times R$ (assumption 3). Example 4 illustrates the identification argument in one market with two manufacturers, two retailers, and one display format.

Example 4. Identification of supply-side parameters in one market with two manufacturers, two retailers, and one display format.
There are two manufacturers, two retailers, one display format, and one market. Both manufacturers also sell their products directly to consumers. Both retailers bargain with both manufacturers. Denote the manufacturers by M_1 and M_2, the direct sales from those manufacturers by R_1 and R_2, and the retailers by R_3 and R_4. There are 6 products in this example. The set of differentiated products is: $\mathcal{J} = \{j_{11}^D, j_{13}^R, j_{14}^R, j_{22}^D, j_{23}^R, j_{24}^R\}$, where j_{11}^D is the product sold directly by manufacturer M_1, j_{13}^R is the product manufactured by M_1 and sold by retailer R_3, *etc.* That is, $\Omega_{M_1}^R = \{j_{13}^R, j_{14}^R\}$, $\Omega_{M_1}^D = \{j_{11}^D\}$, $\Omega_{M_2}^R = \{j_{23}^R, j_{24}^R\}$, $\Omega_{M_2}^D = \{j_{22}^D\}$, $\Omega_{R_3} = \{j_{13}^R, j_{23}^R\}$, and $\Omega_{R_4} = \{j_{14}^R, j_{24}^R\}$. Index final prices in a similar form, being p_{kl}^f the final price for product $j_{kl}^f \in \mathcal{J}$ with $f \in \{\mathrm{R}, \mathrm{D}\}$. Next, index accordingly wholesale prices, w_{kl}; market shares, $s_{kl}^f(p)$; marginal costs c_{kl}, bargaining weights λ_{kl}, and change in shares, $\Delta s_{i,-j}^f(p)$. Recall that the change in shares is defined as: $\Delta s_{i,-j}^f(p) \equiv s_{i,-j}^f(p_{-j}) - s_i^f(p)$ according to equation (6) and $f \in \{\mathrm{R}, \mathrm{D}\}$. Then, equation (6) becomes:

$$(w_{13}): \quad \frac{\lambda_{13}}{1-\lambda_{13}} = \frac{(p_{13}^R - w_{13})s_{13}^R(p) - (p_{23}^R - w_{23})\Delta s_{23,-13}^R(p)}{(w_{13} - c_{13})s_{13}^R(p) - (w_{14} - c_{14})\Delta s_{14,-13}^R(p) - (p_{11}^D - c_{11})\Delta s_{11,-13}^D(p)},$$

$$(w_{14}): \quad \frac{\lambda_{14}}{1-\lambda_{14}} = \frac{(p_{14}^R - w_{14})s_{14}^R(p) - (p_{24}^R - w_{24})\Delta s_{24,-14}^R(p)}{(w_{14} - c_{14})s_{14}^R(p) - (w_{13} - c_{13})\Delta s_{13,-14}^R(p) - (p_{11}^D - c_{11})\Delta s_{11,-14}^D(p)},$$

$$(w_{23}): \quad \frac{\lambda_{23}}{1-\lambda_{23}} = \frac{(p_{23}^R - w_{23})s_{23}^R(p) - (p_{13}^R - w_{13})\Delta s_{13,-23}^R(p)}{(w_{23} - c_{23})s_{23}^R(p) - (w_{24} - c_{24})\Delta s_{24,-23}^R(p) - (p_{22}^D - c_{22})\Delta s_{22,-23}^D(p)},$$

$$(w_{24}): \quad \frac{\lambda_{24}}{1-\lambda_{24}} = \frac{(p_{24}^R - w_{24})s_{24}^R(p) - (p_{14}^R - w_{14})\Delta s_{14,-24}^R(p)}{(w_{24} - c_{24})s_{24}^R(p) - (w_{23} - c_{23})\Delta s_{23,-24}^R(p) - (p_{22}^D - c_{22})\Delta s_{22,-24}^D(p)}.$$

Using assumption 2, $c_{13} = c_{14} = c_{11} \equiv c_1$ because $(j_{13}, j_{14}) \in \Omega_{M_1}^R$ and $c_{11} \in \Omega_{M_1}^D$, and $c_{22} = c_{23} = c_{24} \equiv c_2$ because $(j_{23}, j_{24}) \in \Omega_{M_2}^R$ and $c_{22} \in \Omega_{M_2}^D$. Using assumption 3, $\lambda_{13} = \lambda_{23} \equiv \lambda_3$ because $(j_{13}, j_{23}) \in \Omega_{R_3}$, $\lambda_{14} = \lambda_{24} \equiv \lambda_4$ because $(j_{14}, j_{24}) \in \Omega_{R_4}$. The system of equations in (5) simplifies to a system of 4 equations in 4 unknowns, c_1, c_2, λ_3, and λ_4.[27]

A similar argument to the one in Example 4 can be used for multiple manufacturers and retailers. Consider the necessary first-order condition of the bargaining between a given

[27] A question that arises is whether this system of equations has a unique solution that is sensible economically. (Being sensible economically in our setting means that marginal costs are nonnegative and bargaining weights lie between 0 and 1.) Such uniqueness is necessary to guarantee identification of the supply model. We have used a variety of methods, solvers, and starting values and have always obtained convergence to the same solution. However, we have not proved uniqueness (of economically sensible solution) of the system.

manufacturer with two retailers. Using assumption 2, the only difference in parameters are the bargaining weights, as can be seen in equation (6). Then, the variation between these two equations identifies the bargaining weights of the retailers *vis-à-vis* this manufacturer. Next, consider the necessary first-order condition of the bargaining between a given retailer with two different manufacturers. Using assumption 3, the variation in these equations allows us to identify the different marginal costs for these manufacturers. Also, due to assumption 3, the marginal costs of the products sold to consumers directly are the same as the manufacturer marginal costs of selling those products to the retailers. All manufacturers marginal costs and bargaining weights are thus identified.

Estimation of supply. We estimate the supply-side parameters conditional on the demand estimates. Assumptions 1 to 3 simplify the computational burden of the supply side for the estimation and counterfactual analysis. They reduce the dimensionality of the supply parameters. The total number of final products in a given market is given $J_t = D_t \times M_t \times (R_t)$. Under the maintained assumption of constant parameters across markets, the vectors of stacked retail marginal costs (c^r), manufacturer marginal costs (c^m), and bargaining weights (λ) have each dimension J-by-1, for a total of $3 \times J$ supply-side parameters. Under assumptions 1 to 3, the number of total parameters is reduced to $0 + M + R \ll 3 \times J$, where the summands on the left-hand side represent respectively the numbers of parameters for the vectors of stacked retail marginal costs, manufacturer marginal costs, and bargaining weights. As discussed above, assumptions 1 to 3 are not necessary for identification. They simplify the supply-side computational burden. On the one hand, they reduce the number of parameters to estimate. The estimation routine is simpler and the parameters are more precisely estimated. The latter is important in the empirical setting studied, given the nature of the data aggregated at the market level. On the other hand, the assumptions ease the computation of the counterfactual analysis. Solving for the equilibrium prices downstream is a difficult problem. It entails solving an implicit nonlinear system of $J = 57$ equations in J unknowns, the downstream vector prices p^D and p^R. We performed several robustness tests on our model. We also tested different specifications of the supply model. The implications discussed in Section 5 are robust.

The system of equations in (6) defines marginal costs implicitly as a function of the bargaining parameters, $c^m = \mathcal{M}(\lambda)$ by applying the implicit function theorem to (6). Instead of numerically solving for the marginal costs in (6), we stack equations (4) and (6) which allows us to use matrix inversion to obtain closed-form solutions of the marginal costs as a function of bargaining weights, $c^m = \mathcal{M}(\lambda)$.[28] We then make the standard parametrization of marginal costs: $c_{jt} = x^S_{jt}\gamma + \tilde{\epsilon}_{jt}$, where x^S_{jt} includes manufacturer and months/markets fixed effects, γ is the corresponding vector of parameters, and $\tilde{\epsilon}_{jt}$ is an unobservable error term. Rearranging terms write the supply unobservable error term as:

$$\tilde{\epsilon}(\lambda, \gamma) = \mathcal{M}(\lambda) - x^S\gamma, \tag{15}$$

[28]See Appendix A.3 for details.

where variables without subscripts denote the corresponding stacked vectors of parameters.

We estimate the supply parameters by GMM using the moment condition $\mathbb{E}[Z^{s\prime} \cdot \tilde{\epsilon}(\lambda^*, \gamma^*)] = 0$, where Z^s is a matrix of supply-side instruments described next, $\tilde{\epsilon}(\cdot)$ is the error term defined in equation (15), and (λ^*, γ^*) is the true value of the supply parameters. For the supply instruments, Z^s, we use the average price of a product in other markets as an instrument for that price of the same product in a given market. We also include in Z^s manufacturer, month, and retailer fixed effects. The identifying assumption is that the prices of a product in other markets are uncorrelated with the marginal cost shock after accounting for the manufacturer, month, and retailer fixed effects. The power of the instrument comes from the prices of a product in other markets being correlated with the price of the product in the given market through the bargaining equations in (6).

4.2 Results

Demand Estimates. The estimated demand parameters are presented in Table 3 using the following specifications of the model: (1) a simple logit model (without instruments for price, without random coefficients for price); (2) a simple logit model with instruments for price (without random coefficients for price); (3) a mixed logit model (without channel-specific preferences); and (4) the full model, corresponding to the mixed logit model with channel-specific preferences described in Section 3. All the specifications include a set of dummy variables for manufacturers, retailers, display formats, and months fixed effects. The instruments are described in Section 4. The estimation algorithm from Section 4 is applied to each model with the obvious modifications. For example, for the simple logit without instruments, model 1, the structural error in the system of equations in (14) has a closed-form expression and the model is estimated by OLS. The demand estimates do not impose the equilibrium conditions from the supply side.[29]

The demand estimates are sensible in magnitude and sign, and are precisely estimated. By comparing models 1 and 2, one can see the role of price endogeneity on the demand estimates. The price coefficient almost doubles in absolute terms when we instrument for price. By comparing models 2 and 3, one can see the importance of consumer heterogeneity for price. The dispersion of the price sensitivity across consumers is statistically different from zero and relatively large in magnitude. Finally, by comparing models 3 and 4, we see the role of allowing consumers to self-select into the distribution channels based on their preferences. Model 3 does not allow for correlation in consumer preferences for the products in the same distribution channel. In model 4, the null hypothesis of no preference heterogeneity for the distribution channels, $\hat{\lambda} = 0$, is rejected. In model 4, consumers are less responsive (lower α in absolute value) and more homogeneous (lower σ) in their taste for price for products in the same channel, relative to model 3. Not accounting for channel-specific preferences when they are relevant overestimates price sensitivity and price heterogeneity. In model 4, demand

[29]See Table A1 in Appendix B.2 for a robustness analysis.

is relatively elastic; the average own-price elasticity is -1.88. We use the results from model 4 for the remainder of the article.

Supply Estimates. Table 4 displays the results.[30] The estimated parameters are sensible. They are consistent with the ones in Donna, Pereira, Pires, and Trindade (2022). Panel A shows the distribution of estimated manufacturer marginal costs. Manufacturers' marginal costs are relatively low in the industry studied. The mean marginal cost, 6.6 Euros, is about 80 percent of the mean wholesale price from the data, which is 8.2 Euros in Table 2. There is a relatively large variation in marginal costs across manufacturers conditional on display formats and markets. The coefficient of variation is 0.6 ($^{3.73}/_{6.60}$). This result indicates that heterogeneities across manufacturers are important and reflects different margins.

Panel B displays the estimates from the bargaining weights. Retailers have low bargaining power, 0.1 on average, relative to a bargaining power of 0.9 on average for manufacturers. Retailers r_8^v and r_5^v have the largest bargaining weights, 0.2 and 0.1, respectively.

Two observations suggest these numbers are consistent with the large concentration at the manufacturer level, the low retail margins, and the large heterogeneities at the retail level in the empirical setting. First, the largest manufacturer has nearly 50 percent of the sales. Second, retail margins are low; the median (mean) margin of the retailers is 0.57 (1.72) Euros per square meter. To gain intuition regarding the relationship between bargaining weights and retail margins, consider the following expression for product j:

$$\frac{\lambda_j}{1-\lambda_j} \approx \frac{p_j^R - w_j}{w_j - c_j^m}, \tag{16}$$

where the approximation in (16) is due to firms selling multiple products.[31] In words, the ratio of bargaining weights is approximately equal to the ratio of retailer margins relative to manufacturer margins. In our setting, the ratio $\lambda_j/(1-\lambda_j)$ has a mean of 11.4 percent, while the ratio of retailer margins relative to manufacturer margins has a mean of 10.4 percent.

5 The Welfare Effects of Direct-to-Consumer Sales

Next, we use the estimated model to examine the effect of direct sales on negotiated prices and consumer welfare.

5.1 Welfare Scenarios and Measures

We simulate the counterfactual scenarios described below. We compare these scenarios to the baseline, where we use the estimated model with direct sales.

[30] See Table A2 in Appendix B.2 for a robustness analysis.

[31] It holds with equality for single-product firms. See equation (6) and Draganska, Klapper, and Villas-Boas (2010, equation 13).

1. **No bargaining leverage from direct sales:** In this scenario, the direct-sale channel continues to operate as in the baseline, but we remove the manufacturers' bargaining leverage due to the direct sales. We implement this scenario by setting $d_j^D = 0$ in equation (6). In words, the manufacturers compete with retailers downstream but do not internalize the profits from direct sales when negotiating wholesale prices with the retailers.

2. **Direct-sale prohibition:** In this scenario, we remove direct sales altogether. This scenario can be conceptualized as a direct-sale prohibition, whereby manufacturers are not allowed to sell directly to consumers.[32] We implement this scenario by removing from the market the products sold directly by the manufacturers in the baseline. Retailers in the retailing channel continue offering the same products as in the baseline.

3. **Divestiture of direct-sale operations:** In this scenario, the vertically integrated manufacturers spin off their retail operations as separately owned companies. Consumers view each separately owned, or divested, company as continuing to produce the same product as before. Product variety is held constant. This scenario can be conceptualized as a direct-sale divestiture. Manufacturers do not longer sell directly to the consumers.

We implement the counterfactual analysis as follows. For each scenario above, we use the equilibrium conditions given by the equations in (3), (4), and (6) to solve respectively for the counterfactual consumer prices, market shares, and negotiated wholesale prices.

We report the following statistics: market shares disaggregated by direct and retail sales, consumer prices disaggregated by direct sales and retail sales, negotiated wholesale prices, profits of the retailers (Π_r), and profits of the manufacturers (Π_r) disaggregated by the part coming from the direct-sale channel (Π_m^D) and retailing channel (Π_m^V). For the computation of the profits of the retailers and manufacturers, we use the formulas given by the equations in (1) and (2), respectively. We report the compensating variation as a measure of consumer welfare. The expected consumer surplus in Euros for consumer type i is:

$$\mathbb{E}(CS_i) = \frac{1}{\alpha_i} \log \left[1 + \sum_{k=1}^{J_t} \exp(\delta_{kt} - \sigma v_i p_{kt}) \right] + C, \tag{17}$$

where $\mathbb{E}(\cdot)$ denotes the expectation operator taken over the random shocks ϵ_{ijt} and C is a constant.

Consumer welfare for type i is the change in consumer surplus (or compensating variation, CV) that results in the scenario performed. We compute the difference between the consumer surplus for consumer i in the baseline and the counterfactual scenarios described above. We compute the total consumer surplus as the weighted sum of $\mathbb{E}(CS_i)$ using the weights reflecting the number of consumers who face the same representative utilities as the sampled consumer:

[32] This counterfactual may have important policy consequences. For example, see our discussion in the introduction about the Tesla's case and the responses by the FTC and the DOJ.

$$\mathbb{E}(CV) = \int_{\nu_i} \left[\mathbb{E}(CS_i^j) - \mathbb{E}(CS_i^0)\right] \mathrm{d}P_\nu(\nu_i), \qquad j = 1, 2, \tag{18}$$

where $\mathbb{E}(CV)$ denotes the weighted sum across types of consumers of the compensating variation, the superscript 0 refers to the baseline, the superscripts j refer to the counterfactuals scenarios described above, and $\mathbb{E}(CS_i^k)$ is given by equation (17) for $k = 0, 1, 2$.

5.2 Results

Table 5 displays the estimates from the counterfactual analysis.[33] The table shows the percentage change in the counterfactual scenarios relative to the baseline.

In counterfactual scenario 1, we remove the bargaining leverage of manufacturers from the direct sales. When direct sales are present, manufacturers internalize in the negotiated wholesale prices the increase in profits due to direct sales if the negotiation fails. This effect is captured by the term d_j^D in equation (6). It generates upward pressure on wholesale prices. In equilibrium, however, wholesale prices are also affected by the change in downstream prices because the latter affects both manufacturer's and retailer's gains-from-trade, as seen in equation (6). In scenario 1, we held constant competition and product variety at the retail level. This feature allows us to isolate the leverage effect of manufacturers due to direct sales.

Negotiated wholesale prices should decrease unambiguously. Scenario 1 shows that they decrease by about 4 percent in the application studied; direct sales increase manufacturers' bargaining leverage allowing them to charge wholesale prices that are 4 percent higher. In the downstream, the decrease in wholesale prices generates two effects. First, it reduces retailers' costs, thus decreasing retail-sale prices. Second, it induces manufacturers to reduce direct-sale prices as indicated by the first-order condition (4). The reduction in consumer retail prices is larger than the reduction in direct-sale prices. Retail market shares increase substantially, 4 percent, while direct-sale shares decline. The decrease in manufacturers' profits by approximately 5 percent reflects the decrease in their direct-sale profits (last term in equation 2) and retailing (first term in equation 2) channels. Retailers' profits increase substantially, about 9 percent. Consumer surplus increases by a relatively small magnitude, 1 percent. Total welfare increases slightly; it could decrease in other cases. The results are consistent with the economic intuition presented in Examples 1 to 3.

In counterfactual scenario 2, we remove the direct-sale channel completely. In the downstream, there is a decrease in the number of products and competition. Retail prices increase substantially by 51 percent. There is a net increase in wholesale prices by 3 percent. This increase reflects two effects. First, there is a decrease in the manufacturers' bargaining leverage because they no longer have direct sales. This effect generates downward pressure on wholesale prices, as discussed in counterfactual scenario 1. Second, without direct sales, there are fewer products available to the consumer, thus reducing retail competition and increasing all

[33] See Table A3 in Appendix B.2 for a robustness analysis.

prices (including wholesale prices). This effect generates upward pressure on wholesale prices (equation 6). Table 5 shows that the latter effect dominates. Retail market shares increase because consumers divert from direct to retail products. Retailers are the conspicuous winners from the direct-sale prohibition. Their profits increase substantially by 184 percent. It is a consequence of the large share of the direct sales in the counterfactual. Although manufacturers' vertical sales profits increase substantially, such an increase is insufficient to offset the reduction in profits due to direct sales. Overall, manufacturers' profits decrease by 3 percent; consumer surplus and total welfare decrease substantially, 81 and 21 percent, respectively.

In counterfactual scenario 3, the vertically integrated manufacturers spin off their direct-sale divisions as separately owned firms. From the consumer standpoint, these separately owned companies continue to produce the same products as in the baseline. This scenario can be seen as a mixture of scenarios 1 and 2. Similar to scenario 1, product variety is held constant downstream. Now, however, manufacturers no longer sell directly to the consumers (the second term in equation 2 vanishes); direct sales disappear, similar to scenario 2. There is no loss in product variety because the divested retailers continue offering the original products.

The increase in the wholesale prices by 3 percent reflects the culmination of two countervailing effects. Although the wholesale prices tend to decrease due to the decrease in the manufacturers' bargaining leverage (similar to scenario 1), wholesale prices tend to increase due to the reverse elimination of double marginalization (reverse EDM). Relative to a situation where a manufacturer and a retailer are vertically integrated, the negotiated wholesale price increases due to the reverse EDM. Counterfactual scenario 3 shows that the reverse EDM dominates the bargaining-leverage effect. The reverse EDM generates upward pricing pressure on the retail prices from the divested retailers, which increase by 9 percent relative to the direct-sale prices in the baseline. This effect, in turn, generates upward pressure on retail prices from the non-divested retailers (as indicated by the first-order condition 4), which increase by 7 percent. Overall, consumer prices increase substantially, 8 percent (weighted average). Non-divested and divested retail shares decrease (the latter relative to direct-sale share in the baseline), while total retail shares, which include the divested retailers' shares, also increase substantially. The decrease in manufacturers' profits by 4 percent reflects that the larger profits in the vertical channel do not offset the profit loss due to the elimination of the retail operations. The significant increase in the profits of the non-divested retailers by 51 percent is a consequence of the two effects discussed above: the increase in the retail prices and the lower negotiated wholesale prices (due to the elimination of the bargaining leverage of manufacturers from their direct sales). The profits of the divested retailers are positive. However, they decrease relative to the direct-sale-channel profit in the baseline, primarily due to the reverse EDM. Consumer surplus decreases by 5 percent. The net effect on total welfare, which could go in either direction, is slim.

In sum, the counterfactual analysis sheds light on three fundamental economic issues:

1. It quantifies the magnitude of the bargaining-leverage effect; it measures the extent to

which direct sales increase manufacturers' bargaining power when negotiating wholesale prices with the retailers.

2. It quantifies the welfare effects of direct sales.

3. It provides insights regarding how much of the welfare loss results from the decrease in product variety (in the direct-sale prohibition scenario) relative to the reverse EDM (in the alternate divestiture of direct-sale scenario).

The results above are specific to the empirical context studied. We briefly discuss how they might change under different industry configurations. Manufacturers have substantial bargaining power in our setting. In a scenario where retailers are the ones with more strength, we might expect a smaller effect on retailers' profits from the manufacturers' direct-sales leverage. The significant welfare effect due to the direct-sale prohibition is partly due to their relatively large market share in the counterfactual and the extent to which consumers view the downstream products as being differentiated. Finally, one might expect that a direct-sale prohibition would have a lower impact on welfare in industries where direct sales are in the early stages, where downstream products are more homogeneous, or where there is less product differentiation between the direct-sale and retailing channels (lower nesting parameter, λ).

Next, we examine the relevance of the effects for evaluating vertical mergers.

6 Implications for Vertical Mergers

We finish discussing the relationship between a vertical merger and creating a direct-to-consumer channel or manufacturer's retailer. Consider an oligopolistic industry with a few manufacturers and a few retailers. Manufacturers sell production factors to retailers, and retailers sell retail products to consumers. Manufacturers bargain first with retailers over wholesale prices; afterward, retailers set retail prices. Suppose that a manufacturer merges with a retailer. We discuss two effects. These effects are well known in the vertical-merger literature. A vertical merger may also involve additional effects. See Riordan and Salop (1995) and Donna and Pereira (2023) for details.

The first effect is that the vertical merger increases the bargaining leverage of the merged firm upstream. Consider the situation before the merger using the model in Section 3. Suppose that the merged firm sells production factors to a rival retailer and that the rival retailer has no alternative equally competitive suppliers. Suppose the manufacturer of the merging firm does not reach an agreement with the rival retailer or refuses to supply the retailer. Then, the manufacturer loses the profit it would earn if it supplied the rival retailer. The rival retailer also loses sales (if it does not find an alternative supplier, it loses the sales related to the reduction of supply of the merged firm; if it finds a more expensive alternative supplier, it has to raise its prices, thus losing sales). Part of the lost sales diverges to the retailer of the merged firm. After the merger, if the merged firm does not reach an agreement, it still loses the profit it would earn if supplied the rival retailer. However, now it earns the profits from the sales diverted from the rival retailer. Thus, because it internalizes the sales diversion downstream, it is less costly for the merged firm not to reach an agreement with a rival retailer than for the retailer of the merged firms acting independently. This effect increases the *bargaining leverage* of the merged firm. It enables the manufacturer to charge a higher price for the upstream product as in Section 5 and as in Rogerson (2020). The resulting upward pricing pressure on upstream prices may lead to higher downstream prices. Consumer surplus, therefore, declines. A horizontal merger increases the market power of the merged firm by allowing the internalization of the diversion of sales between firms that produce substitute products. Similarly, a vertical merger increases the upstream market power of the merged firm by allowing the internalization of the diversion of sales between firms that produce complementary products.

Second, a vertical merger may allow the merged firm to eliminate its upstream margin, thus eliminating the *double marginalization*, as in Lerner (1934), Spengler (1950), and Tirole (1988, pp. 174-6). Suppose the manufacturer of the merged firm sells production factors to the retailer of the merged firm. Before the merger, the manufacturer and the retailer of the merged firm maximize their profits independently. The manufacturer charges a price above the marginal cost. After the merger, the merged firm maximizes the joint profit, thus internalizing the increase in sales downstream caused by a decrease in the upstream price and allowing it to assign a price equal to the upstream marginal cost. The decrease in the upstream price reduces the marginal cost of the merged firm's retailer, allowing it to charge a lower downstream price. Downstream rivals may respond by lowering their prices. Consumer surplus, therefore, increases.

Regarding social welfare, the bargaining leverage and double marginalization effects operate in opposite directions. The net impact of the vertical merger on welfare is, thus, ambiguous. Our contribution is to provide a model that isolates and quantifies the bargaining-leverage effect. The increase in bargaining power upstream, in conjunction with the elimination of double marginalization, may give the merged firm a substantial strategic advantage relative to its upstream and downstream rivals. The bargaining leverage and the double marginalization are present in creating a direct-to-consumer channel and a vertical merger. The magnitude of the effects, however, may differ across strategies. The former effect differs if the products of the new retailer and the retailer of the merged firm have different degrees of substitutability. The latter effect differs if the new retailer and the retailer of the merged firm have different marginal costs. Furthermore, creating a direct-to-consumer channel involves an additional effect, creating a new brand, thus increasing competition and product variety downstream. Therefore, creating a direct-to-consumer channel is socially preferable to a vertical merger, holding everything else constant.

7 Concluding Remarks

We develop a model that incorporates direct-to-consumer sales by manufacturers to the workhorse supply model, where manufacturers and retailers bargain over wholesale prices. We show that direct sales by manufacturers generate two effects that have opposing welfare implications. First, direct sales generate potential consumer welfare gains due to additional competition and product variety downstream. Second, there is an increase in the bargaining leverage of the manufacturers selling directly to consumers. We show that the additional bargaining leverage due to direct sales increases the negotiated wholesale prices, thus increasing final prices to consumers and decreasing consumer welfare.

We show how our model can be used to measure these effects. To that end, we estimate our model using a unique dataset from the outdoor advertising industry, where direct sales have been a regular feature. We use the estimated model to simulate counterfactual scenarios assessing the role of direct sales on prices and welfare.

We discuss three main findings from the empirical application. First, direct sales increase manufacturers' bargaining leverage allowing them to increase wholesale prices by 4 percent. The additional bargaining leverage decreases the profits of the retailers substantially. Consumer welfare is reduced due to the resulting increase in consumer retail prices. Second, direct sales significantly increase consumer welfare and manufacturers' profits. Third, the divestiture of direct sales shows that the reverse elimination of the double marginalization dominates the bargaining-leverage effect, resulting in a net increase in wholesale prices, upward pressure on downstream prices, and consumer welfare loss. It highlights how much of the welfare loss from prohibiting direct sales results from the loss of a product rather than from the reverse elimination of the double marginalization in this alternate scenario. The share of direct sales in the industry is an essential factor influencing the magnitude of the estimates.

We conclude by discussing the relevance of the bargaining-leverage effect for vertical mergers. The economic principles discussed in the article also apply to vertical mergers. For vertical mergers, the *bargaining leverage* and *double marginalization* effects operate in opposite directions in terms of welfare. We argue about the importance of specifying a flexible supply model that allows one to measure the additional bargaining leverage that a manufacturer may obtain when merging with a retailer. Our model allows for such quantification. Measuring the additional bargaining leverage of manufacturers due to a merger adds another layer of consideration for vertical merger evaluation.

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Table 1: Market Shares by Manufacturer, Retailer, and Display Format.

Seller		2 m^2 panel				Senior				Other				Total	Total by seller
		m_1	m_2	m_3	m_4	m_1	m_2	m_3	m_4	m_1	m_2	m_3	m_4		
Retailers	r_4^v	0.69	0.61	0.16	–	–	0.91	0.06	–	–	–	0.19	1.52	4.14	55.43
	r_5^v	0.35	0.72	0.18	–	–	0.09	0.15	0.11	–	–	0.10	0.51	2.22	
	r_6^v	2.16	2.08	0.63	0.91	–	1.38	0.12	–	–	–	0.07	2.56	9.91	
	r_7^v	0.93	2.23	0.44	0.18	–	0.69	0.29	–	–	0.08	0.36	8.62	13.83	
	r_8^v	0.12	0.14	–	–	–	0.72	0.10	–	–	0.03	0.14	–	1.25	
	r_9^v	4.51	11.43	2.47	0.06	0.02	3.79	0.34	0.10	0.01	0.32	1.01	0.04	24.09	
Direct Sales	r_1^d	0.99	–	–	–	–	–	–	–	–	–	–	–	0.99	9.65
	r_2^d	–	3.32	–	–	–	2.27	–	–	–	0.14	–	–	5.73	
	r_3^d	–	–	1.05	–	–	–	0.14	–	–	–	1.76	–	2.94	
Total		9.74	20.53	4.92	1.15	0.02	9.85	1.21	0.21	0.01	0.56	3.62	13.25	65.09	
Total by display		36.35				11.29				17.45					65.09

Notes: Each cell corresponds to the percentage of sales to consumers (relative to the market size defined as twenty percent greater than the maximum observed total monthly sales for the year 2013) across all months in the sample by the corresponding combination of Manufacturer, Seller (Retailers and Direct Sales), and Display Format. A cell displays the symbol "–" when no sales are observed for such combination. In Panel B there are a total of 57 cells with positive sales (*i.e* without the symbol "–") corresponding to the 57 inside products.

Table 2: Prices by Manufacturer, Seller, and Display Format.

	Wholesale prices						Retail prices					
	Mean unweighted	Mean weighted	St. Dev.	Min.	Median	Max.	Mean unweighted	Mean weighted	St. Dev.	Min.	Median	Max.
Manufacturer:												
- m_1	13.7	9.4	13.5	1.4	9.8	73.4	14.2	8.8	14.7	1.5	9.7	78.4
- m_2	18.7	11.2	23.4	1.0	11.7	247.3	19.0	10.3	20.0	1.1	12.1	132.1
- m_3	21.9	6.7	31.2	0.4	8.5	163.8	23.3	6.4	33.9	0.6	8.3	172.0
- m_4	15.2	1.9	13.5	0.4	13.6	75.2	16.1	2.0	14.3	0.4	14.4	79.0
Seller:												
- r_4^v	18.0	5.5	28.1	0.5	7.5	148.6	18.5	5.7	28.8	0.5	7.8	153.6
- r_5^v	22.4	10.1	23.3	0.9	13.7	124.6	25.0	11.0	27.2	0.9	14.4	172.0
- r_6^v	11.9	2.9	26.2	0.7	4.4	163.8	12.6	3.0	27.3	0.7	4.6	170.0
- r_7^v	13.6	3.6	14.3	0.4	8.2	79.5	14.2	3.7	14.9	0.4	8.6	81.5
- r_8^v	25.7	6.4	30.9	0.4	14.5	158.1	29.9	7.3	34.3	0.6	16.9	165.8
- r_9^v	22.8	11.8	25.9	2.3	15.7	247.3	21.7	10.2	21.0	1.2	14.8	132.1
- r_1^d	–	–	–	–	–	–	13.3	12.4	3.3	9.4	12.0	19.0
- r_2^d	–	–	–	–	–	–	19.8	14.1	17.9	1.4	15.2	66.9
- r_3^d	–	–	–	–	–	–	8.8	6.5	4.9	2.7	7.9	23.0
Display:												
- 2 m^2 panel	11.3	9.8	11.7	0.8	8.4	79.5	11.8	9.1	12.3	0.9	8.7	83.2
- Senior	20.9	10.0	28.2	1.0	13.5	163.8	21.4	9.5	29.5	1.1	13.1	170.0
- Other	25.6	3.5	29.3	0.4	17.1	247.3	27.2	3.4	28.8	0.4	20.7	172.0
All Products:	18.4	8.2	24.2	0.4	10.3	247.3	19.3	7.7	24.7	0.4	10.5	172.0

Notes: The table reports summary statistics for wholesale and retail prices for each manufacturer, retailer, and display format. Unweighted prices correspond to the mean using equal weights. Weighted prices correspond to the mean using the corresponding market shares as weights. Prices are in Euros per m^2.

Table 3: Demand Estimates.

	Logit OLS		**Logit GMM**		**Mixed logit**		**Mixed logit with channel-specific preferences**	
	(1)		(2)		(3)		(4)	
	Coefficient	St. error	Coefficient	St. error	Coefficient	St. error	Coefficient	St. error
Price:								
- Mean (α)	0.044	0.002	0.083	0.008	0.420	0.009	0.198	0.004
- St. dev. (σ)	–	–	–	–	0.148	0.029	0.069	0.003
Manufacturer dummy variables:								
- Manufacturer m_1	-0.484	0.215	-0.386	0.251	-0.762	0.277	-0.377	0.138
- Manufacturer m_2	0.898	0.184	1.054	0.213	1.140	0.239	0.572	0.119
- Manufacturer m_3	-0.204	0.176	0.185	0.217	-0.654	0.240	-0.317	0.109
Seller dummy variables:								
- Retailer r_4^v	0.583	0.463	0.600	0.540	1.139	0.596	-0.252	0.297
- Retailer r_5^v	-0.407	0.206	-0.554	0.242	-1.838	0.267	-0.901	0.133
- Retailer r_6^v	-0.744	0.197	-0.614	0.231	-0.526	0.255	-0.261	0.127
- Retailer r_7^v	0.200	0.294	0.132	0.343	-0.002	0.379	-0.755	0.189
- Retailer r_8^v	-0.208	0.199	-0.529	0.240	-2.461	0.265	-1.202	0.132
- Retailer r_9^v	0.336	0.296	-0.397	0.371	-0.753	0.410	-1.229	0.204
- Direct sales r_2^d	-0.192	0.191	-0.484	0.230	-1.127	0.254	-0.550	0.127
- Direct sales r_3^d	-1.560	0.219	-1.301	0.260	-1.705	0.287	-0.835	0.143
Product dummy variables:								
- 2 m^2 panel	0.767	0.151	0.202	0.204	0.080	0.225	0.055	0.112
- Senior	-0.437	0.150	-0.713	0.184	-0.916	0.203	-0.441	0.101
Channel-specific preferences:								
- Nesting parameter (λ)	–	–	–	–	–	–	0.498	0.004
Model Specification:								
- OLS	Yes		No		No		No	
- GMM	No		Yes		Yes		Yes	
- Random coefficients for price	No		No		Yes		Yes	
- Channel-specific preferences	No		No		No		Yes	
First-stage:								
- F-Test	–		9.63		9.32		9.00	
- P-Value	–		0.000		0.000		0.000	
Test of Over Identification (Hansen, 1982):								
- Hansen (1982) Test	–		1.606		1.574		1.341	
- P-Value	–		0.205		0.455		0.511	
Number of observations:	684		684		684		684	

Notes: Estimates of selected parameters from the demand model in Section 3. All specifications include dummy variables for manufacturers, sellers/retailers, display format, and months fixed effects (not reported). Model 1 is estimated by OLS. Models 2, 3, and 4 are estimated by GMM. Details about the estimation procedure and the instruments are in Section 4. See Section 2 for details about the data. The share of consumers with negative (positive) price coefficients in models 3 and 4 are 99.77 and 99.78 percent (0.23 and 0.21 percent), respectively.

Table 4: Supply Estimates.

Statistic or Retailer	Estimate
Panel A: Marginal costs of manufacturers	
Mean	6.599
St. dev.	3.732
Min.	0.000
Median	6.858
Max.	12.499
Panel B: Bargaining weights of retailers	
r_4^v	0.041
r_5^v	0.137
r_6^v	0.085
r_7^v	0.089
r_8^v	0.189
r_9^v	0.059

Notes: Estimates of selected parameters from the supply model in Section 3. All specifications include dummy variables for manufacturers, sellers/retailers, and months fixed effects. Details about the estimation procedure and the instruments are in Section 4. See Section 2 for details about the data.

Table 5: Counterfactual Scenarios.

Percentage change relative to baseline in:	No bargaining leverage from direct sales (1)	Direct-sale prohibition (2)	Divestiture of direct-sale operations (3)
Market Shares			
- Direct-sale share	-2.42	-100.00	-100.00
- Retail-sale share	4.42	70.56	94.28[a]
- Non-divested retailers share	–	–	-0.42
- Divested retailers share	–	–	-0.39[b]
Consumer prices			
- Direct-sale prices	-1.65	–	–
- Retail-sale prices	-3.30	50.78	8.11[c]
- Non-divested retailers prices	–	–	7.07
- Divested retailers prices	–	–	8.68[d]
Wholesale prices	-3.82	3.08	3.19
Profits			
- Manufacturers' profits	-5.05	-3.35	-3.86
- Direct-sale-channel profits	-6.42	-100.00	-100.00
- Retailing-channel profits	-3.33	75.15	5.82
- Retailers' profits	8.73	183.71	131.99[e]
- Non-divested retailers profits	–	–	51.26
- Divested retailers profits	–	–	-67.36[f]
Consumer surplus	1.34	-80.95	-5.09
Total welfare	0.14	-20.64	-0.03

Notes: The table displays counterfactual scenarios using the estimated model. All numbers in the table represent the percentage change in the counterfactual relative to the baseline. The baseline corresponds to the estimated model with direct sales, tables 3 (model 4) and 4. In counterfactual scenario 1 (no bargaining leverage from direct sales), the direct-sale channel continues to operate as in the baseline, but we remove the manufacturers' bargaining leverage due to the direct sales ($d_j^D = 0$ in equation 6). In counterfactual scenario 2 (direct-sale prohibition), manufacturers' direct sales are prohibited. See Section 5 for details about the implementation of the counterfactuals and the definition of consumer surplus. In counterfactual scenario 3 (divestiture of direct-sale operations), the direct-sale division of each manufacturer is divested into a new retailer. See Section 3 for definitions of the market shares, prices, and profits.

[a] Retail-sale share refers to the total retail sales shares, which includes the divested retailers' share (direct sales share in the baseline).

[b] Retail-sale share of divested retailers refers to the change relative to the direct-sale shares in baseline, which are the sales/products divested.

[c] Retail-sale prices refer to the weighted average of the prices of the non-divested and the divested retailers, using the market shares from the baseline as weights.

[d] Retail sales prices of divested retailers are computed relative to the direct-sale prices in the baseline.

[e] Retailing profits in the divestiture scenario refer to the profits of all retailers in this scenario (non-divested plus divested retailers), and the percent change is computed relative to the retailing profits of all retailers in the baseline, which are the non-divested retailers by construction.

[f] Divested retailers' profits are computed relative to the direct-sale-channel profits in the baseline.

Appendix

A Derivations

A.1 Derivation of the Market Share Function

For the estimation, it is convenient to write the nested-logit choice probability as the product of two standard logit probabilities. Denote by $\overline{u}_{i\hat{j}t} \equiv -\alpha_i p_{\hat{j}t} + x_{\hat{j}t}\beta + \tau_f^D + \tau_m^D + \tau_r^D + \tau_t^D + \xi_{\hat{j}t}$ the indirect utility of consumer i for product $\hat{j}$ in market t, net of the stochastic term, $\hat{\varepsilon}_{ijt}$. Denote by $\mathbb{P}_{i\hat{j}t}$ the nested-logit probability that individual i chooses product $\hat{j}$ in period t. Then:[34]

$$\mathbb{P}_{i\hat{j}t} = \mathbb{P}_{i\hat{j}t|\hat{g}} \times \mathbb{P}_{i\hat{g}t}, \tag{A.1a}$$

$$= \frac{\exp(I_{i\hat{g}})}{\exp(I_{\hat{g}})} \times \frac{\exp\left(\frac{\overline{u}_{i\hat{j}t}}{1-\lambda}\right)}{\exp\left(\frac{I_{i\hat{g}}}{1-\lambda}\right)}, \tag{A.1b}$$

$$i = 1, \ldots, I_t, \qquad \hat{j} \in \hat{g}, \qquad \hat{g} \in \{0, 1, 2\}, \qquad t = 1, \ldots, T,$$

where the first equality follows from the law of total probability; $\mathbb{P}_{i\hat{j}t|\hat{g}}$ is the conditional probability of choosing product $\hat{j}$ given that the product is in group $\hat{g}$; $\mathbb{P}_{i\hat{g}t}$ is the marginal conditional probability of choosing a product in group $\hat{g}$; the last equality follows from the nested-logit structure using the decomposition into two standard logit probabilities; and the terms $I_{i\hat{g}}$ and $I_{\hat{g}}$ are inclusive values given by:[35]

$$I_{i\hat{g}} \equiv (1-\lambda) \log \sum_{j \in \hat{g}} e^{\overline{u}_{ijt}/(1-\lambda)}, \tag{A.2a}$$

$$I_{\hat{g}} \equiv \log\left(1 + \sum_{g=1}^{2} e^{I_{i\hat{g}}}\right). \tag{A.2b}$$

Denote by $\delta_{jt} \equiv -\alpha p_{jt} + x_{jt}\beta + \tau_f + \tau_m + \tau_r + \tau_t + \xi_{jt}$ the mean utility for product j in market t (*i.e.*, the portion of the utility that is constant across types of consumers). Then, $u_{ijt} = \delta_{jt} - \sigma v_i p_{jt} + \hat{\varepsilon}_{ijt}$. Let $A_{jt}(\cdot)$ be the set of individuals who choose product j in market t. Then, $A_{jt}(x_{.t}, p_{.t}, \delta_{.t}, \sigma) = \{(v_i, \hat{\varepsilon}_{i0t}, ..., \hat{\varepsilon}_{iJ_t t}) | u_{ijt} \geq u_{ilt}, \forall l = 0, 1, ..., J_t\}$, where $x_{.t} = (x_{1t}, ..., x_{J_t t})'$, $p_{.t} = (p_{1t}, ..., p_{J_t t})'$, and $\delta_{.t} = (\delta_{1t}, ..., \delta_{J_t t})'$ are observed characteristics, prices, and mean utilities for all products, respectively. Then, the market share function for each product j is:

$$s_{j,t}(x_{.t}, p_{.t}, \delta_{.t}; \sigma) = \int_{A_{jt}} \mathbb{P}_{ijt} \, \mathrm{d}P_{\nu}(\nu_i). \tag{A.3}$$

where $\mathbb{P}_{ijt}$ is given by equation (A.1).

[34] See Donna, Pereira, Pires, and Trindade (2022) for details.

[35] See McFadden (1978).

A.2 Derivation of Bargaining Equations

Derivation of equation (5)

Solving the maximization problem in (3.2):[36]

$$\lambda_j(\Pi_r - \Pi_{r,-j})^{\lambda_j - 1}(\Pi_m - \Pi_{m,-j})^{1-\lambda_j}\frac{\partial \Pi_r}{\partial w_j} + (1-\lambda_j)(\Pi_r - \Pi_{r,-j})^{\lambda_j}(\Pi_m - \Pi_{m,-j})^{-\lambda_j}\frac{\partial \Pi_m}{\partial w_j} = 0.$$

Because manufacturers and retailers take prices set to consumers as fixed when determining wholesale prices, we have $\frac{\partial \Pi_m}{\partial w_j} = s_j^R M$ and $\frac{\partial \Pi_r}{\partial w_j} = -s_j^R M$. Substituting above and simplifying with $s_j^R > 0$ yields:

$$\lambda_j(\Pi_m - \Pi_{m,-j}) + (1-\lambda_j)(\Pi_r - \Pi_{r,-j})(-1) = 0. \tag{A.4}$$

Reorganizing yields equation (5).

Derivation of equation (6)

Substituting the profit functions, from the equations in (1) and (2), and the disagreement payoffs, from the equations in (3.2) and (3.2), into equation (A.4) yields:

$$\lambda_j\left[\sum_{k\in\Omega_m^R}(w_k - c_k^m)s_k^R(p) + \sum_{k\in\Omega_m^D}(p_k^D - c_k^m)s_k^D(p) - \sum_{k\in\Omega_m^R|\{j\}}(w_k - c_k^m)s_{k,-j}^R(p_{-j}) - \sum_{k\in\Omega_m^D}(p_k^D - c_k^m)s_{k,-j}^D(p_{-j})\right]$$
$$- (1-\lambda_j)\left[\sum_{k\in\Omega_r}(p_k^R - w_k)s_k^R(p) - \sum_{k\in\Omega_r|\{j\}}(p_k^R - w_k)s_{k,-j}^R(p_{-j})\right] = 0.$$

Rearranging:

$$\lambda_j\left[(w_j - c_j^m)s_j^R(p) - \sum_{k\in\Omega_m^R|\{j\}}(w_k - c_k^m)\Delta s_{k,-j}^R(p) - \sum_{k\in\Omega_m^D}(p_k^D - c_k^m)\Delta s_{k,-j}^D(p)\right]$$
$$- (1-\lambda_j)\left[(p_j^R - w_j)s_j^R(p) - \sum_{k\in\Omega_r|\{j\}}(p_k^R - w_k)\Delta s_{k,-j}^R(p)\right] = 0, \tag{A.5}$$

where $\Delta s_{k,-j}^f(p) \equiv s_{k,-j}^f(p_{-j}) - s_k^f(p)$, with $f \in \{\mathrm{R}, \mathrm{D}\}$.

Isolating $w_j s_j(p)$ yields equation (6).

[36] To simplify the notation here, we simply write the retailers' profits as Π_r instead of $\Pi_r(w, w_{-j})$, and $\Pi_{r,-j}$ instead of $\Pi_{r,-j}(w_{-j})$. We also adopt the corresponding notational convention for manufacturers.

A.3 Derivation of the Estimating Marginal Cost Equation

Derivation of the term $c^m = \mathcal{M}(\lambda)$ in equation (15)

Write in matrix form equation (4) for the necessary first-order conditions of the manufacturers from their direct sales:[37]

$$s + (T_w \odot \Delta_s)(w - c^m) = 0, \tag{A.6}$$

where:

$$T_w(i,j) = \begin{cases} 1 & \text{if } i = j \text{ or } (i \wedge j) \text{ are owned by the same manufacturer} \\ 0 & \text{otherwise,} \end{cases}$$

Δ_s is the matrix of derivatives with respect to price,

w is a $M \times R$ vector such that $w_j = p_j^D$ if j is a product sold directly by manufacturers.

Similarly, write in matrix form equation (6) for the necessary first-order conditions of the wholesale bargaining prices in the retailing channel:

$$(T_w \odot \bar{s})(w - c^m).\lambda - (T_r \odot \bar{s})(p^R - w).(1 - \lambda) = 0, \tag{A.7}$$

where:

$$\bar{s} \text{ is such that } \bar{s}(i,j) = \begin{cases} s_j & \text{if } i = j \\ \text{-}\Delta s_i^{-j} & \text{otherwise,} \end{cases}$$

$$T_r \text{ is such that } T_r(i,j) = \begin{cases} 1 & \text{if } i = j \text{ or } (i \wedge j) \text{ are sold by the same retailer} \\ 0 & \text{otherwise.} \end{cases}$$

Next, sum the equations in (A.6) and (A.7) as follows:

$$I_d[s + (T_w \odot \Delta s)(w - c^m)] + I_v[(T_w \odot \bar{s})(w - c^m).\lambda - (T_r \odot \bar{s})(p^R - w).(1 - \lambda)] = 0, \tag{A.8}$$

where:

$$I_d \text{ is a } J \times J \text{ matrix such that } I_d(i,j) = \begin{cases} 1 & \text{if } i = j \text{ and product } j \text{ is sold directly} \\ 0 & \text{otherwise,} \end{cases}$$

$$I_v \text{ is a } J \times J \text{ matrix such that } I_v(i,j) = \begin{cases} 1 & \text{if } i = j \text{ and product } j \text{ is sold by retailers} \\ 0 & \text{otherwise.} \end{cases}$$

Finally, let:

$$c^m = \mathcal{M}(\lambda) \equiv A^{-1}(\lambda)B(\lambda), \tag{A.9}$$

where:

$$A(\lambda) = I_v(T_w \odot \bar{s}).\lambda + I_d(T_w \odot \Delta s),$$
$$B(\lambda) = I_v[(T_w \odot \bar{s})w.\lambda - (T_r \odot \bar{s})(p^R - w).(1 - \lambda)] + I_d(s + (T_w \odot \Delta s)w).$$

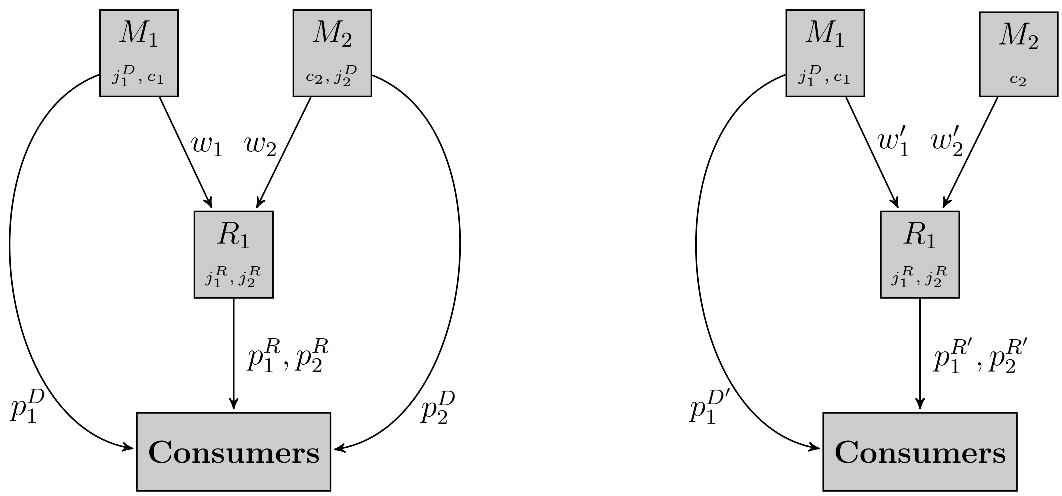
[37] Henceforth, denote by "$\odot$" the element-by-element matrix multiplication and by "." the element-by-element vector multiplication.

B Additional Examples and Robustness Analyses

B.1 Additional Examples

Example 5. No direct sales from one manufacturer.

Figure A1: No direct sales from one manufacturer.



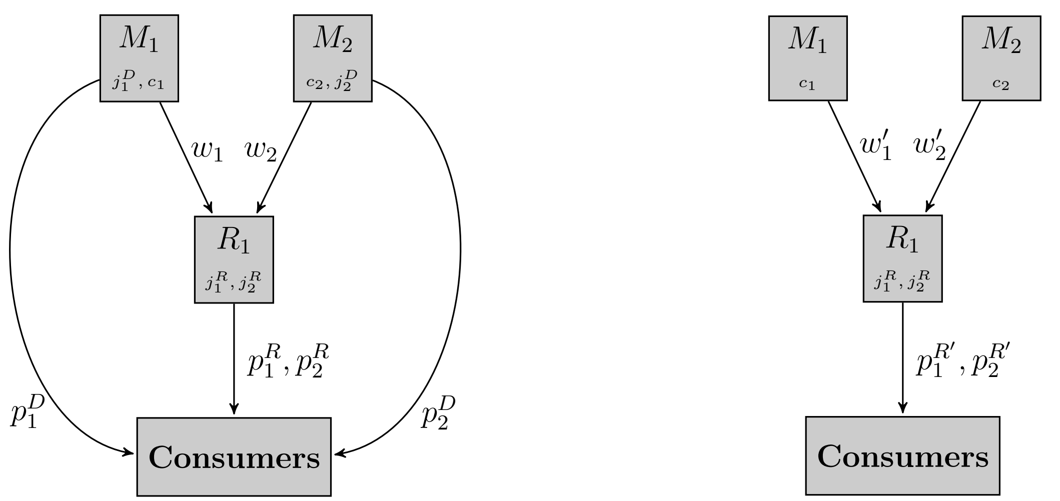
(a) Both M_1 and M_2 sell directly.

(b) Only M_1 sells directly.

Notes: The figure illustrates the leverage effect of one manufacturer with two manufacturers and one retailer from Example 5.Panel a. In the upstream, manufacturers M_1 and M_2 produce, respectively, inputs 1 and 2 at costs c_1 and c_2. These inputs are sold to retailer R_1 at, respectively, the negotiated wholesale prices w_1 and w_2, and used to manufacture products j_1^D and j_2^D. In the downstream, there are three competing firms, M_1, M_2, and R_1. Manufacturers M_1 and M_2 sell, respectively, products j_1^D and j_2^D directly to consumers at prices p_1^D and p_2^D. Retailer R_1 sells products j_1^R and j_2^R at prices p_1^R and p_2^R, respectively. Panel b. Similar to panel a, but now manufacturer M_2 does not sell products j_2^D to consumers.

Example 6. No direct sales from both manufacturers.

Figure A2: No direct sales from both manufacturers.



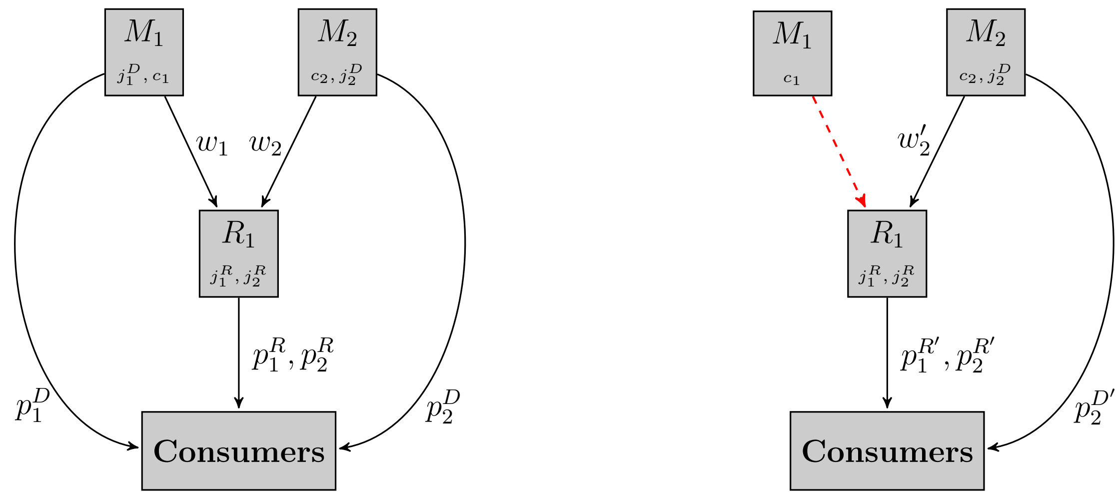
(a) Both M_1 and M_2 sell directly.

(b) Neither M_1 nor M_2 sell directly.

Notes: The figure illustrates the leverage effect of one manufacturer with two manufacturers and one retailer from Example 6. Panel a. In the upstream, manufacturers M_1 and M_2 produce, respectively, inputs 1 and 2 at costs c_1 and c_2. These inputs are sold to retailer R_1 at, respectively, the negotiated wholesale prices w_1 and w_2, and used to manufacture products j_1^D and j_2^D. In the downstream, there are three competing firms, M_1, M_2, and R_1. Manufacturers M_1 and M_2 sell, respectively, products j_1^D and j_2^D directly to consumers at prices p_1^D and p_2^D. Retailer R_1 sells products j_1^R and j_2^R at prices p_1^R and p_2^R. Panel b. Similar to panel a, but now manufacturers do not sell products j_1^D and j_2^D to consumers.

Example 7. Direct sales *vs.* vertical integration.

Figure A3: Direct sales *vs.* vertical integration.



(a) M_1 sells directly to consumers.

(b) M_1 vertically integrates with R_1.

Notes: The figure illustrates the leverage effect of one manufacturer with two manufacturers and one retailer from Example 7. Panel a. In the upstream, manufacturers M_1 and M_2 produce, respectively, inputs 1 and 2 at costs c_1 and c_2. These inputs are sold to retailer R_1 at, respectively, the negotiated wholesale prices w_1 and w_2, and used to manufacture products j_1^D and j_2^D. In the downstream, there are three competing firms, M_1, M_2, and R_1. Manufacturers M_1 and M_2 sell, respectively, products j_1^D and j_2^D directly to consumers at prices p_1^D and p_2^D. Retailer R_1 sells products j_1^R and j_2^R at prices p_1^R and p_2^R, respectively. Panel b. Similar to panel a, but now the dashed red line denotes vertical integration between M_1 and R_1. The vertically integrated firm sells products j_1^R and j_2^R to consumers at prices p_1^R and p_2^R, respectively.

B.2 Robustness Analyses

Table A1: Robustness: Demand Estimates using Lognormal Random Coefficients.

	Mixed logit with channel-specific preferences	
Price:	Coefficient	St. error
- Mean (α)	0.159	0.004
- St. dev. (σ)	0.010	0.003
Manufacturer dummy variables:		
- Manufacturer m_1	-0.400	0.138
- Manufacturer m_2	0.572	0.119
- Manufacturer m_3	-0.281	0.120
Seller dummy variables:		
- Retailer r_4^v	-0.419	0.297
- Retailer r_5^v	-0.905	0.133
- Retailer r_6^v	-0.285	0.127
- Retailer r_7^v	-0.779	0.189
- Retailer r_8^v	-1.091	0.132
- Retailer r_9^v	-1.308	0.204
- Direct sales r_2^d	-0.569	0.127
- Direct sales r_3^d	-0.824	-0.143
Product dummy variables:		
- 2 m^2 panel	-0.064	0.112
- Senior	-0.549	0.101
Channel-specific preferences:		
- Nesting parameter (λ)	0.499	0.003
Model Specification:		
- OLS	No	
- GMM	Yes	
- Random coefficients for price	Yes	
- Channel-specific preferences	Yes	
Number of observations:	684	

Notes: Estimates of selected parameters from the demand model in Section 3 using lognormally distributed random coefficients for price. All specifications include dummy variables for manufacturers, sellers/retailers, display format, and months fixed effects (not reported).The model is estimated by GMM. Details about the estimation procedure and the instruments are in Section 4. See Section 2 for details about the data. The average own-price elasticity is -1.562.

Table A2: Robustness: Supply Estimates using Demand with Lognormally distributed Random Coefficients.

Statistic or Retailer	Estimate
Panel A: Marginal costs of manufacturers	
Mean	5.701
St. dev.	3.401
Min.	0.000
Median	6.483
Max.	12.333
Panel B: Bargaining weights of retailers	
r_4^v	0.039
r_5^v	0.134
r_6^v	0.082
r_7^v	0.072
r_8^v	0.190
r_9^v	0.057

Notes: Estimates of selected parameters from the supply model in Section 3 using the demand estimates from Table A1. All specifications include dummy variables for manufacturers, sellers/retailers, and months fixed effects. Details about the estimation procedure and the instruments are in Section 4. See Section 2 for details about the data.

Table A3: Robustness: Counterfactual Scenarios using Demand with Lognormally distributed Random Coefficients.

Percentage change relative to baseline in:	**No bargaining leverage from direct sales** (1)	**Direct-sale prohibition** (2)	**Divestiture of direct-sale operations** (3)
Market Shares			
- Direct-sale share	-0.76	-100.00	-100.00
- Retail-sale share	3.65	34.42	100.85[a]
- Non-divested retailers share	–	–	-9.12
- Divested retailers share	–	–	-9.01[b]
Consumer prices			
- Direct-sale prices	-0.28	–	–
- Retail-sale prices	-2.82	49.97	13.73[c]
- Non-divested retailers prices	–	–	12.80
- Divested retailers prices	–	–	14.12[d]
Wholesale prices	-2.75	9.25	9.45
Profits			
- Manufacturers' profits	-1.14	-51.16	-9.85
- Direct-sale-channel profits	-1.27	-100.00	-100.00
- Retailing-channel profits	-0.91	48.00	6.04
- Retailers' profits	0.32	153.09	118.86[e]
- Non-divested retailers profits	–	–	24.45
- Divested retailers profits	–	–	-64.53[f]
Consumer surplus	0.84	-68.11	-11.06
Total welfare	-0.23	-23.37	-3.77

Notes: The table displays counterfactual scenarios using the estimated model. All numbers in the table represent the percentage change in the counterfactual relative to the baseline. The baseline corresponds to the estimated model with direct sales, Tables A1 and A2. In counterfactual scenario 1 (no bargaining leverage from direct sales), the direct-sale channel continues to operate as in the baseline, but we remove the manufacturers' bargaining leverage due to the direct sales ($d_j^D = 0$ in equation 6). In counterfactual scenario 2 (direct-sale prohibition), manufacturers' direct sales are prohibited. See Section 5 for details about the implementation of the counterfactuals and the definition of consumer surplus. In counterfactual scenario 3 (divestiture of direct-sale operations), the direct-sale division of each manufacturer is divested into a new retailer. See Section 3 for definitions of the market shares, prices, and profits.

[a] Retail-sale share refers to the total retail sales shares, which includes the divested retailers' share (direct sales share in the baseline).

[b] Retail-sale share of divested retailers refers to the change relative to the direct-sale shares in baseline, which are the sales/products divested.

[c] Retail-sale prices refer to the weighted average of the prices of the non-divested and the divested retailers, using the market shares from the baseline as weights.

[d] Retail sales prices of divested retailers are computed relative to the direct-sale prices in the baseline.

[e] Retailing profits in the divestiture scenario refer to the profits of all retailers in this scenario (non-divested plus divested retailers), and the percent change is computed relative to the retailing profits of all retailers in the baseline, which are the non-divested retailers by construction.

[f] Divested retailers' profits are computed relative to the direct-sale-channel profits in the baseline.