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Vertical Bargaining and Retail Competition: What Drives Countervailing Power?*

Germain Gaudin†

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Abstract

This paper investigates the effects of changes in retail market concentration when input prices are negotiated. Results are derived from a model of bilateral Nash-bargaining between upstream and downstream firms which allows for general forms of demand and retail competition. Whether countervailing buyer power arises, in the form of lower negotiated prices following greater concentration downstream, depends on the pass-through rate of input prices to retail prices. Countervailing buyer power arises in equilibrium for a broad class of demand forms, and its magnitude depends on the degree of product differentiation. However, it generally does not translate into lower retail prices because of heightened market power at the retail level. The demand systems commonly used in the literature impose strong restrictions on the results.

Keywords: Countervailing buyer power, Bilateral oligopoly, Vertical relations, Bargaining, Pass-through, Market concentration, Mergers, Entry, Exit.

JEL Codes: C78, D43, L13, L14, L81.

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1 Introduction

In industries where markets are vertically related, variations in market concentration typically alter the equilibrium of the whole supply chain. Absent cost efficiencies, greater retail concentration is often thought to increase retail prices because it raises market power. However, the appealing concept of *countervailing buyer power* claims that greater retail concentration also increases retailers' bargaining power as buyers of an input and thus induces the price of this input to fall. According to this concept, this decrease in the input price is further passed-on to consumers and compensates for the price hike due to heightened market power at the retail level.

The concept of countervailing power was introduced by John K. Galbraith in his authoritative 1952 book. He argued that it explained the success and stability of the American economy of the mid-twentieth century, which had drifted away from the model of perfect competition after waves of market concentration in many industries.[1] Countervailing buyer power remained a very influential concept since then and, as such, has been identified as a source of pro-consumer effects from mergers by competition authorities in their horizontal merger guidelines.[2]

When faced with a proposed merger, competition authorities usually evaluate its impact for competitors and final consumers but also for the merging firms' trading partners. It is therefore essential to evaluate the pressures exerted on prices that arise from strategic reactions from firms which operate at a different level in the supply chain than the one where the merger occurs. These effects generally depend on trading partners' agreements and relative bargaining power.

The relevance of countervailing buyer power, and more generally of the interplay between vertical bargaining and retail competition, has recently been highlighted in several empirical studies. For instance, Crawford and Yurukoglu (2012) showed that retail prices in the cable TV industry are affected both by negotiated input prices at the wholesale level and competition at the retail level. Bargaining

[1] More precisely, Galbraith (1952) stated that "new restraints on private power did appear to replace competition. They were nurtured by the same process of concentration which impaired or destroyed competition. But they appeared not on the same side of the market but on the opposite side, not with competitors but with customers or suppliers."

[2] See, e.g., documents from the U.S. Department of Justice and the Federal Trade Commission (2010), Section 12, from the European Commission (2004), Section V, and from the UK Competition Commission and Office of Fair Trading (2010), Section 5.9.

between vertically-related firms coupled with retail competition were also found to be major drivers of equilibrium retail prices in health care markets (Ho and Lee (2017)) or in the coffee industry (Draganska, Klapper and Villas-Boas (2010)).

Despite the prominence of the concept of countervailing buyer power for more than 60 years, theoretical support is sparse and limited. In order to justify the recent empirical findings mentioned above, a compelling theory should allow for flexible demand systems and encompass the case of price-setting firms selling differentiated products. However, the few papers which study countervailing buyer power arising from greater market concentration focus on deriving *possibility results*, showing that cases in which countervailing buyer power does or does not arise exist, and work with specific examples.[3] This says little about the generality of Galbraith's concept and can only give meagre guidance to antitrust authorities, courts, and policymakers.

This paper presents a tractable solution for a bargaining game of bilateral negotiations between a manufacturer and several retailers, which admits a general, yet flexible demand system. The analysis thus virtually nests any framework where firms compete either in prices or quantities and sell homogeneous or differentiated products. This general setting is then used to pin down the determinants of countervailing buyer power in order to go *beyond* possibility results. The analysis amounts to understanding distortions arising from double-marginalization under vertical bargaining and retail competition.

Countervailing buyer power emerges in equilibrium for a broad range of demand systems. A necessary condition for countervailing buyer power effects to arise in the form of lower input prices is that the retail market displays an increasing pass-through rate of input prices to retail prices. This condition also becomes sufficient under a wide range of demand systems when the manufacturer makes take-it-or-leave-it offers. The intuition is as follows. An increase in retail market concentration induces an upward pricing pressure because of heightened market power. When the retail pass-through rate is increasing, this pricing pressure is amplified, for a given input price. As a response, in equilibrium, the manufacturer lowers the input price to alleviate the output reduction effect which results from this upward pricing pressure. By contrast, when the pass-through rate is decreasing, the manufacturer can raise its input price with limited effect on quantity.

[3] A review of the related literature is provided in the next section.

Moreover, a major determinant of the magnitude of input price changes is the reaction of *competition intensity* to a change in market concentration, which is roughly equivalent to the degree of product differentiation. Generally, however, a countervailing buyer power effect does not compensate the price hike driven by the increase in market power, and consumers are worse-off when the retail market becomes more concentrated.

We provide various extensions to check the robustness of our findings. For instance, we develop a tractable equilibrium model of interlocking relationships with both upstream and downstream competition. In this setting where retailers become multi-products firms, countervailing buyer power and welfare effects are also impacted by the interplay between downstream and upstream competition. We also extend our main results to demand systems with a variable conduct parameter, such as the logit demand system, and we analyse the impact of exogenous changes in bargaining power on the equilibrium.

An important feature of our model is that vertical agreements between manufacturers and retailers are simple linear contracts.[4] Whereas these contracts lead to a double-markup problem, they are widely used in practice. For instance, this type of contract is prominent in relations between TV channels and cable TV distributors (Crawford and Yurukoglu (2012)), between hospitals and medical device suppliers (Grennan (2013, 2014)), or between book publishers and resellers (Gilbert (2015)).[5] Finally, large disparities between the frequency at which retailers order inputs (e.g., weekly, in order to adjust to demand) and that at which they meet with manufacturers to negotiate contracts (e.g., annually) also favour the use of simple linear tariffs in practice (Dobson and Waterson (1997, 2007)).

The remainder of the paper is as follows. A review of the related literature is provided in Section 2. Then, in Section 3, a model of vertical bargaining with a flexible demand system is introduced, and solved. Determinants of countervailing buyer power are derived in Section 4 in the special case where the manufacturer makes take-it-or-leave-it offers, and then generalized to any distribution of bargaining power between firms in Section 5. A discussion of the main modelling assumptions is presented in Section 6. Section 7 extends the model to a broader set

[4] We provide a discussion of the impact of such modelling choice in Section 6.

[5] It also used to be the norm in the video-rental industry, as explained by Mortimer (2008). Linear contracts are also widely used in the literature on input price discrimination, for instance; see, e.g., the papers by DeGraba (1990), Inderst and Valletti (2009), and O'Brien (2014).

of demand systems, the case of upstream competition, and exogenous changes in bargaining power. Finally, Section 8 concludes.

2 Related Literature

This paper relates to the literature on vertical bargaining and on countervailing power. The Nash-bargaining solution was first introduced in a model of vertical relations with competing retailers by Horn and Wolinsky (1988). Since that paper, this solution has been widely used when modelling vertical relations to address questions relative to countervailing power, but also, e.g., to input price discrimination (O'Brien (2014)).

Recent empirical work also used the Nash-solution in order to investigate models of bargaining between vertically-related firms with firms in the downstream segment competing for consumers. Studying the cable TV industry, Crawford and Yurukoglu (2012) estimated a model in which (upstream) channels and (downstream) competing distributors bargain over a linear input price.[6] Similarly, Ho and Lee (2017) analysed a bargaining game between hospitals and health insurers. In their model, transfers between firms take the form a linear price while insurers also compete for consumers at the retail level.[7] Investigating manufacturer-retailer relations in the coffee market, Draganska, Klapper and Villas-Boas (2010) also set up a model of bargaining over linear wholesale prices with downstream competition.

Our analysis mostly relates to the literature on countervailing buyer power, and focuses on its original definition, which is probably also the most relevant to competition authorities: there is a countervailing buyer power effect when greater concentration in a retail market reduces input prices.[8] As such, this paper extends the work of von Ungern-Sternberg (1996), Dobson and Waterson (1997), and Iozzi and Valletti (2014), who studied the impact of retail concentration on wholesale and retail prices under linear demand systems when firms engage in bilateral bargaining over a linear input price.[9] It also generalises and extends the work of

[6] See also the paper by Chipty and Snyder (1999) for an earlier analysis of this industry.

[7] Grennan (2013, 2014), and Gowrisankaran, Nevo and Town (2015) also demonstrated the importance of negotiated wholesale prices in markets for medical device and health care, respectively.

[8] See the quote extracted from the book by Galbraith (1952) in footnote 1.

[9] In his model where retailers compete *à la* Cournot, von Ungern-Sternberg (1996) assumed that retailers would not increase their quantities when benefiting from a reduced input price; an assumption which conflicts with the existence of an outside option for the manufacturer.

Greenhut and Ohta (1976), Perry (1978), and Tyagi (1999), where an upstream firm makes take-it-or-leave-it offers to retailers competing *à la* Cournot.

Iozzi and Valletti (2014) studied four different models with either price or quantity competition under either observable or non-observable negotiation breakdowns.[10] They found that countervailing buyer power may arise in some cases. Dobson and Waterson (1997) investigated the case of price competition under observable breakdowns and analysed the effects of retail concentration for final consumers. Indeed, countervailing buyer power effects – i.e., lower input prices – exert a downward pressure on retail prices, thereby opposing the upward pricing pressure resulting from greater market power due to an increasing retail concentration.[11] They found cases where pro-consumer effects of retail mergers arise.[12]

In these papers, however, the conditions for countervailing buyer power to arise are case-dependent and expressed as functions of parameters of the selected demand system. Therefore, they only allow for an understanding of the economic drivers of countervailing power that is specific to the demand system they use. By contrast, we provide a clear economic intuition with broad applicability, stated in terms of the pass-through rate of input prices to retail prices.

Other theories explain why larger buyers would obtain lower input prices.[13] They are based on various interpretations of Galbraith's concept. For instance, Chen (2003), and Christou and Papadopoulos (2015) considered that greater buyer power corresponds to an increase in a retailer's (exogenous Nash-parameter) bargaining power. We discuss this interpretation of buyer power in light of our model in Section 7. Alternatively, Snyder (1996) suggested that large buyers benefit from heightened competition between tacitly colluding suppliers. (See also the related work of Ellison and Snyder (2010) for some empirical evidence in the US antibiotics market.)

[10] A bilateral negotiation can either be successful or not, and retailers can observe the outcomes of competitors' negotiations only when breakdowns are observable.

[11] In an early critic of Galbraith's concept, Whitney (1953) wrote, on the balance between increased market power and potential countervailing effects: "One might even argue that market power, when it raises up countervailing power to oppose it, automatically creates not only an organization big enough to beat buying prices down but, by that very fact, one which may be big enough to achieve a similar power on the selling side and thus increase the exploitation of consumers."

[12] Related analyses by Lommerud, Straume and Sørgard (2005) and Symeonidis (2010) focused on the impact of retail mergers either when different linear input prices are set for the merging firms and outsiders, or when upstream and downstream firms engage in exclusive relationships, respectively. Both models are also based on a linear demand system.

[13] See the reviews by Noll (2005) and Snyder (2008).

The closest alternative theory to ours also considers the effect of mergers between retailers on input prices, but only when retailers operate in separate markets (Inderst and Wey (2007, 2011)). This typically leads to asymmetries between retailers, with some large buyers and some smaller ones being simultaneously active and facing different wholesale prices, thus potentially leading to the so-called "waterbed effect" (Inderst and Valletti (2011)). While this approach is appealing as it disentangles "pure" countervailing buyer power effects from market power effects – which arise when considering retail mergers *within* a market – it does not provide strong guidance to antitrust authorities or policymakers when mergers take place between competing retailers. In addition, it raises the question of market definition and that of legal support for antitrust intervention in separate markets.

3 Model and Equilibrium

This section introduces and solves a model of bargaining with the Nash-solution which allows for general demand systems. The equilibrium will then be used in the rest of the paper to derive general results on countervailing buyer power.

3.1 The Model

A single manufacturer, M, sells inputs to $n \geq 1$ retailers.[14] The retailers need one unit of input to produce one unit of output, and then resell substitute, and possibly differentiated products to final consumers. Each consumer purchases at most a single unit in the market. The manufacturer faces a constant marginal cost of production $c \geq 0$ and retailers face no other cost than the price of their inputs.

In the last stage of the game, retailers simultaneously set their strategic variables after having observed the input prices faced by their competitors.[15] Retailer i sets its quantity q_i and faces the inverse demand $P_i(q_i, \mathbf{q_{-i}})$ for its product variety, where $\mathbf{q_{-i}}$ is the vector of its competitors' quantities, $\forall i$. Alternatively, retailers set prices and each variety quantity $q_i(p_i, \mathbf{p_{-i}})$ depends on firm i's own price, p_i, and the vector of its competitors' prices, $\mathbf{p_{-i}}$, $\forall i$. We denote by $Q \equiv \sum_i^n q_i$ the total market

[14] The assumption of upstream monopoly is relaxed in Subsection 7.2.

[15] Interim observability is a common assumption in the literature; see, e.g., Horn and Wolinsky (1988) and Iozzi and Valletti (2014). See Section 6 for a discussion of the various assumptions related to our model.

quantity and $P(Q) \equiv P_i(Q/n, \mathbf{Q}/\mathbf{n})$ the marketwide inverse demand evaluated at symmetric quantities.[16] The inverse demands $P_i(\cdot)$ and $P(\cdot)$ are thrice continuously differentiable and decreasing over the relevant interval.

In the first stage, the manufacturer contracts with retailers over a linear price determined through simultaneous, bilateral bargains. In a bilateral negotiation, the manufacturer and retailer i bargain over the input price w_i but not over the retail quantity or price, and they do not set any vertical restraint.[17] Retailer i's profit is thus given by $\pi_i^R = [P_i(q_i, \mathbf{q}_{-\mathbf{i}}) - w_i] q_i$. The manufacturer sells inputs to retailers and its profit is $\pi^M = \sum_i^n (w_i - c)\widetilde{q_i}$ where $\widetilde{q_i}$ is the quantity ordered by retailer i. In equilibrium, if all bargains are successful, every unit purchased by retailer i is sold in the downstream market and $\widetilde{q_i} = q_i$. Finally, we follow Horn and Wolinsky (1988) in using the Nash-bargaining solution of this game and assuming that firms have passive beliefs at this stage: if a negotiation fails, outcomes of all other negotiations are formed according to the anticipated equilibrium.[18]

A critical point when deriving the Nash-bargaining solution is to properly model firms' disagreement payoffs when a negotiation breaks down.[19] First, retailers have a disagreement payoff of zero because the manufacturer is a monopolist in the upstream market. In addition, once an agreement has been reached over an input price with the manufacturer, each retailer orders the number of inputs it needs based on its beliefs. This assumption seems to illustrate well the functioning of retailing markets, where firms engage in forward-buying and rarely purchase from manufacturers on a day-to-day basis.[20] Only then retailers may (or may not)

[16]The marketwide inverse demand $P(\cdot)$ mirrors Chamberlin's *DD* curve in the quantity space.

[17]Because linear wholesale contracts are not optimal, inefficiencies due to double markups will emerge in equilibrium. These inefficiencies are the source of potential countervailing buyer power effects. See Section 6 for a discussion of related effects under other optimal and sub-optimal contractual agreements.

[18]The equilibrium concept used in this setting is that of contract equilibrium, as described by Crémer and Riordan (1987), and O'Brien and Shaffer (1992). Also, see the work of Rubinstein (1982), Binmore, Rubinstein and Wolinsky (1986), and Collard-Wexler, Gowrisankaran and Lee (2016), for the foundations of the Nash-bargaining solution.

[19]See Section 6 for a detailed discussion of the related modelling assumptions. Iozzi and Valletti (2014) demonstrated that the equilibrium is sensitive to the specification of the disagreement payoff. They compare equilibrium outcomes under unobservable and observable breakdowns. In the latter case, firms can react to their competitors' negotiation breakdowns, whereas in the former case they set retail prices or quantities without knowing whether their competitors' bargains were successful or not. On this topic, see also the work of Raskovich (2003).

[20]By contrast, when retailers place orders frequently, it is likely that manufacturers post prices instead of bargaining. In this case, the specification of disagreement payoffs plays no role.

observe their competitors' negotiation success or failure.

In the event a negotiation breaks down, we make the standard assumption that outcomes of other bilateral bargains cannot be renegotiated (without the failing agreement also being renegotiated). As a result, the manufacturer's disagreement payoff when negotiating with retailer i is given by $\pi_0^M = \sum_{k \neq i} (w_k - c)\widetilde{q_k}$, where $\widetilde{q_k}$ is the quantity ordered by retailer k before breakdown observability.[21] This specification implies that the quantity ordered by retailer i to the manufacturer is invariant in its competitors' negotiation success or failure, for both cases of unobservable and observable breakdowns. However, the quantity retailer i orders in the input market, $\widetilde{q_i}$, could differ from the quantity q_i it sells in the retail market (out of the equilibrium), as it could always destroy or stockpile unsold units of input if needed.

Our specification of the disagreement payoff thus encompasses both the cases of observable and unobservable breakdowns, while remaining close to reality and actual retailing firms' conduct. Encompassing both of these cases constitutes an important feature of the model as we believe that there is no dominant specification in terms of breakdown observability, but rather that it depends on the market characteristics. This specification also keeps the model tractable, as discussed in more detail in Section 6.

3.2 The Equilibrium

Retail competition. In the last stage of the game, a retailer seeks to equalize its perceived marginal cost to its marginal revenue. When firms compete in quantities, the equilibrium is thus given by:

$$P_i(q_i, \mathbf{q_{-i}}) + q_i \frac{\partial P_i(q_i, \mathbf{q_{-i}})}{\partial q_i} = w_i \ , \forall i \ . \tag{1}$$

Alternatively, when retailers compete in prices the equilibrium is given by:[22]

$$p_i + \frac{q_i(p_i, \mathbf{p_{-i}})}{\partial q_i(p_i, \mathbf{p_{-i}}) / \partial p_i} = w_i \ , \forall i \ . \tag{1'}$$

We express the intensity of competition as a *conduct parameter*, $\theta \in [0, 1]$. It is

[21] This disagreement payoff does not depend on the input price firms bargain over: $\partial \pi_0^M / \partial w_i = 0$.

[22] In what follows, we use a specific equation numbering where equations (t) and (t') correspond to the same result expressed with different strategic variables.

given by $(\partial P_i/\partial q_i) / \left(\sum_k \partial P_k/\partial q_i\right)$ when firms set quantities, which gives $1/n$ under homogeneous Cournot competition. This conduct parameter is given by $\left(\sum_k \partial q_k/\partial p_i\right) / (\partial q_i/\partial p_i)$ under price competition in differentiated markets.[23] It equals unity when the retail market is monopolized or when firms collude, and goes towards zero as competition becomes more intense. In what follows, we assume that this parameter is constant in the equilibrium quantity (or price), for clarity of exposition. This assumption does not qualitatively change our results, and is relaxed in Subsection 7.1. Models or demand systems with a constant conduct parameter in quantity are, for instance, Cournot models, linear, or constant-elasticity of substitution (CES) demand systems.

Assumption 1. *The conduct parameter is invariant in the equilibrium quantity.*

Under either price or quantity competition, the symmetric equilibrium can thus be expressed as:

$$MR = w \ , \tag{2}$$

with $w_i = w$, $\forall i$, and where $MR \equiv P(Q) + Q\theta(Q)P_Q(Q)$ corresponds to a firm's marginal revenue, with $P_Q \equiv \partial P(Q)/\partial Q$ the derivative of the marketwide inverse demand with respect to total quantity.

Moreover, we denote by $MR_Q = (1+\theta)\, P_Q + Q\theta P_{QQ}$ the derivative of marginal revenue with respect to total market quantity, where $P_{QQ} \equiv \partial^2 P(Q)/\partial Q^2$ is the second-derivative of the marketwide inverse demand.

The associated second-order conditions to the above-mentioned equilibrium in equation (2) are assumed to hold everywhere over the relevant interval and imply $MR_Q < 0$, that is, a decreasing retailer's marginal revenue (see Appendix A).

Wholesale bargaining. In the first stage, retailers simultaneously bargain with the manufacturer over input prices. As there is a single manufacturer, a retailer's disagreement payoff equals zero in case the negotiation breaks down, whereas the manufacturer would obtain $\pi_0^M \geq 0$. The relative bargaining power of the manufacturer is denoted β, and retailers have the complement share $1-\beta$. The

[23] Weyl and Fabinger (2013) provided a detailed explanation about this reduced-form approach. Formally, this conduct parameter is equal to the difference between unity and the aggregate diversion ratio.

equilibrium of the bargaining game between M and retailer i is given by the input price w_i which solves the following maximization problem:

$$\underset{w_i}{\operatorname{argmax}} \left\{ \left(\pi^M - \pi_0^M \right)^{\beta} \left(\pi_i^R - 0 \right)^{1-\beta} \right\} . \tag{3}$$

The first-order condition of this problem is equivalent to solving the following equation for w_i:

$$-\beta \, \pi_i^R \frac{\partial \pi^M}{\partial w_i} = (1-\beta) \left(\pi^M - \pi_0^M \right) \frac{\partial \pi_i^R}{\partial w_i} . \tag{4}$$

We assume that the associated second-order conditions are satisfied (see Appendix A for details).

From the retail equilibrium given by equations (1) and (1′) and our specification of π_0^M, we have $\pi^M - \pi_0^M = (w_i - c) \, q_i$, and $\pi_i^R = -q_i^2 \partial P_i / \partial q_i$ under quantity competition, or $\pi_i^R = -q_i^2 / \left(\partial q_i / \partial p_i \right)$ under price competition. However, in order to solve the above-mentioned maximization problem, we need to determine the impact of the input price w_i on equilibrium quantities q_i and Q. This represents the equilibrium pass-through of a (perceived, marginal) variety-specific "cost-shock" to both the associated variety-specific quantity and total market quantity, respectively.[24] These pass-through rates are obtained by differentiating equations (1) and (1′) with respect to w_i and w_k, respectively, $\forall \theta \in (0, 1]$,[25] and by noticing that, in a symmetric equilibrium, $\partial q_k / \partial w_i = \partial q_i / \partial w_k$, and $\partial Q / \partial w_i = \partial q_i / \partial w_i + (n-1) \partial q_k / \partial w_i$, $\forall i, k \neq i$.[26]

When firms compete in quantities, the impact of a variety-specific cost-shock on a firm's own quantity in a symmetric equilibrium is given by, $\forall n \geq 2$:

$$\frac{\partial q_i}{\partial w_i} = \frac{1}{n^2} \left[\frac{1}{MR_Q} - \frac{(n-1)^2}{MR_Q - MR_q} \right] , \tag{5}$$

where $MR_q \equiv \partial \left[P_i + q_i \left(\partial P_i / \partial q_i \right) \right] / \partial q_i$ is the derivative of a retailer's marginal revenue with respect to its own quantity, $\forall i$. In the formula above, MR_q accounts for the fact that input prices are negotiated bilaterally between the manufacturer and each retailer and that a shock on one retailer's input price affects this re-

[24] See the work of Alexandrov and Bedre-Defolie (2017) for a related analysis of the effects of cost-shocks in single- and multi-product markets.

[25] The case of perfect competition (where $\theta = 0$ and/or $n \to +\infty$) implies $\pi_i^R = 0$ in a symmetric equilibrium. The retailers are thus indifferent to the level of the input price and the manufacturer can sell at the monopoly price for any positive β. Hence, the equilibrium is given by $P + QP_Q = c$.

[26] See Appendix B for a complete characterization of these pass-through rates.

tailer differently than the others. The variable MR_q is negative due to the retail second-order conditions as it equals $\partial^2 \pi_i^R / \partial q_i^2$ (see Appendix A), and is given by $MR_q = 2n\theta P_Q + (Q/n)\left(\partial^2 P_i / \partial q_i^2\right)$ in the symmetric equilibrium, $\forall i$.

Alternatively, when firms compete in prices, the retail variety-specific pass-through equals, $\forall n \geq 2$:

$$\frac{\partial q_i}{\partial w_i} = \frac{1}{n^2}\left[\frac{1}{MR_Q} - \frac{(n-1)(n/\theta - 1)}{MR_Q - MR_p}\right], \tag{5'}$$

where $MR_p \equiv (\partial Q/\partial p_i)^{-1} \partial \left[p_i + q_i/(\partial q_i/\partial p_i)\right]/\partial p_i$ represents the impact of a own-price increase on a retailer's marginal revenue in a symmetric equilibrium, $\forall i$. It is negative due to the retail second-order conditions, as $MR_p = \left(n^2 \theta P_Q^2\right) \partial^2 \pi_i^R / \partial p_i^2$, and equals $2nP_Q - QP_Q\left(n\theta P_Q\right)^2 \left(\partial^2 q_i / \partial p_i^2\right)$ in the symmetric equilibrium, $\forall i$.

The second-order conditions ensure that a retailer's marginal revenue decreases faster in its own strategic variable than after a common, symmetric quantity increase by all firms. That is, $0 > MR_Q > MR_x$ with $MR_x \in \{MR_q, MR_p\}$ whether retail competition is in quantities or prices; see Appendix A.

Under both quantity and price competition, the impact of a variety-specific cost-shock on total market demand in a symmetric equilibrium is given by, $\forall n \geq 1$ and $\forall i$:

$$\frac{\partial Q}{\partial w_i} = \frac{1}{nMR_Q}. \tag{6}$$

The latter equality represents the fact that the average pass-through of a variety-specific cost-shock to quantities is a fraction $1/n$ of the quantity decrease triggered by a symmetric increase in all input prices, equal to $1/MR_Q$ in equilibrium.

Equations (5) to (6) allow us to express the derivatives of firms' profits with respect to the input price evaluated at the symmetric retail equilibrium (see equations (31), (33), and (33') in the Appendix). Equation (4) can then be solved for w_i, and we obtain the following symmetric equilibrium where $w_i = w$, $\forall i$:

$$w - c = -QMR_Q\left[\frac{\beta n\theta}{\beta n\theta + (1-\beta)\Delta}\right], \tag{7}$$

where Δ is given by, $\forall n \geq 2$:[27]

$$\Delta(Q) \equiv -1 + \theta + \frac{nMR_Q}{P_Q} - \frac{(n-1)(1-\theta)MR_Q}{MR_Q - MR_x}, \tag{8}$$

with $MR_x \in \{MR_q, MR_p\}$, whether retail competition is in quantities or prices.

Finally, the equilibrium is determined by using equations (2) and (7) together:

$$MR + QMR_Q\left[\frac{\beta n\theta}{\beta n\theta + (1-\beta)\Delta}\right] = c. \tag{9}$$

When the bargaining power lies entirely with retailers, i.e., when $\beta = 0$, it is no surprise that the manufacturer sells at cost and that the equilibrium is found where marginal revenue equates marginal cost, $MR = c$. By contrast, when $\beta = 1$ and retailers take input prices as given, the classic double-marginalization result arises as the equilibrium is given by $MR + QMR_Q = c$.[28] The case of perfect competition is attained for any model with an infinitely large number of retailers and implies that the marketwide marginal revenue, $P + QP_Q$, equals marginal cost in equilibrium. Finally, the opposite extreme case of an equilibrium in a monopolized retail market, where both n and θ equal unity, is given by the equality $MR + \beta QMR_Q / \left[\beta + (1-\beta) MR_Q/P_Q\right] = c$.

This is, to our knowledge, the first equilibrium result of simultaneous bilateral negotiations over a linear input price with a general demand system. It allows both for general demand forms and different types of competition between firms, represented by the conduct parameter, and thus generalizes existing models of bargaining over a linear input price between a manufacturer and symmetric retailers which rely on the Nash-solution.[29] The literature usually assumes linear demand systems (e.g., Horn and Wolinsky (1988), Dobson and Waterson (1997), or Iozzi and Valletti (2014)), likely for tractability motives. Alternatively, it is also often assumed that firms bargain over non-linear contracts which allow the manufacturer and retailers to maximize joint profits (e.g., Inderst and Wey (2003)).

[27] Under monopoly, we have $\Delta = MR_Q/P_Q > 0$.

[28] See the paper by Gaudin and White (2014) for similar and related results in the context of commodity taxation.

[29] This generalization on the demand side is not without cost, as this is only allowed by our modelling of the manufacturer's disagreement payoff in the Nash-bargaining solution game, which remains, nonetheless, reasonable. See Section 6 for a discussion.

4 Take-it-or-leave-it Offers and Countervailing Power

Greater concentration in the retail market increases retailers' market power, thus increasing their markups, but also impacts the price of the input. Apart from the case where retailers have all bargaining power (i.e., $\beta = 0$), which implies that the price of the input is always equal to the upstream marginal cost, it is not obvious how the equilibrium input price given by equation (7) would respond to a change in retail market concentration.

In this section, we investigate the determinants of countervailing buyer power by focusing on the case where the bargaining power entirely lies with the manufacturer, that is, $\beta = 1$, for clarity of exposition. As shown below, this specific case is sufficient to highlight the major determinants of countervailing buyer power. Besides, the equilibrium does not depend on our specification of the disagreement payoffs in this case. More general results are given in Section 5, where we allow for negotiated input prices.

There is a countervailing buyer power effect when the price of the input decreases as the retail market becomes more concentrated.[30] Conversely, there is no such effect when a reduced number of retailers induces the manufacturer to increase its markup. This definition of countervailing buyer power is consistent with the approach of Galbraith (1952), and was already used by von Ungern-Sternberg (1996), Dobson and Waterson (1997), and Iozzi and Valletti (2014). It is also similar to that of Inderst and Wey (2011), who performed comparative statics when there are fewer but larger retailers. A countervailing buyer power effect exerts a downward pressure on retail prices which opposes the upward pressure arising from retailers' greater market power, and may induce pro-consumer effects.

The basic approach to understanding countervailing buyer power is thus to observe how the equilibrium input price, given by equation (7), is impacted as retail concentration changes.[31] However, some models have the perverse effect that the mass of potential consumers (the market size) changes with the number of

[30] Our focus is on symmetric equilibria *before* and *after* changes in retail market concentration. Whereas this corresponds well to models of entry or exit where firms remain symmetric, this does not match models in which mergers create asymmetric firms. We thus implicitly assume that bilateral mergers take place in a merger wave, such that retailers are always symmetric.

[31] The number of retailers active in the market can only be an integer. Below, however, we treat this variable as a continuous one. As we are primarily interested in the directions of the relevant effects, this approach is not problematic as long as local effects keep the same sign over the relevant range over which effects from the discrete change in n should be determined.

available varieties and thus make it difficult to disentangle countervailing buyer power effects from changes in market size.[32] As our focus is solely on countervailing buyer power effects, we make the assumption that the total market size is invariant in the number of retailers.

Assumption 2. *The total size of the market is independent of the number of varieties.*

This assumption is satisfied for a wide range of standard economic models. Note, however, that the approach developed in this paper could easily be modified in order to take into account such variations in market size.

Total-differentiating the first-order conditions given by equations (2) and (7) with respect to n gives the following equation system:

$$\begin{cases} \dfrac{dQ}{dn} = & \dfrac{1}{MR_Q}\left(\dfrac{dw}{dn} - QP_Q\theta_n\right) \\ \dfrac{dw}{dn} = & -\left(MR_Q + QMR_{QQ}\right)\dfrac{dQ}{dn} - Q\theta_n\left(P_Q + QP_{QQ}\right) \end{cases} \tag{10}$$

where $MR_{QQ} \equiv \partial^2 MR/\partial Q^2$ is the second-derivative of a firm's marginal revenue with respect to total market quantity, and $\theta_n \equiv \partial\theta/\partial n$.

The variable θ_n is new to the literature. It represents the change in "competition intensity" when competition increases (i.e., when the number of retailers, n, increases) and is negative. Indeed, when market size is invariant in the number of varieties (see Assumption 2) and total market quantity is kept constant, an increase in the number of retailers makes products more substitutable. This implies that competition is fiercer. Under Cournot competition, for instance, $\theta_n = -1/n^2$.

The variable θ_n may be better understood by defining the "elasticity of competition," $\varepsilon_{comp} \equiv -n\theta_n/\theta \geq 0$. This elasticity represents the percentage change in competition intensity, as measured by θ, in response to a one percent increase in the number of firms in the market, keeping total market quantity constant. It indicates how much an additional competitor would make the market more competitive. Under Cournot competition, for instance, this elasticity equals unity.

In what follows, we use this newly defined variable to analyse the countervailing buyer power effects, given by dw/dn, and then we turn to welfare effects,

[32] This is the case, for instance, in the model of linearly differentiated products *à la* Singh and Vives (1984) used by Dobson and Waterson (1997).

determined by dQ/dn.

4.1 Buyer Power Effects

Solving the equation system (10) for dw/dn gives:

$$\begin{aligned} \frac{dw}{dn} &= \frac{-Q^2\theta_n}{MR_Q - w_Q}\left(P_{QQ}MR_Q - P_Q MR_{QQ}\right), \\ &= \underbrace{\frac{-Q^2\left(MR_Q\right)^3\theta_n}{MR_Q - w_Q}}_{>0}\frac{d^2p}{dw^2}, \end{aligned} \tag{11}$$

where dp/dw is the pass-through of input prices to retail prices, which is strictly positive and equal to P_Q/MR_Q in equilibrium, and d^2p/dw^2 corresponds to its derivative with respect to the retailers' perceived marginal cost. Besides, second-order conditions at the retail and wholesale levels are equivalent to $MR_Q < 0$ and $MR_Q - w_Q = 2MR_Q + QMR_{QQ} < 0$, respectively, as shown in Appendix A.

The sign of dw/dn , which conditions whether there is a countervailing buyer power effect, is readily identified. Indeed, we have the following result.

Proposition 1. *When the manufacturer sets input prices and the conduct parameter is constant, there is a countervailing buyer power effect if and only if the retail market displays an increasing pass-through rate.*

Proof. Consider equation (11). We know that $\theta_n < 0$ following Assumption 2. The second-order conditions give $MR_Q < 0$ (Assumption 3), and $2MR_Q + QMR_{QQ} < 0$ (Assumption 4). Therefore, dw/dn and d^2p/dw^2 have the same sign. □

Proposition 1 identifies the slope of the retail pass-through rate, d^2p/dw^2, as the main determinant of countervailing buyer power effects.[33] A demand system with an increasing (respectively, decreasing) pass-through rate will (resp., will not) induce a countervailing buyer power effect. When the pass-through rate dp/dw is constant,[34] a change in the number of retailers has no impact on the input price set

[33]Note that d^2p/dw^2 can vary with quantity. Therefore, the necessary and sufficient condition stated in Proposition 1 is a *local* condition.

[34]Bulow and Pfleiderer (1983) identified the family of demand curves with a constant pass-through rate under monopoly.

by the manufacturer.

An increasing retail pass-through rate means that retailers are more responsive to a change in the input price at larger prices (or lower quantities). A decrease in the number of retailers induces a downward pressure on quantity because of increased market power. This raises the pass-through rate of input prices to retail prices whenever $d^2p/dw^2 > 0$, and therefore pushes market quantity further downwards. As a response, in equilibrium, the manufacturer lowers the input price to alleviate this output reduction effect. At larger pass-through rates, the manufacturer favours a reduced markup and a greater quantity. (The overall quantity impact is investigated below.) By contrast, when the retail pass-through is decreasing, a lower quantity implies a smaller pass-through rate and, thus, the manufacturer can raise the input price with limited effect on quantity.

The retail pass-through rate depends on both the demand form and the conduct parameter. It combines these two features of the demand system in such a way that only one variable – its derivative – is needed to evaluate whether there is a countervailing buyer power effect.[35] For instance, in a simple setting such as the Cournot case, a large set of demand forms leads to increasing pass-through rates (see Subsection 4.4 below). More generally, Fabinger and Weyl (2016) showed that the pass-through rate is typically increasing when demand aggregates individual unit demands with valuations drawn from unimodal distributions, such as the normal or logistic distributions, when the conduct parameter is constant.

While the derivative of the retail pass-through rate, d^2p/dw^2, determines whether a countervailing buyer power effect exists, its magnitude also depends on how competition intensity is impacted by greater retail concentration. For instance, when products are very differentiated and the exit of a retailer has little impact on competition intensity, countervailing buyer power effects will be mitigated. By contrast, when θ_n is relatively large (in absolute value), countervailing buyer power effects will be intensified, *ceteris paribus*.

[35] Chen and Schwartz (2015) also found the derivative of the pass-through rate to be of particular importance, albeit in a quite different context: that of welfare effects of third-degree price discrimination when costs differ between consumer groups.

4.2 Quantity and Welfare Effects

We now analyze the impact of retail concentration and (potential) countervailing buyer power on the equilibrium quantity. In many models the direction of this effect on quantity also corresponds to that of changes in welfare and consumer surplus. It is the case, for instance, when firms offer homogeneous products or when demand is derived from a representative consumer's utility.[36] By contrast, quantity effects are not indicators of welfare or consumer surplus effects in address models, where retailers' location matters and consumers face a disutility from not consuming their favorite variety.

Solving the equation system (10) for dQ/dn gives:

$$\frac{dQ}{dn} = \underbrace{\frac{-Q\theta_n}{MR_Q - w_Q}}_{<0} \left(2P_Q + QP_{QQ}\right) \ . \tag{12}$$

It is therefore the sign of the derivative of the marketwide marginal revenue (i.e., the derivative of $P + QP_Q$) which determines the direction of the quantity effects. When this marginal revenue slopes downwards, dQ/dn takes a positive sign. By contrast, it is negative when $2P_Q + QP_{QQ} > 0$. We can state this result as follows.

Proposition 2. *When the manufacturer sets input prices and the conduct parameter is constant, an increase in the number of retailers (weakly) raises total market quantity if and only if the marketwide marginal revenue is decreasing.*

Proof. Consider equation (12). We know that $\theta_n < 0$ following Assumption 2. The second-order conditions give $MR_Q < 0$ (Assumption 3), and $2MR_Q + QMR_{QQ} < 0$ (Assumption 4). Therefore, $dQ/dn > 0 \Leftrightarrow 2P_Q + QP_{QQ} < 0$. □

This result indicates that a marketwide (locally) *increasing* marginal revenue is a necessary and sufficient condition for countervailing buyer power effects to be passed-on to consumers in the form of lower retail prices. This condition is permitted by the second-order conditions, as long as the number of firms is large enough, and is satisfied only when the market demand is highly convex. When n is small, though, an increasing marketwide marginal revenue could jeopardize the existence of the equilibrium; this is readily verified in the case of a monopoly.

[36] For instance, when firms sell homogeneous products, a change in consumer surplus with respect to quantity is given by $-QP_Q$ and a change in welfare by $P - c$.

The standard setting where the marketwide marginal revenue slopes downwards would thus imply that greater retail concentration does not benefit consumers.[37] This is an important result, which contradicts what was one of Galbraith's main arguments in favour of his concept.

Note that we can also express the result of Proposition 2 with respect to the curvatures of the marketwide inverse demands faced by retailers and the manufacturer,[38] respectively given by $\sigma \equiv -QP_{QQ}/P_Q$ and $\xi \equiv -QMR_{QQ}/MR_Q$:

$$\frac{dQ}{dn} = \underbrace{\frac{-QP_Q\theta_n}{MR_Q}}_{>0} \frac{2-\sigma}{2-\xi} \, . \tag{13}$$

An increasing marketwide marginal revenue is equivalent $\sigma > 2$. Note that the second-order conditions imply $2 > \xi$, and that, from the definition of the retail pass-through, we have $d^2p/dw^2 > 0 \Leftrightarrow \sigma > \xi$. Therefore, when the retail pass-through is constant, the ratio $(2-\sigma)\,/\,(2-\xi)$ equals unity and lowering n always reduces market quantity. Moreover, an increasing pass-through, leading to countervailing buyer power effects, is a necessary condition to observe $dQ/dn < 0$, as seen from the first equation in the system (10).

4.3 Effects on Firms' Profits

The impact of retail concentration on firms' profits depends on the signs of dw/dn and dQ/dn evaluated above. Indeed, by total differentiating the manufacturer's profit, we find that $d\pi^M/dn = (w-c)\,dQ/dn + Qdw/dn$. By using equations (11) and (12) as well as the equilibrium input price given by $w - c = -QMR_Q$, we obtain $d\pi^M/dn = Q^2P_Q\theta_n > 0$. Hence, a rising number of retailers always has a positive impact on the manufacturer's profit, because of increased retail competition.

Similarly, the effect of an increase in n on retailers' joint profits is given by $\Big(P + QP_Q - w\Big)\,dQ/dn - Qdw/dn$. As $P + QP_Q - w \leq 0$ from the second-stage first-order condition, these effects are readily identified when dQ/dn and dw/dn are both

[37] Discussing the book by Galbraith (1952), Morris A. Adelman stated that "[t]he disagreement is not over the possibility [that countervailing buyer power lowers retail prices], but over its generality and its importance." See the discussion by Wright, Kottke and Adelman (1954).

[38] Formally, these curvatures correspond to the elasticities of the slopes of the inverse demands faced by retailers and the manufacturer, respectively.

positive. This is the case when there is a buyer power effect ($dw/dn > 0$) which does not translate into pro-consumer effects ($dQ/dn > 0$): an increased concentration will lower the input price while increasing the retail price and reducing output. In that case, retailers gain both as buyers of an input and sellers of a final good. In general, however, the direction of changes in retailers' profit after variation in market concentration depends on the demand system.[39]

Finally, the effect of an increase in the number of retailers on industry profits is given by $\left(P + QP_Q - c\right) dQ/dn$. However, by reorganizing the equilibrium given by equation (9) we observe that $P + QP_Q - c = -Q\theta\left(2P_Q + QP_{QQ}\right)$. Using this result as well as equation (12) allows us to state that changes in industry profits always follow the direction of shifts in the number of retailers. We can express these results as follows.

Proposition 3. *When the manufacturer sets input prices and the conduct parameter is constant, an increase in the number of retailers raises the manufacturer's profit as well as industry profits. The effects on retailers' joint profits can be positive or negative.*

Proof. Omitted. □

4.4 An Example: Cournot Competition

As an example, consider the case of homogeneous Cournot competition as analysed by Tyagi (1999). (We review other examples in Section 5 below.) In this case, retailers set quantities, and θ equals $1/n$.

From Proposition 1, a greater retail concentration would reduce the price of the input if and only if $d^2p/dw^2 > 0$. In the Cournot setting, the retail pass-through rate is given by $dp/dw = 1/\left[1 + 1/n\left(1 - \sigma\right)\right]$. Therefore, an increasing pass-through is equivalent to a decreasing curvature in quantity, i.e., $\sigma_Q \equiv \partial\sigma/\partial Q < 0$. This condition is also equivalent to the curvature at the retail level being larger than that at the wholesale level, that is $\sigma > \xi$. Regarding welfare effects, Proposition 2 applies directly: retailers' mergers or exit raise welfare if and only if the marketwide marginal revenue curve slopes up.

[39] In a setting with exclusive territories where retailers compete *à la* Cournot and demand is linear, Naylor (2002) showed that retailers' profit increases in n when $n \leq 3$, and decreases otherwise.

5 Negotiated Input Prices and Countervailing Power

We now extend our results to the general case where the manufacturer engages in bilateral negotiations with retailers, that is, $\beta \in (0, 1]$. In this section, we first derive some general results and then we provide deeper insights for selected standard models. Note that we do not discuss the effects of retail concentration on firms' profits as they are generally inconclusive when $\beta \neq 1$.

Implicitly differentiating equations (2) and (7) with respect to the number of retailers, we obtain:

$$\begin{cases} \dfrac{dQ}{dn} = & \dfrac{1}{MR_Q}\left(\dfrac{dw}{dn} - QP_Q\theta_n\right) \\ \dfrac{dw}{dn} = & \dfrac{dQ}{dn}w_Q + w_n \end{cases} \tag{14}$$

with the partial derivatives $w_Q \equiv \partial w/\partial Q$ and $w_n \equiv \partial w/\partial n$ computed from equation (7), and with $\theta_n < 0$ and $MR_Q < 0$ from Assumption 2 and the retail second-order conditions, respectively. As above, the first equation of this system implies that countervailing buyer power is a necessary condition for greater retail concentration to raise the equilibrium market quantity.

Solving this equation system gives:

$$\begin{cases} \dfrac{dQ}{dn} = & \dfrac{1}{MR_Q - w_Q}\left(w_n - QP_Q\theta_n\right) \\ \dfrac{dw}{dn} = & \dfrac{1}{MR_Q - w_Q}\left(MR_Q w_n - QP_Q w_Q\theta_n\right) \end{cases} \tag{15}$$

with $MR_Q - w_Q < 0$ from the wholesale second-order conditions.

First, this implies that $w_n > 0$ also is a necessary condition to observe $dQ/dn < 0$.[40] Also, this shows that an increase in the number of retailers would lower the input price if both w_n and w_Q are negative. By contrast, when $w_n > 0$ and $w_Q > 0$, an increase in n would induce a countervailing buyer power effect as it would raise w. Finally, this general approach is not conclusive when the two partial derivatives of the input price have opposite signs.

[40] Whether $w_n > 0$ implies $dw/dn > 0$ or whether the reverse holds depends on the sign of w_Q, as can be seen from the equation system (14).

5.1 Buyer Power Effects

We can now emphasize the role of the retail pass-through by defining:

$$\Psi(Q) \equiv \frac{\beta n \theta}{\beta n \theta + (1-\beta)\Delta}, \tag{16}$$

where Δ is given by equation (8).

This variable, which is positive, allows equation (7) to be simply expressed as $w - c = -Q\Psi MR_Q$.[41] Note that, when the manufacturer sets input price (i.e., when $\beta = 1$), we have $\Psi = 1$. Defining $\Psi_Q \equiv \partial\Psi/\partial Q$ and $\Psi_n \equiv \partial\Psi/\partial n$, we can then rewrite the second equation from system (15). We obtain the following result.

Proposition 4. *Countervailing buyer power effects are determined by:*

$$\frac{dw}{dn} = \underbrace{\frac{-Q^2\left(MR_Q\right)^3\theta_n}{MR_Q - w_Q}}_{>0}\left(\frac{d^2p}{dw^2}\Psi - \frac{dp}{dw}\frac{\Psi_Q}{MR_Q} + \frac{\Psi_n}{QMR_Q\theta_n}\right). \tag{17}$$

Proof. Omitted. □

This equation generalizes and nests equation (11) and shows that countervailing buyer power relies on the retail pass-through rate and its derivative. When Ψ is a constant, the results from Proposition 1 hold in the general setting. Otherwise, one needs to account for the effects of the derivatives of Ψ with respect to Q and n when determining the direction and magnitude of the impact of retail concentration on the input price. These effects are determined by the modelling assumptions (see the examples below), and, when both derivatives are negative, the condition on the slope of the retail pass-through rate to observe buyer power effects is more restrictive than when the manufacturer makes take-it-or-leave-it offers, *ceteris paribus*.

The intuition is that the manufacturer's incentive to lower the price of the input in order to alleviate the intense drop in output that occurs when $d^2p/dw^2 > 0$ is mitigated by the relative decrease in its own markup this would induce when Ψ_Q is negative. Besides, its profit is less affected by the downward pressure on output

[41] This also implies that $MR_Q - w_Q = \left(1 + \Psi + Q\Psi_Q\right)MR_Q + Q\Psi MR_{QQ}$, which is negative according to Assumption 4. In addition, we see that $\Psi < 1 \Leftrightarrow \Delta > 0$.

due to higher retail market power when $\Psi_n < 0$ as the direct effect of retail mergers is to increase its markup.

Consider for instance the case of Cournot competition under symmetric bargaining power (see Appendix C). In this case, $\beta = 1/2$, both d^2p/dw^2 and Ψ_Q have opposite signs, and Ψ_n is negative. This implies that an increasing pass-through rate is not a sufficient condition for observing countervailing buyer power effects, in contrast to the case where input prices are posted by the manufacturer. As a result, it is more difficult to observe countervailing buyer power effects when prices are negotiated than when the manufacturer makes take-it-or-leave-it offers.

5.2 Quantity and Welfare Effects

Similarly, solving equation system (15) for dQ/dn, we obtain the following result.

Proposition 5. *Quantity effects from a change in retail concentration are determined by:*

$$\frac{dQ}{dn} = \underbrace{\frac{-Q\theta_n}{MR_Q - w_Q}}_{<0}\left[(1+\Psi)P_Q + Q\Psi P_{QQ} + \frac{\Psi_n MR_Q}{\theta_n}\right]. \tag{18}$$

Proof. Omitted. □

This result generalizes that given by equation (12) above. It shows that the *adjusted* slope of the marketwide marginal revenue, $(1+\Psi)P_Q + Q\Psi P_{QQ}$, plays a crucial role for determining quantity and welfare effects. Besides, the derivative Ψ_n also impacts quantity effects, and, when it is negative, makes it less likely for countervailing buyer power to have pro-consumer implications.

Intuitively, when the bargaining power mainly lies with retailers the input price is constant and $dQ/dn > 0$. Indeed, when β is close to zero the function Ψ tends towards zero as well, and, therefore, dQ/dn has the sign of $\theta_n P_Q$, which is always positive. In addition, a countervailing buyer power effect is a necessary (but not a sufficient) condition for pro-consumer effects to arise, because such effects only appear when retailers face a drop in their perceived marginal cost that they transmit to consumers.

Pro-consumers effects arise from retail mergers and countervailing buyer power when dQ/dn is negative. However, this condition is generally more difficult to obtain when input prices are negotiated than when $\beta = 1$. In the standard case where

$\Psi \in [0, 1]$, the adjusted slope of the marketwide marginal revenue is smaller than the non-adjusted one given by $2P_Q + QP_{QQ}$, when the latter is positive. Moreover, when Ψ_n is negative (as, e.g., in the Cournot setting), the adjusted slope of the marketwide marginal revenue also needs to be large enough to compensate for the effect on quantity from the negative term $\Psi_n MR_Q/\theta_n$. The conditions for pro-consumer effects from retail mergers are thus typically more restrictive when β decreases.

5.3 Some Examples

We now apply our findings to specific demand systems, starting with the standard case of a linear demand system. All examples are detailed in Appendix C.

When the demand system modelling the retail market is linear, the conduct parameter, the retail pass-through rate, and the variable Ψ are invariant in firms' strategic variables. This implies, following equation (17), that the existence of countervailing buyer power effects solely depends on the sign of Ψ_n. As it is always negative (or null, when $\beta = 1$), the wholesale price always (weakly) increases with greater retail concentration. This also implies that market quantity is always reduced after retail mergers.

When retailers compete in a framework with constant-elasticity of substitution (CES), the results are very similar to that under linear demand systems. Indeed, the conduct parameter, the retail pass-through rate, and Ψ are invariant in price in this setting, while Ψ_n is negative for any $\beta < 1$.[42] Therefore, an increase in market concentration never results in countervailing buyer power or pro-consumer effects.

By contrast, under Cournot competition the retail pass-through rate and Ψ need not be independent of the equilibrium quantity. Both d^2p/dw^2 and Ψ_Q have opposite signs. Besides, we always have $\Psi_n < 0$. Therefore, when the retail pass-through rate is constant, as for the demand forms identified by Bulow and Pfleiderer (1983), all results follow that of the two other examples above. However, countervailing buyer power effects arise when the retail pass-through rate is increasing enough.

[42] Second-order conditions restrict the analysis to $\beta \in (0, 1)$ under a CES demand system.

6 Discussion

We now discuss our main modelling hypotheses.

6.1 Contractual agreements

The market distortions analysed in this paper rely on vertical contracts being sub-optimal in that they do not allow for joint profit maximization. In equilibrium, a double-marginalization problem will arise. How the double-markup would vary with market concentration generates our results.

6.1.1 Distortive vs. Efficient Contracts

In general, the type of contracts one should model depends on the specific market and firms' practice. As detailed in the Introduction, linear wholesale agreements are common in many markets. For instance, Grennan (2013, 2014) observed that prices for medical devices that manufacturers and hospitals bargain on are typically linear. Often, the empirical literature uses this type of agreements, either because linear input prices are actually observed, or because they provide a good approximation of reality (see, e.g., the papers by Crawford and Yurukoglu (2012), Ho and Lee (2017), and Draganska, Klapper and Villas-Boas (2010)).

In some markets however, firms use optimal, non-linear contracts which may allow them to maximize joint profits. In this case, focusing on the input price is restrictive because other transfers between firms take place (e.g., fixed fees). However, whereas linear contracts may sometimes be too simple to accurately represent actual market conduct it is worth emphasizing that optimal contracts correspond to an extreme case scenario as well and lead to strong predictions.

Our analysis of countervailing buyer power cannot be reproduced under optimal contracts because it relies on inefficiencies due to double-marginalization. However, when bilateral contracts are efficient, an important question is that of division of profits between firms. This was one of the main concern of early critics of the concept of countervailing power, who were challenging the fact that consumers would benefit from buyer power but instead that it would result in a different partition of surplus between manufacturers and retailers.[43]

[43] As put by Stigler (1954): "why bilateral oligopoly should in general eliminate, and not merely redistribute, monopoly gains"?

Finally, our analysis could also be performed under different, sub-optimal types of contracts. Under revenue-sharing contracts, for instance, retailers leave a share of their revenues to manufacturers, while paying a positive, per-unit input price. Whether determinants of countervailing buyer power remain exactly the same across contract types remains an open question for future work.

6.1.2 Interim Observability

In our analysis, there is interim observability: input prices are observable by all retailers before they compete.[44] Instead, if contracts remained private until retail competition takes place, the manufacturer could have the incentive to engage in an opportunistic behaviour (see, e.g., the papers by Hart and Tirole (1990), O'Brien and Shaffer (1992), and McAfee and Schwartz (1994)).[45] Because of this opportunism problem, the manufacturer would not be able to fully exert its market power.

Whereas fully private contracts are sometimes closer to what is observed in real markets, interim observability is commonly used in the literature on vertical relations, and helps to circumvent issues related to the opportunism problem. This is especially true, for instance, in the literature on input price discrimination; see, e.g., the work of DeGraba (1990), or, more recently, of Inderst and Valletti (2009). Moreover, in markets where a limited number of firms interact regularly and repeatedly, such as retailing markets, it seems likely that retailers have a precise idea of the wholesale prices paid by their competitors. Finally, the Robinson-Patman Act of 1936 prohibits anticompetitive input price discrimination in the U.S., thereby allowing retailers to gain some information about their competitors' supply.

6.2 Disagreement Payoffs

When the manufacturer possesses all bargaining power and offers take-it-or-leave-it contracts, disagreement payoffs do not matter to the equilibrium analysis. Therefore, all results from Section 4 above, where $\beta = 1$, are entirely robust to different

[44] Note that interim observability does not imply breakdown observability. Indeed, a contract relies on (i) an offer and (ii) an acceptance decision, and interim observability relates to the former, whereas breakdown observability relates to the latter. In our setting, interim observability takes place before retailers order their inputs.

[45] Under linear contracts, interim observability prevents any opportunistic behaviour and leads to the same outcome as public contracts; see the related work by Gaudin (2016).

specifications of the disagreement payoffs.

In general, however, disagreement payoffs play a crucial role when deriving the Nash-bargaining solution of the game. We set the disagreement payoff of a retailer to zero in case its negotiation with the monopolist manufacturer breaks down. This seems a natural first step hypothesis, which could be relaxed by considering, e.g., upstream fringe competitors. In addition, our specification of the manufacturer's disagreement payoff relies on three assumptions mentioned in Section 3. First, after a successful bargain over the price of their own input, retailers commit to ordering a given quantity of inputs based on (i) the input prices negotiated by their competitors (interim observability), and (ii) their beliefs about their competitors' potential negotiation breakdowns. Second, breakdown observability (if any) takes place after this commitment. Third, bargained prices cannot be renegotiated without the failing pair.

Altogether, these assumptions allow for a unified, tractable, and general model. Without them, the only case which is tractable under a general demand system is that of quantity competition under unobservable breakdowns, as in the model of Horn and Wolinsky (1988). Indeed, without these assumptions the (out-of-equilibrium) quantities entering the manufacturer's disagreement payoff would differ from that in equilibrium, when breakdowns are observable and/or firms compete in prices, and, therefore, one would need to specify a demand system in order to solve the model.

The first assumption mentioned above (in particular, point (ii)) is necessary to keep constant the manufacturer's sales to a given retailer in case another retailer's negotiation fails. If it were not satisfied, retailers would equate the quantity they purchase to that they would like to sell to consumers. Hence, these quantities would be different in and out of the equilibrium, when breakdowns are observable and/or firms compete in prices, as shown by Iozzi and Valletti (2014).[46] As argued above, however, it is common for retail firms to order some specific quantity of input, after contracting and before competing. This is generally true, for instance, in physical good markets, where a precise quantity of inputs needs to be delivered to the retailers' facilities.

The second assumption only plays a role when breakdowns are observable. It ensures that observability does not impede on the quantity purchased by retailers.

[46]This assumption relates to the work of Kreps and Scheinkman (1983), who showed that price competition after capacity commitments is tantamount to quantity competition.

This is often satisfied, as a retailer typically gains information about its competitors' negotiation success or failure by observing their product shelves or catalogues, only once all retailers (including itself) have been supplied.

These two assumptions drive the behaviour of retailers when *a competitor's* negotiation failed. The third one, however, explains what a given bargaining pair believes when *its own* negotiation breaks down. Assuming no contract renegotiation without a failing pair – that is, that firms cannot bargain over the input price conditional on one retailer being left out of the market – ensures tractability of the model.[47] Ultimately, whether the model should allow for renegotiation relies on the bargaining game of which the Nash-solution is a reduced form.[48] However, in bilateral negotiations with a limited number of firms, it seems unlikely that the manufacturer and a retailer would permanently separate following a breakdown, and remain separated even when other retailers (re)negotiate.

7 Extensions

We now extend the model and demonstrate the robustness of our results.

7.1 Variable Conduct Parameter

The analysis above can be extended to the case where the conduct parameter of the demand system varies with quantity (or price), that is, when Assumption 1 is not satisfied. This is the case, for instance, in the logit model. In a symmetric equilibrium the conduct parameter takes a scalar, the total market quantity, Q, as an argument, and we assume it is twice continuously differentiable. We denote by $\theta_Q \equiv \partial\theta(Q)/\partial Q$ the impact of total market quantity on competition intensity.[49]

The conduct parameter appears in the formula for retailers' marginal revenue, and, therefore, θ_Q is a component of derivatives of marginal revenue. For instance,

[47] Note also that negotiations take place simultaneously, so that the manufacturer could not respond, in a given bilateral negotiation, to the breakdown of a different negotiation.

[48] For instance, Stole and Zwiebel (1996) developed a model of firm-workers wage bargaining with renegotiations. In their paper, a given worker permanently parts from the firm after a breakdown, allowing the firm to renegotiate solely with the remaining workers.

[49] The derivative of the conduct parameter with respect to total quantity is generally null or negative, because a large equilibrium quantity implies that competition is fierce and, therefore, that the conduct parameter is small. See the discussion by Weyl and Fabinger (2013), pp. 548-551. The logit model has a decreasing conduct parameter in quantity: $\theta = (n - nQ) / (n - Q)$, with $Q < 1$.

we now have $MR_Q = \left(1 + \theta + Q\theta_Q\right) P_Q + Q\theta P_{QQ}$. Apart from this new definition of MR_Q the equilibrium results given by equations (7) and (9) do not change.

A similar analysis as above shows that buyer power effects are now given by:

$$\frac{dw}{dn} = \frac{-Q^2 \left(MR_Q\right)^3 \theta_n}{MR_Q - w_Q} \left[\frac{d^2p}{dw^2} \Psi - \frac{dp}{dw} \left(\frac{\Psi_Q}{MR_Q} - \frac{\Psi \theta_{Qn}}{MR_Q \theta_n} \right) + \frac{\Psi_n}{QMR_Q \theta_n} \right], \tag{19}$$

where $\theta_{Qn} \equiv \partial \left(\partial\theta/\partial Q\right)/\partial n$.

This result generalizes that given by equation (17). The variable θ_{Qn} represents the change in the rate at which competition intensifies in quantity when n increases. Its impact is more easily addressed when $\beta = 1$ (and, thus, $\Psi = 1$). In this case, when $\theta_{Qn} < 0$, as, for instance, in the case of a logit demand system when the equilibrium quantity is not too large,[50] there is a countervailing power effect if and only if $d^2p/dw^2 > -\left(dp/dw\, \theta_{Qn}\right) / \left(MR_Q \theta_n\right)$. Everything else being equal, it is thus more complicated to observe a countervailing buyer power effect than when the conduct parameter is constant in quantity. The intuition is that the boost in market competitiveness as Q increases is tempered when the number of retailers is reduced, which scales down the transition from a lower w to a larger Q. By contrast, when $\theta_{Qn} > 0$, it is more likely to observe countervailing buyer power effects from an increase in retail concentration.

Similarly, quantity effects are now given by:

$$\frac{dQ}{dn} = \frac{-Q\theta_n}{MR_Q - w_Q} \left[\left(1 + \Psi\right) P_Q + Q\Psi P_{QQ} + \frac{1}{\theta_n} \left(\Psi_n MR_Q + Q\Psi P_Q \theta_{Qn} \right) \right]. \tag{20}$$

This result generalizes equation (18). When $\theta_{Qn} < 0$, the adjusted slope of the marketwide demand needs to be larger than when $\theta_Q = 0$ in order to induce pro-consumer effects following an increase in retail concentration. This makes pro-consumer effects less likely to occur, due to the second-order conditions which limit the level of demand convexity. By contrast, when the partial derivative of θ_Q increases in the number of retailers, pro-consumer effects of a drop in the number of retailers are more likely to occur than when Assumption 1 holds and θ is constant.

[50] In the logit demand system $\theta_{Qn} < 0$ when $Q < 1/\left(2 - 1/n\right)$.

7.2 Upstream Competition

We now study the robustness of our main results to upstream oligopolistic competition. In what follows, we derive the symmetric equilibrium of a model of interlocking relationships over linear input prices which allows for either price or quantity competition between retailers selling potentially differentiated products.

There are $m \geq 1$ upstream manufacturers bilaterally contracting with the n retailers. Demands for the nm product combinations are symmetric. We study the symmetric equilibrium, where each retailer carries the products from all manufacturers. Retailers are thus multi-product firms selling substitute products. We denote by q_{ik} the quantity of products from manufacturer k sold by retailer i. Similarly, the retail and wholesale prices for the product of this particular retailer-manufacturer combination are given by p_{ik} (or $P_{ik}(q_{ik}, \mathbf{q_{-ik}})$ when retailers set quantities) and w_{ik}, respectively. For clarity of exposition and tractability, we focus on the case where manufacturers simultaneously make take-it-or-leave-it offers to retailers.

7.2.1 The Equilibrium

In the last stage of the game, retailers take all input prices as given and simultaneously set their strategic variables. When retailers set quantities, retailer i seeks to maximize its profit given by $\pi_i^R = \sum_k^m (P_{ik} - w_{ik}) q_{ik}$, and its first-order conditions give:[51]

$$P_{ik} + \sum_r^m q_{ir} \frac{\partial P_{ir}}{\partial q_{ik}} = w_{ik} \ , \forall k \in \{1, ..., m\} \ . \tag{21}$$

Alternatively, when retailers compete in prices, retailer i's profit is given by $\pi_i^R = \sum_k^m (p_{ik} - w_{ik}) q_{ik}$, and we obtain:

$$p_{ik} + \frac{q_{ik} + \sum_{r \neq k}^m (p_{ir} - w_{ir}) (\partial q_{ir} / \partial p_{ik})}{\partial q_{ik} / \partial p_{ik}} = w_{ik} \ , \forall k \in \{1, ..., m\} \ . \tag{21'}$$

By carefully computing the marketwide derivatives, we can express the second-stage symmetric equilibrium as $MR = w$, where $w_{ik} = w$, $\forall i, k$, as in equation (2). In this case, we have $MR = P + Q\theta P'$, where Q equals the total market

[51] We omit arguments for clarity of exposition.

quantity, $P(Q)$ is the inverse marketwide demand evaluated at this quantity in a symmetric equilibrium, and where the retail conduct parameter, θ, is now given by $\left(\sum_{r}^{m} \partial P_{ir}/\partial q_{ik}\right) / \left(\sum_{j}^{n}\sum_{r}^{m} \partial P_{jr}/\partial q_{ik}\right)$ when retailers compete in quantities, and by $\left(\sum_{j}^{n}\sum_{r}^{m} \partial q_{jr}/\partial p_{ik}\right) / \left(\sum_{r}^{m} \partial q_{ir}/\partial p_{ik}\right)$ when they compete in prices. As above, we assume that this conduct parameter is invariant in quantity, for simplicity of exposition. This is satisfied, for instance, under a linear demand system.

The associated second-order conditions are detailed in Appendix A, and imply that the marketwide marginal revenue decreases in market quantity: $MR_Q < 0$. Differentiating equations (21) and (21′) with respect to input prices, we obtain the various pass-through rates of input prices to retail prices and quantities. The effect of a symmetric, marginal increase in all input prices on the total market quantity is then given by $\sum_{s}^{n}\sum_{r}^{m}\sum_{i}^{n}\sum_{k}^{m} \partial q_{ik}/\partial w_{sr}$, and equals $1/MR_Q$ in a symmetric equilibrium.

In the first stage of the game, upstream manufacturers simultaneously set their markups. Manufacturer k's profit equals $\pi_k^M = \sum_{i}^{n} (w_{ik} - c)\, q_{ik}$. The first-order conditions of manufacturer k are given by:

$$w_{ik} + \frac{q_{ik} + \sum_{j\neq i}^{n} \left(w_{jk} - c\right)\left(\partial q_{jk}/\partial w_{ik}\right)}{\partial q_{ik}/\partial w_{ik}} = c \ , \forall i \in \{1, ..., n\} \ . \tag{22}$$

Aggregating over all firms, we can define the symmetric equilibrium by the following equation:

$$MR + Q\Theta MR_Q = c \ , \tag{23}$$

where Θ is the upstream conduct parameter which represents the intensity of competition between upstream manufacturers. It is given by:

$$\Theta \equiv \frac{\sum_{j}^{n}\sum_{r}^{m} \partial q_{jr}/\partial w_{ik}}{\sum_{j}^{n} \partial q_{jk}/\partial w_{ik}} \ . \tag{24}$$

As with the retail conduct parameter, a small (respectively, large) Θ implies that competition between upstream manufacturers is fierce (resp., mild). The retail second-order conditions imply that $\Theta > 0$. Also, $\Theta = 1$ when there is a single

manufacturer. Whereas Θ typically lies in the $[0, 1]$ interval, this upstream conduct parameter could also be larger than unity, even though retail products are gross substitutes. This is the case, for instance, when retail competition is in quantity and retailers' instruments are all strategic complements. In what follows we assume that $\partial\Theta/\partial Q = 0$, for simplicity of exposition. (This assumption is satisfied for, e.g., linear demand systems.)

The wholesale markup is given by $w - c = -Q\Theta MR_Q$ in the symmetric equilibrium. Finally, the associated second-order conditions, detailed in Appendix A, imply that $MR_Q - w_Q$ is negative.

7.2.2 Buyer Power and Quantity Effects

We can now analyse the effects of market concentration at the retail level. As in the case with single-product retailers, we assume that $\theta_n \equiv \partial\theta/\partial n < 0$, which means that competition intensity at the retail level increases in the number of retailers, *ceteris paribus*. We have, however, no prior on the sign of $\Theta_n \equiv \partial\Theta/\partial n$, that is, on the direction of the effect of retail concentration on the upstream intensity of competition.

Performing the same exercise as in Section 4, we find that the equilibrium input price reacts to changes in retail concentration as follows:

$$\frac{dw}{dn} = \frac{-Q^2\left(MR_Q\right)^3\theta_n}{MR_Q - w_Q}\left(\frac{d^2p}{dw^2}\Theta + \frac{\Theta_n}{QMR_Q\theta_n}\right). \tag{25}$$

As before, the slope of the pass-through rate of input prices to retail prices is the main determinant of countervailing buyer power effects. However, a new term appears and countervailing buyer power effects arise for a larger set of demand systems when $\Theta_n > 0$, that is, when the intensity of competition at the wholesale level decreases in the number of retailers. Indeed, this implies that upstream manufacturers compete more fiercely after a reduction in retail concentration, and, thus, puts a downward pressure on input prices.[52] By contrast, when $\Theta_n < 0$ this effect is reversed and countervailing buyer power is more difficult to obtain.

Our analysis of quantity effects is also robust to introducing upstream competition. Indeed, we find that the impact of retail concentration on total market

[52]For instance, in the simple case of retail price competition under a linear demand system where the diversion ratio is the same between any two products, we obtain $\Theta_n > 0$.

quantity is given by:

$$\frac{dQ}{dn} = \frac{-Q\theta_n}{MR_Q - w_Q}\left[(1+\Theta)P_Q + Q\Theta P_{QQ} + \frac{\Theta_n MR_Q}{\theta_n}\right]. \tag{26}$$

There are two main differences compared to the case with a single manufacturer. First, quantity effects depends on the slope of $P + Q\Theta P'$, which is the marketwide marginal revenue adjusted for upstream competition, instead of the slope of $P + QP'$. This implies that quantity effects now depends on the intensity of upstream competition: when $\Theta < 1$ (respectively, $\Theta > 1$), it is more difficult (resp., easier) to find demand systems for which $(1+\Theta)P_Q + Q\Theta P_{QQ} > 0$ than the previous condition (i.e., $2P_Q + QP_{QQ} > 0$), and, thus, more difficult (resp., easier) to observe pro-consumer effects following an increase in retail concentration. Second, a more concentrated retail market is more likely to expand market quantity when the intensity of upstream competition decreases in the number of retailers (i.e., when $\Theta_n > 0$), as retail concentration puts a downward pressure on input prices, *ceteris paribus*.

7.2.3 Upstream Concentration

Our model also allows us to study the impact of changes in the upstream market structure. Several authors have already addressed this topic in various settings. For instance, Horn and Wolinsky (1988) studied mergers between manufacturers which would otherwise engage in exclusive bilateral relationships with retailers. Antelo and Bru (2006) analysed coalitions between upstream firms which contract with retailers over non-linear agreements. Finally, Cho (2014) and Gosh, Morita and Wang (2014) investigated the effects of mergers or entry in a two-tier Cournot oligopoly with a decentralized upstream marketplace.

In order to study the effects of a change in the number of upstream firms, m, on our equilibrium, we need to consider how this would impact both conduct parameters. It is natural to assume that the upstream conduct parameter, Θ, decreases in m, as a greater number of upstream manufacturers makes upstream competition more intense, *ceteris paribus*. In addition, there is no reason for the intensity of competition between retailers to depend on m, because retailers take upstream firms' offers as given in our model. Thus, we assume that $\partial\theta/\partial m = 0$. Note that both assumptions are satisfied, for instance, for linear demand systems.

Differentiating the equilibrium input price and market quantity with respect to the number of upstream manufacturers, we find that the second-order conditions always guarantee that the intuitive results $dw/dm < 0$ and $dQ/dm > 0$ hold. That is, a reduction in the number of manufacturers always increases the equilibrium input price, and decreases market quantity, *ceteris paribus*.

7.3 Exogenous Changes in Bargaining Power

A variant approach to countervailing buyer power than the one we took in this paper is to study what happens when the number of retailers remains constant but the bargaining power β varies. This approach was supported by Chen (2003) and Christou and Papadopoulos (2015) in a model where a dominant retailer faces fringe competitors.[53] Our model developed in Section 3 allows us to investigate this question when the downstream market is oligopolistic.

By total-differentiating equations (7) and (9) with respect to β and solving the resulting system, we obtain:

$$\frac{dw}{d\beta} = \frac{-Q\left(MR_Q\right)^2 \Psi_\beta}{MR_Q - w_Q} \,, \tag{27}$$

and:

$$\frac{dQ}{d\beta} = \frac{-QMR_Q \Psi_\beta}{MR_Q - w_Q} \,, \tag{28}$$

with the partial derivative of Ψ with respect to the bargaining power parameter:

$$\Psi_\beta \equiv \frac{\partial \Psi}{\partial \beta} = \frac{n\theta\Delta}{\left[\beta n\theta + (1-\beta)\Delta\right]^2} \,. \tag{29}$$

As MR_Q and $MR_Q - w_Q$ are negative from the second-order conditions, $dw/d\beta$ simply takes the sign of Ψ_β whereas $dQ/d\beta$ takes the opposite sign. From equation (29), we see that it is therefore the sign of Δ which determines the effects of a change in bargaining power on the input and retail prices. We can thus express the following result.

[53] In their model, firms contract over two-part tariffs. Also, Dobson and Waterson (2007) studied local changes in bargaining power in a model with two retailers, two manufacturers, and interlocking relationships over linear tariffs.

Proposition 6. *When $\Psi < 1$, the input price increases in the manufacturer's bargaining power, and the market quantity decreases in the manufacturer's bargaining power. Both results are reversed when $\Psi > 1$.*

Proof. Comparing equations (16) and (29), we see that Ψ_β is positive if and only if $\Psi < 1$, and negative otherwise. We also have $\Psi_\beta = 0$ when $\Psi = 1$. □

In order to understand the intuition behind the results of Proposition 6, recall first that $\Delta > 0 \Leftrightarrow \Psi < 1$. In the standard case where $\Delta > 0$, retailers benefiting from a greater bargaining power would pull input prices downwards and increase total market quantity. However, equations (7) and (8) indicate that Δ need not be positive. For instance, we have $\Delta < 0$ under Cournot competition when the market demand is extremely convex, such that $2n < (2 - 1/n)\sigma$, where $\sigma \equiv -QP_{QQ}/P_Q$ is the curvature of the marketwide inverse demand.[54] In this case, greater bargaining power for the retailers would raise the price they pay to the manufacturer, as well as the retail price to consumers because the number of retailers remains constant in this setting. This unexpected result is explained by the fact that retailers would actually benefit from an increase in their marginal cost in such setting. This relates to the work of Seade (1985), who showed in a model of conjectural variations that firms' profits increase in their marginal cost when the marketwide marginal revenue slopes upwards.[55]

We can compare this result to that of Christou and Papadopoulos (2015) who found that, under a linear demand, an increase in a dominant retailer's bargaining power has no impact on the retail price. Proposition 6 shows that this invariance result does not hold when the retail market is oligopolistic, because a linear demand system gives $\Psi < 1$, for any $\beta < 1$. In this case, the retail price decreases in retailers' bargaining power (i.e., when β decreases).

8 Conclusion

In this paper, we introduced a flexible model of vertical negotiations over a linear input price using the Nash-bargaining solution which allows for general demand

[54] The retail second-order conditions give $n + 1 > \sigma$ in this case.

[55] In his single-tier model, however, quantities always decrease when cost rises. See also the analysis of Anderson, de Palma and Kreider (2001) for similar results under price competition and differentiated products.

systems, when downstream firms compete at the retail level. This presents theoretical support to the empirical literature which uses the Nash-bargaining solution to address economic issues in, e.g., the cable TV industry, retailing, or health care markets.

We then used this model to determine the drivers of countervailing buyer power which can arise following an increase in market concentration at the retail level. We showed that the slope of the pass-through rate of input prices to retail prices is the main determinant of countervailing buyer power effects. Besides, the impact of entry on market competitiveness – as measured by the conduct parameter – influences the magnitude of these effects. At the retail level, countervailing buyer power effects are passed-on to consumers in the form of lower prices only when the market demand is highly convex.

Our results are robust to the case where the manufacturer makes take-it-or-leave-it offers to retailers or when input prices are negotiated. A greater bargaining power for retailers typically makes the requirement on the slope of the pass-through rate more restrictive, thus making it more difficult to observe countervailing buyer power effects, and, therefore, pro-consumer effects. Our results are also robust to a large set of demand systems, including the logit demand system, and to introducing competition at the upstream level.

Appendices

A Second-Order Conditions

A.1 Retail Competition

The first-order condition which defines the symmetric retail equilibrium is given by $MR = w$ as in equation (2). The corresponding second-order conditions (SOC) are given by the following assumption.

Assumption 3 (Retail SOC)**.** *The following inequalities hold:*

- $\partial^2 \pi_i^R / \partial x_i^2 < 0$, $\forall i$, *with* $x_i \in \{q_i, p_i\}$, *whether retailers compete in quantity or price;*
- $\partial^2 \pi_i^R / \partial x_i^2 + \sum_{k \neq i} \left| \partial^2 \pi_i^R / \partial x_k \partial x_i \right| < 0$, $\forall i$, *with* $x_i \in \{q_i, p_i\}$, *whether retailers compete in*

quantity or price.

Following Vives (2001), the first point, together with the fact that $P_Q(\cdot)$ is decreasing, ensures the existence of the retail equilibrium. The second point implies that a retailer's marginal revenue decreases in total market quantity at the symmetric equilibrium: $MR_Q(Q) < 0$, $\forall Q$ such that $MR(Q) > 0$. It also implies that $MR_x < MR_Q < 0$, with $MR_x \in \{MR_q, MR_p\}$ at the symmetric equilibrium. This means that the marketwide demand should not be too convex, and ensures uniqueness and stability of the symmetric equilibrium. Defining $\sigma(Q) \equiv -QP_{QQ}/P_Q$ as the marketwide curvature and $\varepsilon_\theta(Q) \equiv -\theta/\left(Q\theta_Q\right)$ as the elasticity of the conduct parameter, Assumption 3 is equivalent to $1 + 1/\theta > \sigma + 1/\varepsilon_\theta$.

A.2 Wholesale Bargaining

The following condition, associated with the first-order condition equivalent to equation (4), ensures that the equilibrium results from a maximization problem:

$$\begin{aligned} 0 > W \equiv \quad & -\beta(1-\beta)\left[\frac{\left(\pi_i^R\right)^2}{\left(\pi^M - \pi_0^M\right)^2}\left(\frac{\partial \pi^M}{\partial w_i}\right)^2 + \left(\frac{\partial \pi_i^R}{\partial w_i}\right)^2 - 2\frac{\pi_i^R}{\left(\pi^M - \pi_0^M\right)}\frac{\partial \pi_i^R}{\partial w_i}\frac{\partial \pi^M}{\partial w_i}\right] \\ & +\beta\frac{\left(\pi_i^R\right)^2}{\left(\pi^M - \pi_0^M\right)}\frac{\partial^2 \pi^M}{\partial w_i^2} + (1-\beta)\,\pi_i^R\frac{\partial^2 \pi_i^R}{\partial w_i^2}\ . \end{aligned} \tag{30}$$

Retailers' profits are $\pi_i^R = -q_i^2 \partial P_i/\partial q_i$ or $\pi_i^R = -q_i^2/\left(\partial q_i/\partial p_i\right)$, $\forall i$, whether competition is in quantity or in price, respectively. The manufacturer earns $\pi^M = \sum_i (w_i - c)\, q_i$. In the symmetric equilibrium, where $q_i = q = Q/n, \forall i$, this gives $\pi_i^R = -q^2 n \theta P_Q$ and $\pi^M - \pi_0^M = (w-c)q$, as well as the following derivatives:

$$\frac{\partial \pi^M}{\partial w_i} = \frac{Q}{n} + (w-c)\frac{\partial Q}{\partial w_i}\ , \tag{31}$$

and

$$\frac{\partial^2 \pi^M}{\partial w_i^2} = 2\frac{\partial q_i}{\partial w_i} + (w-c)\frac{\partial^2 Q}{\partial w_i^2}\ , \tag{32}$$

where $(w-c)$ is given by equation (7) in equilibrium.

Besides, when retailers compete in quantities, we have:

$$\frac{\partial \pi_i^R}{\partial w_i} = \frac{Q}{n}\left[\frac{\partial q_k}{\partial w_i} n P_Q (1-\theta) - 1\right], \tag{33}$$

$\forall i, k \neq i$, where $\partial q_k / \partial w_i$ is given by equation (34) below.

By contrast, when they compete in prices, derivatives of retailers' profit function are given by:

$$\frac{\partial \pi_i^R}{\partial w_i} = \frac{Q}{n}\left[\frac{\partial p_k}{\partial w_i} (1-\theta) - 1\right], \tag{33'}$$

$\forall i, k \neq i$, where $\partial p_k / \partial w_i$ is given by equation (38) below.

Finally, by differentiating the retail equilibrium given equation (1) with respect to w_i and w_k, respectively, and noticing that $\partial Q / \partial w_i = \partial q_i / \partial w_i + (n-1)\partial q_k / \partial w_i$, $\forall i, k \neq i$, in a symmetric equilibrium, we obtain, $\forall \theta \in (0, 1]$, the first-derivatives $\partial q_i / \partial w_i$ and $\partial Q / \partial w_i$ respectively given by equations (5) (or (5'), under price competition), and (6). Through a similar exercise, one can also derive $\partial^2 q_i / \partial w_i^2$, $\partial^2 q_k / \partial w_i^2$, $\partial^2 Q / \partial w_i^2$, as well as $\partial^2 \pi_i^R / \partial w_i^2$, $\forall i, k \neq i$, in a symmetric equilibrium.

The wholesale second-order conditions are given by the following set of assumptions.

Assumption 4 (Wholesale SOC)**.** *The following inequalities hold:*

- $W < 0$, *as indicated by inequality (30);*
- $\partial^2 \pi^M / \partial w_i^2 + \sum_{k \neq i} \left| \partial^2 \pi^M / \partial w_k \partial w_i \right| < 0$, $\forall i$*;*
- $d\pi_i^R / d\beta < 0$ *and* $d\pi^M / d\beta > 0$, $\forall \beta \in [0, 1]$, $\forall i$*.*

The first point ensures that the Nash-bargaining solution results from a maximization problem. Taken jointly with the second point, they ensure existence and uniqueness of the symmetric equilibrium. In addition, they imply that $MR_Q - w_Q < 0$, which is equivalent to $\left(1 + \Psi + Q\Psi_Q\right) MR_Q + Q\Psi MR_{QQ} < 0$, $\forall Q$ such that the left-hand side of equation (9) is positive, where $\Psi(\cdot)$ is defined by equation (16). Finally, the last point ensures that the parameter β is a correct measure of firms' relative bargaining power, and implies that the bargaining game is non-cooperative.

A.3 Second-Order Conditions under Upstream Competition

We now adjust our second-order conditions to the case of upstream competition with interlocking relationships over linear input prices, studied in Subsection 7.2.

The retail second-order conditions are given by the following assumptions.

Assumption 5. *The following inequalities hold:*

- $\partial^2 \pi_i^R / \partial x_{ik}^2 < 0$, $\forall i, k$, *with* $x_{ik} \in \{q_{ik}, p_{ik}\}$, *whether retailers compete in quantity or price;*
- $\partial^2 \pi_i^R / \partial x_{ik}^2 + \sum_{r \neq k}^{m} \left| \partial^2 \pi_i^R / \partial x_{ir} \partial x_{ik} \right| + \sum_{j \neq i}^{n} \sum_{r}^{m} \left| \partial^2 \pi_i^R / \partial x_{jr} \partial x_{ik} \right| < 0$, $\forall i, k$, *with* $x_{ik} \in \{q_{ik}, p_{ik}\}$, *whether retailers compete in quantity or price.*

The wholesale second-order conditions are given by the following set of assumptions.

Assumption 6. *The following inequalities hold:*

- $\partial^2 \pi_k^M / \partial w_{ik}^2 < 0$, $\forall i, k$;
- $\partial^2 \pi_k^M / \partial w_{ik}^2 + \sum_{j \neq i}^{n} \left| \partial^2 \pi_k^M / \partial w_{jk} \partial w_{ik} \right| + \sum_{r \neq k}^{m} \sum_{j}^{n} \left| \partial^2 \pi_k^M / \partial w_{jr} \partial w_{ik} \right| < 0$, $\forall i, k$.

B Variety-specific Pass-through Rates

Variety-specific pass-through rates are determined by differentiating the first-order conditions given by equations (1) and (1′) with respect to w_i.

B.1 Quantity Competition

When firms compete in quantities, the impact of a variety-specific cost-shock on a firm's own quantity is given by equation (5), in a symmetric equilibrium. In addition, we have:

$$\frac{\partial q_k}{\partial w_i} = \frac{1}{n^2} \left[\frac{1}{MR_Q} + \frac{n-1}{MR_Q - MR_q} \right], \tag{34}$$

$\forall i, k \neq i$, with $MR_q = 2n\theta P_Q + (Q/n)\left(\partial^2 P_i / \partial q_i^2\right)$.

Because $\partial P_j/\partial w_i = \sum_k \left(\partial P_j/\partial q_k\right)\left(\partial q_k/\partial w_i\right)$, $\forall i, j$, price effects are given by:

$$\frac{\partial P_i}{\partial w_i} = \frac{P_Q}{n}\left[\frac{1}{MR_Q} - \frac{(n-1)(n\theta-1)}{MR_Q - MR_q}\right], \tag{35}$$

$\forall i$, and, $\forall i, k \neq i$:

$$\frac{\partial P_k}{\partial w_i} = \frac{P_Q}{n}\left[\frac{1}{MR_Q} + \frac{n\theta-1}{MR_Q - MR_q}\right]. \tag{36}$$

Finally, the impact of a variety-specific cost-shock on total market demand is given by $\partial Q/\partial w_i = 1/\left(nMR_Q\right)$, as indicated by equation (6).

B.2 Price Competition

Alternatively, when firms compete in prices, we have, in a symmetric equilibrium:

$$\frac{\partial p_i}{\partial w_i} = \frac{P_Q}{n}\left[\frac{1}{MR_Q} - \frac{(n-1)^2}{MR_Q - MR_p}\right], \tag{37}$$

$\forall i$, with $MR_p = 2nP_Q - QP_Q\left(n\theta P_Q\right)^2\left(\partial^2 q_i/\partial p_i^2\right)$, and, $\forall i, k \neq i$:

$$\frac{\partial p_k}{\partial w_i} = \frac{P_Q}{n}\left[\frac{1}{MR_Q} + \frac{n-1}{MR_Q - MR_p}\right]. \tag{38}$$

Because $\partial q_j/\partial w_i = \sum_k \left(\partial q_j/\partial p_k\right)\left(\partial p_k/\partial w_i\right)$, $\forall i, j$, we obtain the own quantity-cost pass-through rate given by equation (5′), and also, $\forall i, k \neq i$:

$$\frac{\partial q_k}{\partial w_i} = \frac{1}{n^2}\left[\frac{1}{MR_Q} + \frac{n/\theta-1}{MR_Q - MR_p}\right]. \tag{39}$$

Again, the impact of a variety-specific cost-shock on total market demand is $\partial Q/\partial w_i = 1/\left(nMR_Q\right)$, as indicated by equation (6).

C Examples

C.1 Linear Demand Systems

Models of a representative consumer with quadratic utility, which give rise to linear demand systems, have constituted the workhorse of the literature so far (see, e.g., the analyses of Horn and Wolinsky (1988), Dobson and Waterson (1997), and Iozzi and Valletti (2014)). In these systems, the second-order derivatives of the inverse demand curves are null, i.e., $P_{QQ} = 0$, and $\partial^2 P_i / \partial q_i^2 = 0$ (or $\partial^2 q_i / \partial p_i^2 = 0$). As demonstrated below, these systems also have quantity-invariant conduct parameters. Therefore, the derivative of the marginal revenue is constant and given by $MR_Q = (1 + \theta) P_Q < 0$. It is thus straightforward from equation (11) to see that retail concentration has no impact on the input price in these settings, i.e., $dw/dn = 0$, when $\beta = 1$. Moreover, equation (12) indicates that, when $\beta = 1$, greater retail concentration will always reduce the market quantity.

Below we analyze in detail the n-firm model *à la* Levithan and Shubik (1971), in which retailer i faces the inverse demand $P_i(q_i, \mathbf{q}_{-\mathrm{i}}) = 1 - \left(n q_i + \mu \sum_k q_k \right) / (1 + \mu)$ with $\mu \geq 0$.[56] In this model, μ represents a measure of product differentiation, and retailers act as local monopolists when $\mu = 0$. This model satisfies Assumption 2, and the marketwide inverse demand displays a constant first-derivative: $P_Q = -1$.

C.1.1 Quantity Competition

When firms compete in quantities, the conduct parameter equals $(1 + \mu/n) / (1 + \mu)$. This implies that $\theta_Q = 0$, and $\theta_n = -\mu / [n^2 (1 + \mu)]$. Also, we have:

$$\Psi = \frac{\beta (2n + \mu)}{\beta (2n + \mu) + 2n (1 - \beta) (2 + \mu)} \ . \tag{40}$$

This gives $\Psi_Q = 0$, and, thus, $w_Q = -(1 + \theta) P_Q \Psi$. Using equation (17), we obtain:

$$\frac{dw}{dn} = \frac{-Q P_Q (1 + \theta)}{1 + \Psi} \Psi_n \ . \tag{41}$$

[56] This demand system can be derived from a representative consumer with quasi-linear preferences who cares about available products. Note that we obtain similar results under a demand system derived from a representative consumer with quasi-linear preferences who also cares about products which are not available, as the one defined by Höffler (2008).

The impact of concentration on the input price appears through the derivative Ψ_n. Differentiating the right-hand side of equation (40) shows that this derivative is always negative for $\beta \in (0,1)$. Therefore, greater retail concentration will always raise the negotiated input price under a linear demand system, when firms compete in quantity. When the manufacturer has all bargaining power, $\Psi = 1$ and, therefore, concentration has no impact on the wholesale price: $dw/dn = 0$. For any β, these results imply that changes in retail quantity are always positively correlated with changes in the number of firms.

C.1.2 Price Competition

When firms compete in price at the retail level, retailer i faces the demand $q_i = (1/n)\left[1 - (1+\mu)\, p_i + (\mu/n) \sum_k p_k\right]$. The conduct parameter is $\theta = n/\left[n + \mu\,(n-1)\right]$, which gives $\theta_Q = 0$, and $\theta_n = -\mu/\left[n + \mu\,(n-1)\right]^2$. This also gives:

$$\Psi = \frac{\beta n \left[2n\,(1+\mu) - \mu\right]}{(2-\beta)\, n \left[2n\,(1+\mu) - \mu\right] + 2\mu\,(n-1)\,(1-\beta)\left[n + \mu\,(n-1)\right]}\,, \tag{42}$$

which does not vary with quantity. Hence, by using equation (17), we obtain the same relation between w and n as given by equation (41). It can then be verified that Ψ_n is always negative for $\beta \in (0,1)$, and, therefore, that $dw/dn < 0$ for any differentiation parameter μ, number of retailers, or equilibrium quantity. Again, this implies that $dQ/dn > 0$ everywhere.

C.2 Constant Elasticity of Substitution

Now consider a different model of price competition: that where a representative consumer has a utility function with constant elasticity of substitution (CES). Following Anderson, de Palma and Thisse (1992), we focus on the simple CES representative consumer's utility function given by $\left(\sum_i q_i^{1/(1+\delta)}\right)^{1+\delta}$, where $\delta \geq 0$. Demand for each variety is given by $q_i = p_i^{-(1+1/n)} / \left(\sum_k p_k^{-1/\delta}\right)$. We focus on the case where $\beta < 1$, for which second-order conditions are satisfied.

The conduct parameter equals $n\delta/\left(n\delta + n - 1\right)$, which is invariant in price and gives $\theta_n = -\delta/\left(n\delta + n - 1\right)^2$. Besides, the retail pass-through is constant and given

by $dp/dw = 1 + n\delta/(n-1)$, which means that $d^2p/dw^2 = 0$. This also gives:

$$\Psi = \frac{\beta\delta\left[1 + n\left(n-1\right)\left(1+\delta\right)\right]}{\delta + n\beta\delta\left(n-1\right)\left(1+\delta\right) + \left(1-\beta\right)\left[1 + n\left(n-2\right)\left(1+\delta\right)\right]}\ , \tag{43}$$

which does not change with quantity. In addition, differentiating with respect to n shows that Ψ_n is negative for any $\beta \in (0,1)$. The CES demand system therefore implies that there is never any countervailing buyer power effect from an increase in market concentration at the retail level. This, in turn, implies that an increase in the number of retailers would always raise the equilibrium quantity.

C.3 Cournot Competition

Under homogeneous Cournot competition, the conduct parameter is given by $\theta = 1/n$, and, hence, $\theta_Q = 0$ and $\theta_n = -1/n^2$. The function Ψ is thus equivalent to:

$$\Psi = \frac{\beta}{\beta + \left(1-\beta\right)\left[-1 + 1/n + \left(2n-1\right)MR_Q/P_Q\right]}\ . \tag{44}$$

This gives, for all $1 > \beta > 0$, the following derivatives:

$$\Psi_n = \frac{-\left(1-\beta\right)\Psi^2}{\beta n^2}\left(2n^2 + \frac{QP_{QQ}}{P_Q}\right)\ , \tag{45}$$

and:

$$\Psi_Q = \left(2n-1\right)\left(\frac{\Psi MR_Q}{nP_Q}\right)^2\frac{\left(1-\beta\right)MR_Q}{\beta}\frac{d^2p}{dw^2}\ . \tag{46}$$

Whereas the derivative of Ψ with respect to n is always negative from Assumption 3, Ψ_Q takes the opposite sign of d^2p/dw^2. Moreover, using equation (17), we obtain:

$$\frac{dw}{dn} = \frac{-\left(QMR_Q\right)^2}{MR_Q - w_Q}\left(\frac{-\kappa\Psi^2 MR_Q}{\beta n^2}\frac{d^2p}{dw^2} + \frac{\Psi_n}{Q}\right)\ , \tag{47}$$

where $\kappa \equiv \beta - \left(1-\beta\right)\left(1-1/n\right)$ is positive for any finite number of retailers when $\beta \geq 1/2$. Therefore, in this case, the condition on the slope of the retail pass-through rate is more restrictive than that in Section 4 in order to have $dw/dn > 0$, because this slope needs to be positive enough to compensate for the negative component Ψ_n. Everything else equal, a decrease in the manufacturer's bargaining power

makes it less likely to observe countervailing buyer power effects.

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