A Buyer Power Theory of Exclusive Dealing and Exclusionary Bundling

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We develop a unified theory of exclusive dealing and exclusionary bundling. In a framework with two competing manufacturers which supply their product(s) through a monopolist retailer, we show that buyer power restores the profitability of such practices involving inefficient exclusion. The mechanism underlying this exclusion is that the compensation required by the retailer to renounce selling the rival product erodes with its buyer power. Among others, we further show that our theory holds when the buyer power differs across manufacturers or when the retailer can strategically narrow (or expand) its product assortment.

Vertical restrictions imposed by a manufacturer on a retailer's purchases have been the subject of a long-standing debate in the antitrust literature.[1] Prominent examples include exclusive dealing contracts by which a manufacturer prohibits its retailer to buy and distribute products of rival manufacturers.[2] Bundling or full-line forcing practices, whereby a manufacturer sells its products in a package, are also observed in many industries.[3] While these restrictions may enable a manufacturer to foreclose its rivals, the core of the debate is whether such a foreclosure is anticompetitive or not.[4] Starting in the 1950s, the Chicago School argued that

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[1]See, e.g., Rey and Vergé (2008) for a survey.

[2]See, for instance, Masterfoods Ltd v HB Ice Cream (European Court of Justice, 2003); United States vs Dentsply case (2005); The Coca-Cola Company (2005) – Case COMP/A.39.116/B2; Google Search – AdSense (2019) – Case AT.40411; FTC v Qualcomm Inc (2019) – Case No 17-cv-00220-LHK.

[3]See, for instance, The Coca-Cola Company (2005) – Case COMP/A.39.116/B2; Cablevision v. Viacom (2013) – Case No. 13 Civ. 1278; Google Android (2018) – Case AT.40099. The use of full-line forcing practices has also been documented in other sectors such as the U.S. video rental industry (Ho, Ho and Mortimer, 2012*a*,*b*).

[4] While a manufacturer inherently excludes its rivals through exclusive dealing, the foreclosure effect

inefficient exclusion is unlikely to arise because a retailer cannot accept a bundling or an exclusive dealing restriction without asking for a compensation that makes these practices unprofitable for the manufacturer.[5] Our article offers a new perspective on this debate in showing that the retailer need not require to be (fully) compensated when it has buyer power. As a result, buyer power enables inefficient vertical restrictions such as exclusive dealing or exclusionary bundling to arise.

To formalize our argument, we develop a framework of vertical relations with two manufacturers and a monopolist retailer. One manufacturer offers a leading product while its rival offers a less efficient secondary product. Products are either imperfect substitutes or independent, implying that efficiency requires the sale of the two products. We consider the following sequence of play. First, each manufacturer chooses whether or not to impose an exclusive dealing restriction on the retailer. The retailer then selects its product assortment which comprises only one of the two products under exclusive dealing or both products otherwise. Finally, the retailer and the manufacturer(s) of the selected product(s) negotiate over efficient contracts according to the "Nash-in-Nash with Threat of Replacement" (NNTR) bargaining solution. This bargaining protocol developed by Ho and Lee (2019) has the appealing property that when one manufacturer is excluded from the retailer's assortment, its product may still be used by the retailer as a threat of replacement during the course of the negotiation with the other manufacturer. The potential profit accruing from the sale of the excluded product thus imposes a constraint on the bargaining between the retailer and the manufacturer of the selected product.

We show that the retailer's ability to play off manufacturers against each other and obtain a compensation for renouncing to the rival product under exclusive dealing erodes with its buyer power. Indeed, absent buyer power, the retailer is fully compensated for not selling the rival product implying that the standard Chicago School argument applies, that is, exclusive dealing is not profitable. In contrast, when the buyer power increases, the retailer obtains a larger amount of surplus from its negotiation for the exclusive product which alters its ability to threaten to replace it with the rival product. As a result, the compensation required by the retailer to renounce selling the rival product decreases in its buyer power and, when it is sufficiently high, the manufacturer of the exclusive product need not pay the retailer any compensation. We thus show that buyer power may restore the profitability of exclusive dealing for the leading product manufacturer to the detriment of the retailer and the industry profit. Hence, what makes the retailer stronger in its negotiations with manufacturers makes it weaker vis-à-vis

of bundling practices is more likely when retailers have a limited stocking capacity. As pointed out by the European Commission (EC) in the Coca-Cola Company (TCCC) case (2005, page 8): "making the supply of the strongest TCCC brands conditional upon the purchase of less-selling Carbonated Soft Drinks (CSDs) and non-CSDs [...] has the effect of making sales space in outlets harder to obtain for rival suppliers [...]." (Case COMP/A.39.116/B2).

[5]See, e.g., Posner (1976) and Bork (1978).

exclusive dealing practices.

Our exclusionary mechanism readily extends to upstream bundling practices. To formalize this, we adapt our previous framework by allowing the leading product manufacturer to also offer a secondary product which is, however, less efficient than that of its rival. Due to a limited stocking capacity, we consider that the retailer cannot sell more than two products. In the first stage of the game, the leading product manufacturer now decides whether to bundle its products or not. The subsequent stages are as before. We show that buyer power restores the profitability of bundling practices leading to an inefficient exclusion of the rival manufacturer. This provides a new rationale for the so-called "leverage theory" according to which a multi-product manufacturer has the incentive to leverage its monopoly power in one market to foreclose a more efficient rival in a competitive market through bundling practices. We further show that the mechanism through which this leverage occurs may hold even if the rival sells the leading product or when the multi-product manufacturer offers a bundle of complementary products (instead of imperfect substitutes or independent products).

We then analyze the profitability of these inefficient vertical restrictions when the buyer power differs across manufacturers. We highlight that our exclusionary mechanism depends only on the presence of buyer power vis-à-vis the manufacturer which imposes the restriction. We also study the retailer's incentive to narrow or expand its product assortment. While such a strategy does not affect the profitability of exclusive dealing, we find that the retailer may choose to expand its product assortment and distribute all available products to offset the harmful effect of bundling. Despite inefficient exclusion, we also show that the retailer may find profitable to keep a narrow product assortment and distribute only the bundle of products for a rent-extraction motive.

To further motivate our results, we finally introduce the "Nash-in-Nash with Prior Competition for Slots" (NNPCS) model in which the retailer auctions off a limited number of slots and receives upfront payments before negotiating wholesale contracts with manufacturers according to the "Nash-in-Nash" solution (Horn and Wolinsky, 1988). We highlight that the surplus division in the NNPCS model coincides with the NNTR solution and that the scope of our buyer power theory extends to markets where upfront payments are prevalent.

Our article contributes to a large literature on exclusive dealing and exclusionary bundling. In response to the Chicago School critique, one strand of this literature has put forward the prominent role of scale economies in the profitability of such practices. This is the case in the two seminal contributions of Aghion and Bolton (1987) and Rasmusen, Ramseyer and Wiley (1991) which have formally demonstrated the (inefficient) entry deterrence effect of exclusive dealing.[6]

[6] The main difference between these two articles is that contracts in Aghion and Bolton (1987) are not designed to deter entry *per se* but to extract rent from the entrant through breakup fees. Among others, this "rent-extraction" theory has been extended to investment choice and contractual renegotiation (Spier and Whinston, 1995), sequential bargaining (Marx and Shaffer, 2010*a*), elastic demand and nonlinear pricing (Choné and Linnemer, 2015), and nonpivotal buyers (Bedre-Defolie and Biglaiser,

Similarly, since Whinston's (1990) pioneering work, a large number of articles have relied on scale economies to provide support for the leverage hypothesis.[7] Another body of the literature has highlighted that the profitability of exclusive dealing and exclusionary bundling crucially depends on the presence of imperfect rent extraction due to contracting externalities. For instance, it has been shown that linear contracts (Mathewson and Winter, 1987), moral hazard (Bernheim and Whinston, 1998), or adverse selection (Calzolari and Denicolò, 2013, 2015) create price distortions that may restore the profitability of exclusive dealing.[8] In the same vein, a number of "leverage theories" of bundling have been based on the presence of linear contracts or moral hazard (e.g., de Cornière and Taylor, 2021).[9] Our theory abstracts from scale economies and contracting externalities. Instead, we rely on the presence of buyer power which, under exclusive dealing or bundling practices, alters the retailer's ability to exploit the competition between manufacturers and receive a compensation for relinquishing to buy the rival product. Our article thus provides a new theory of competitive harm in vertical markets.[10]

Finally, we also contribute to a growing literature that analyzes the formation of buyer-seller networks in vertically related markets. A strand of research has pointed out that strategic restrictions of a distribution network may work out as a bargaining leverage within a vertical channel (Inderst and Shaffer, 2007; Montez, 2007; Marx and Shaffer, 2010*b*). More recently, Ho and Lee (2019) have developed the NNTR bargaining solution to analyze the strategic decision of an insurer to adjust the size of its hospital network.[11] We show that the NNPCS model developed in our article offers a microfoundation for the NNTR bargaining solution.

The remainder of our article is organized as follows. Section I introduces the

2017). Similarly, the "naked-exclusion" theory of Rasmusen, Ramseyer and Wiley (1991), subsequently refined by Segal and Whinston (2000), has been extended in several directions including secret contracts (Miklós-Thal and Shaffer, 2016) and vertical relations with downstream competition (Fumagalli and Motta, 2006; Simpson and Wickelgren, 2007; Wright, 2009).

[7]For instance, when scale economies stem from fixed costs of entry, bundling has been shown to serve as an entry-deterrent strategy in an oligopolistic market (Whinston, 1990; Peitz, 2008) or in multiple markets (Carlton and Waldman, 2002; Nalebuff, 2004). Similar findings have been found with scale economies in R&D activities (Choi, 1996, 2004).

[8]Calzolari, Denicolò and Zanchettin (2020, page 714) emphasize that "the source of price distortions is not important: the theory applies whenever marginal prices exceed marginal costs, and for whatever reason."

[9]As pointed out in Fumagalli, Motta and Calcagno (2018), imperfect rent extraction arising from regulated pricing, demand uncertainty (Greenlee, Reitman and Sibley, 2008), or future quality upgrades (Carlton and Waldman, 2012) may also restore the profitability of bundling. Similarly, non-negative price constraints which, for instance, prevent consumers' moral hazard also create room for imperfect rent extraction which restores the profitability of bundling in two-sided markets (Choi and Jeon, 2021).

[10]It is worth noting that, to our knowledge, we provide one of the few "leverage theory" of bundling in vertical relations. Other theories in this strand have found that the profitability of bundling relies on the presence of contracting externalities (de Cornière and Taylor, 2021) or on retail competition and shopping costs (Ide and Montero, 2019).

[11]The use of strategic network size restrictions is also analyzed in Liebman (2018) and Ghili (Forthcoming) under alternative frameworks. As in Ho and Lee (2019), the gain in bargaining leverage of a downstream firm stems from its ability to play upstream firms off against each other by exercising threats of replacement during negotiations.

main assumptions of our model. Section II shows that the profitability of exclusive dealing stems from the presence of buyer power. Section III extends the analysis to bundling practices and offers a new "leverage theory" in vertical markets. Section IV considers the welfare implications of exclusive dealing and bundling practices. Section V discusses key assumptions and presents various extensions of our model. Section VI highlights that the logic of our argument holds under the NNPCS model which provides a noncooperative microfoundation for the NNTR bargaining solution. Section VII concludes.

I. The Model

We consider a vertical market with two manufacturers at the upstream level, denoted by U_i with $i = 1, 2$, and a monopolist retailer at the downstream level, denoted by D. Three differentiated products, indexed by $X \in \{H, M, L\}$, may be offered on the market. U_1 produces H and L and U_2 produces M.

INDUSTRY PROFITS. — The primitive profit functions representing the industry profit (that is, the profit of a fully integrated firm) generated by each product assortment are denoted as follows: Π^X when only product X is offered on the market, Π^{XY} when products X and Y are offered on the market, and Π^{HML} when the three products are offered on the market. We make the following assumptions:

ASSUMPTION A1: *Among the assortments of one product, H generates a higher industry profit than M which generates a higher industry profit than L:*

$$\Pi^H > \Pi^M > \Pi^L > 0.$$

The assortment HML generates the highest industry profit. Among the assortments of two products, HM generates a higher industry profit than HL which generates a higher industry profit than ML:

$$\Pi^{HML} > \Pi^{HM} > \Pi^{HL} > \Pi^{ML} > 0.$$

A product generates a higher industry profit than another may be due to a lower cost, a higher quality or preferred variety, or a combination of both.

ASSUMPTION A2: *Products are either independent or imperfect substitutes:*

$$\Pi^X + \Pi^Y \geq \Pi^{XY} > \Pi^X \text{ with } Y \neq X.$$

Note that we also consider complementarity among products in Section III.

TIMING AND INFORMATION. — We assume that firms interact according to the following sequence of play:

- Stage 1: Each manufacturer decides whether or not to impose an exclusive dealing/bundling requirement to D. Then, D publicly announces its product assortment.
- Stage 2: Given D's product assortment decision, trade takes place. Terms of trade are determined through bilateral negotiations and take the form of two-part tariffs. If D purchases from both manufacturers, negotiations take place simultaneously and secretly.
- Stage 3: D sets its price(s) and sells to consumers.

We now discuss each stage of the game including our network formation protocol and bargaining solution.

Product assortment decision. — Our first stage builds on the vertical restraints literature as well as on the literature on endogenous buyer-seller network in which the network formation takes place prior to contract negotiations (we refer to Section V.A for a discussion). Given each manufacturer's selling policy, we consider that the announced product assortment commits D to engage in negotiations with manufacturer(s) of the corresponding product(s). To ease exposition, we assume that only manufacturers are able to constrain D's product assortment through an exclusive dealing/bundling requirement. We relax this assumption in Section V.C by considering that D is also able to adjust the size of its product assortment.

Bargaining solution. — We use the "Nash-in-Nash with Threat of Replacement" (NNTR) bargaining solution developed by Ho and Lee (2019) to determine the terms of trade in stage 2. We denote by $\alpha \in [0, 1]$ the bargaining weight of D in each bilateral negotiation and use the terms "bargaining weight" and "buyer power" interchangeably.[12]

The NNTR bargaining solution has attractive properties compared to the more commonly used "Nash-in-Nash" bargaining solution (Horn and Wolinsky, 1988) when some firms are excluded from negotiations. Indeed, a typical representation of the "Nash-in-Nash" bargaining is that each upstream and downstream firm behave independently across bilateral bargains by sending separate delegated agents to negotiate tariffs according to the Nash bargaining solution (Nash, 1950), each pair of agents anticipating that the other pairs reach an agreement (see, e.g., Rey and Vergé, 2020).[13] Applied to our framework, this bargaining model thus

[12] For the sake of exposition, we consider that D's bargaining weight vis-à-vis U_1 and U_2 is similar. We relax this assumption in Section V.B.

[13] Firms' independent behavior across negotiations implies that each delegated agent participates in only one bilateral negotiation, cannot communicate with its counterparts (even those coming from the same firm), and never revises its beliefs about the tariffs negotiated elsewhere. In our framework, however, a pair that succeeds in its bargaining when an exclusive dealing/bundling requirement is imposed would infer that the other pair has not reached an agreement. The independent behavior assumption required by the "Nash-in-Nash" solution is thus difficult to apply when, among multiple bilateral negotiations, only one (or a few) can come to an agreement.

predicts that the manufacturer excluded from the market due to an exclusive dealing/bundling requirement has no role to play on the bargaining outcome. Instead, the NNTR bargaining solution extends the "Nash-in-Nash" by allowing the downstream firm to threaten to replace each of its upstream trading partners with an excluded alternative one during negotiations. In each bilateral negotiation, the downstream firm thus has an outside option defined as the surplus obtained from replacing its current upstream trading partner with another (excluded) one at its reservation price (that is, the price that makes this excluded upstream firm indifferent between replacing or not the downstream firm's current trading partner).[14] Building on Manea (2018), Ho and Lee (2019) have shown that the NNTR solution replicates the Markov perfect equilibrium of a noncooperative bargaining game in which the downstream firm can go "back and forth" between upstream firms during negotiations. To further motivate the use of this solution concept, we provide in Section VI a novel microfoundation for the NNTR solution in which D plays U_1 and U_2 off against each other by auctioning a limited number of slots.[15]

Bilateral efficiency. — The common agency literature has shown that competing manufacturers can use the common agent D as a coordination device to replicate a collusive outcome and maximize the industry profit regardless of the distribution of bargaining power in the vertical chain (e.g., Bernheim and Whinston, 1985; O'Brien and Shaffer, 2005).[16] Bilateral efficiency (cost-based wholesale contracts) thus prevails in our framework whatever manufacturers' selling strategies. This implies that, in stage 3, D always chooses prices that maximize the integrated industry profit. Based on this result, we consider throughout our article that stages 2 and 3 are gathered in a unique stage where each pair $D - U_i$ bargains over a fixed fee F_i to share the integrated industry profit.

II. Exclusive Dealing

In this section, we consider a framework in which U_1 only offers product H (the case where U_1 also offers product L is considered in Section III devoted to the bundling analysis). In what follows, we solve the subgames with and without exclusive dealing and then analyze the optimal selling strategy for manufacturers.

[14] As discussed in Ho and Lee (2019), the NNTR solution directly relates to the literature on bargaining with outside options (e.g., Shaked and Sutton, 1984; Binmore, 1985; Binmore, Shaked and Sutton, 1989).

[15] It is worth noting that the NNTR solution also coincides with a number of other noncooperative bargaining models when the buyer faces multiple sellers but can reach an agreement with only one of them, a situation analog to our framework when a bundling or an exclusive dealing requirement is imposed (see, e.g., Osborne and Rubinstein, 1990; Bolton and Whinston, 1993; Manea, 2018; Thomas, 2018).

[16] Note that this efficiency result would also hold under public contracts.

A. Absent exclusive dealing requirement

Consider first that manufacturers do not impose any exclusive dealing requirement to D. In this case, D engages in bilateral negotiations with U_1 for H and U_2 for M. As D deals with both manufacturers, it cannot threaten any of its trading partner of replacement. The NNTR solution is here equivalent to the "Nash-in-Nash" solution, implying that the division of surplus in each bilateral negotiation is determined according to the (asymmetric) Nash bargaining solution given that the other pair of firms comes to an agreement. Formally, the fixed fee negotiated between D and U_1 for H is derived from the following maximization problem:

$$\max_{F_1^{HM}} \left(\Pi^{HM} - F_1^{HM} - F_2^{HM} - (\Pi^M - F_2^{HM})\right)^{\alpha} \left(F_1^{HM}\right)^{1-\alpha} \tag{1}$$

where $\Pi^{HM} - F_1^{HM} - F_2^{HM} - (\Pi^M - F_2^{HM})$ and F_1^{HM} are the gains from trade of D and U_1 respectively. These gains correspond to the difference between the profits obtained by D and U_1 if an agreement is reached (that is, $\Pi^{HM} - F_1^{HM} - F_2^{HM}$ and F_1^{HM} respectively) and their status quo payoff if the negotiation never comes to an agreement (that is, $\Pi^M - F_2^{HM}$ and 0 respectively). Similarly, the fixed fee negotiated between D and U_2 for product M is derived from the following maximization problem:

$$\max_{F_2^{HM}} \left(\Pi^{HM} - F_1^{HM} - F_2^{HM} - (\Pi^H - F_1^{HM})\right)^{\alpha} \left(F_2^{HM}\right)^{1-\alpha} \tag{2}$$

From (1) and (2), we obtain that U_1's fixed fee equals $F_1^{HM} = (1-\alpha)\left(\Pi^{HM} - \Pi^M\right)$ and U_2's fixed fee equals $F_2^{HM} = (1-\alpha)\left(\Pi^{HM} - \Pi^H\right)$. As a result, the equilibrium profit of D, U_1 and U_2 are respectively given by:

$$\begin{aligned} \pi_D^{HM} &= (2\alpha - 1)\Pi^{HM} + (1-\alpha)(\Pi^H + \Pi^M); \\ \pi_1^{HM} &= (1-\alpha)(\Pi^{HM} - \Pi^M); \\ \pi_2^{HM} &= (1-\alpha)(\Pi^{HM} - \Pi^H). \end{aligned} \tag{3}$$

The industry profit sharing in (3) shows that each manufacturer obtains a share $1-\alpha$ of its marginal contribution to the industry profit.

B. Exclusive dealing requirement

Consider now that either U_1, or U_2, or both impose an exclusive dealing requirement to D. In this case, D engages in a bilateral negotiation with either U_1 for H or U_2 for M. As previously described, the NNTR solution allows D to threaten to replace the product of its current trading partner with that of its (excluded) rival when bargaining. Following Ho and Lee (2019), we apply the NNTR solution only to stable buyer-seller networks which requires that each product in D's assortment generates greater bilateral surplus than any product used as a replacement threat (taking as given all other agreements). Otherwise, the selected product assortment would not be stable as D would wish to terminate a relationship with one of its current trading partner and replace its product with another one which generates a greater surplus when playing them off against each other.[17] Under Assumption A1, we have that H is the unique product assortment which satisfies this stability condition. As a result, D always engages in a bilateral negotiation with U_1 for H when an exclusivity requirement is imposed. There is thus no equilibrium in which U_2 alone imposes an exclusive dealing requirement to D. Following the NNTR solution, the fixed fee resulting from the negotiation between D and U_1 for H is determined as follows:

$$\max_{F_1^H} (\Pi^H - F_1^H)^\alpha (F_1^H)^{1-\alpha} \quad \text{such that} \quad \Pi^H - F_1^H \geq \Pi^M - f_2 \tag{4}$$

where the gains from trade of D and U_1 are $\Pi^H - F_1^H$ and F_1^H respectively. In this case, both D and U_1 have a status quo payoff of 0 because none of them is involved in any other bilateral negotiation. The constraint $\Pi^H - F_1^H \geq \Pi^M - f_2$, however, reflects that D's gains from trade must at least be equal to what it would obtain by replacing H with M at U_2's reservation tariff. This tariff, denoted by f_2, is equal to the surplus U_2 would be willing to accept to replace H with M and deal with D taking as given its other agreements (if any). As U_2 has no alternative downstream partner to deal with, it is willing to accept any nonnegative payment to replace H, implying that $f_2 = 0$. From (4), we thus obtain that U_1's fixed fee equals $F_1^H = \min\left\{(1-\alpha)\Pi^H, \Pi^H - \Pi^M\right\}$. Hence, the equilibrium profit of D, U_1 and U_2 are respectively given by:

$$\begin{aligned} \pi_D^H &= \max\left\{\alpha\Pi^H, \Pi^M\right\}; \\ \pi_1^H &= \min\left\{(1-\alpha)\Pi^H, \Pi^H - \Pi^M\right\}; \\ \pi_2^H &= 0. \end{aligned} \tag{5}$$

The industry profit sharing in (5) can be described as follows. When $\alpha > \alpha_C \equiv \Pi^M/\Pi^H$, D gets a large fraction of the industry profit from its negotiation with U_1 and its option to replace H with M cannot be a credible threat, which implies that the surplus division yields the same outcome as the (asymmetric) Nash bargaining solution. In contrast, when $\alpha_C > \alpha$, the option of replacing H with M becomes a credible threat and U_1's fixed fee is capped. In particular, this threat ensures

[17]More precisely, Ho and Lee's (2019) Proposition 2 states that a network is stable if two main conditions are satisfied. First, as for the "Nash-in-Nash" solution, every firm involved in a bilateral negotiation must have positive gains from trade. Second, due to the downstream firm's ability to exercise threats of replacement, each of its upstream trading partners must generate a higher surplus than any alternative upstream firm used as a replacement threat.

that D obtains a profit at least equal to Π^M (i.e., the profit it would obtain from replacing H with M at U_2's reservation tariff). Hence, the NNTR solution allows the excluded manufacturer U_2 to affect the surplus division in the vertical chain following the logic of the "outside option principle" in bargaining theory (e.g., Binmore, Shaked and Sutton, 1989).[18]

C. *Buyer power and the profitability of exclusive dealing*

We now analyze the profitability of exclusive dealing. As U_2 has no incentive to impose an exclusive dealing requirement to D, we compare U_1's profit in (3) and (5) and obtain the following proposition:[19]

PROPOSITION 1: *Exclusive dealing arises in equilibrium when the buyer power of the retailer vis-à-vis manufacturers is high:* $\alpha > \alpha_{ED} \equiv \left(\Pi^{HM} - \Pi^{H}\right) / \left(\Pi^{HM} - \Pi^{M}\right)$. *Exclusive dealing harms the rival manufacturer, the retailer and the industry profit.*

PROOF:
See Appendix A. While the harm for the rival manufacturer and the industry profit is straightforward, we show in Appendix B that exclusive dealing also harms the retailer.

Several comments are in order. First, Proposition 1 extends the Chicago School argument to the case where the retailer has some bargaining power vis-à-vis manufacturers. The insight is as follows. On the one hand, under exclusive dealing and when $\alpha_C > \alpha$, we have seen that D's option to deal with U_2 is a credible threat and induces U_1 to leave a surplus of Π^M to D, which is tantamount to paying D a compensation for not dealing with U_2. On the other hand, absent exclusive dealing, (3) shows that U_1's profit equals $(1-\alpha)(\Pi^{HM} - \Pi^M)$. Focusing on the polar case $\alpha = 0$, the Chicago School argument correctly asserts that exclusive dealing is never profitable because the compensation U_1 has to pay reduces its profit to $\Pi^H - \Pi^M$ which is lower than what it can get absent exclusive dealing (that is, $\Pi^{HM} - \Pi^M$). Proposition 1 thus generalizes this argument by showing that it holds whenever the buyer power of the retailer is limited: $\alpha_{ED} > \alpha \geq 0$.

When $\alpha > \alpha_{ED}$, Proposition 1 highlights that the Chicago School argument ceases to operate as exclusive dealing which leads to an inefficient exclusion becomes profitable. The logic underlying this result is that the compensation $C = \max\left\{\Pi^M - \alpha\Pi^H, 0\right\}$ paid by U_1 for exclusivity is decreasing in α.[20] Indeed,

[18] According to this principle, a bargainer's outside option is irrelevant to the bargaining outcome unless it provides a higher payoff than what the bargainer can get from his negotiation. Note that numerous experimental studies have provided support for this treatment of outside options in bilateral bargains (see, e.g., Binmore, Shaked and Sutton, 1989; Binmore et al., 1991; Kahn and Murnighan, 1993; Binmore et al., 1998).

[19] Note that when U_1 chooses to impose an exclusive dealing requirement, U_2 is indifferent between adopting an exclusive dealing requirement or not. U_2's decision is, however, irrelevant to firms' payoffs.

[20] The compensation that D receives from U_1 under exclusive dealing is defined as the extra amount of surplus D obtains, in addition to what it can get from U_1 ($\alpha\Pi^H$), when the option to replace H with M is a credible threat to exercise.

when D gets a sufficient share of the surplus generated by its exclusive deal with U_1 (that is, Π^H), its bargaining leverage from threatening U_1 of replacement with U_2 erodes. As a result, when $\alpha > \alpha_{ED}$, the compensation paid by U_1 is low enough to make exclusive dealing a profitable strategy. As $\alpha_C > \alpha_{ED}$, it is worth noting that D may still receive a positive compensation when exclusive dealing is profitable for U_1. The profitability of exclusive dealing is even more striking when $\alpha > \alpha_C$ as D can no longer credibly threaten to replace H and require a compensation from U_1. In this case, U_1's profit under exclusive dealing becomes $(1-\alpha)\Pi^H$ which, by Assumption A2, is (weakly) larger than what it can get absent exclusive dealing, that is $(1-\alpha)(\Pi^{HM}-\Pi^M)$. Proposition 1 thus shows that the presence of a powerful retailer which is able to negotiate trading terms with manufacturers facilitates the emergence of anticompetitive exclusive dealing. It is worth noting that the use of the NNTR solution allows us to preserve the main essence of the Chicago School argument: the retailer may exploit the presence of a rival manufacturer to receive a compensation for accepting an exclusive deal. The central result of Proposition 1 is thus to reconsider the Chicago School argument as a special case of a more general bargaining game in which the retailer's compensation decreases in its buyer power.[21]

As shown in Proposition 1, the condition under which exclusive dealing is profitable depends on the substitution among products. The following corollary summarizes this insight:

COROLLARY 1: *More substitution among products favors the emergence of exclusive dealing.*

From Assumptions A1 and A2 as well as Proposition 1, we have $\Pi^H + \Pi^M \geq \Pi^{HM} > \Pi^H$ and $\alpha_{ED} = \left(\Pi^{HM} - \Pi^H\right) / \left(\Pi^{HM} - \Pi^M\right)$. In the polar case where products are independent, Π^{HM} tends to $\Pi^H + \Pi^M$ and α_{ED} tends to α_C. Hence, any positive compensation required by D for not dealing with U_2 makes the use of exclusive dealing unprofitable ($\alpha_C > \alpha$). When this compensation boils down to 0 ($\alpha > \alpha_C$), U_1 is indifferent between imposing or not an exclusive dealing requirement as it gets $(1-\alpha)\Pi^H$ in any case. Consider now that the degree of substitution between products increases such that Π^{HM} gets closer to Π^H (keeping Π^H and Π^M unchanged). On the one hand, U_1's profit absent exclusive dealing decreases as it has a smaller marginal contribution to the industry profit. On the other hand, U_1's profit under exclusive dealing remains unchanged. As a result, exclusive dealing is more likely to arise when the substitution among products increases (α_{ED} decreases).[22] In that case, however, exclusion is less damaging for the industry profit.

[21] Considering instead the "Nash-in-Nash" solution, it is straightforward to see that exclusive dealing is profitable whenever $1 > \alpha \geq 0$. However, the "Nash-in-Nash" solution does not allow to preserve the logic of the Chicago School argument as it rules out the possibility for the retailer to use an excluded manufacturer as a bargaining leverage and receive a compensation for accepting an exclusive deal even when $\alpha = 0$.

[22] In the polar case where products are perfect substitutes, however, D gets the entire industry profit regardless of U_1's selling strategy.

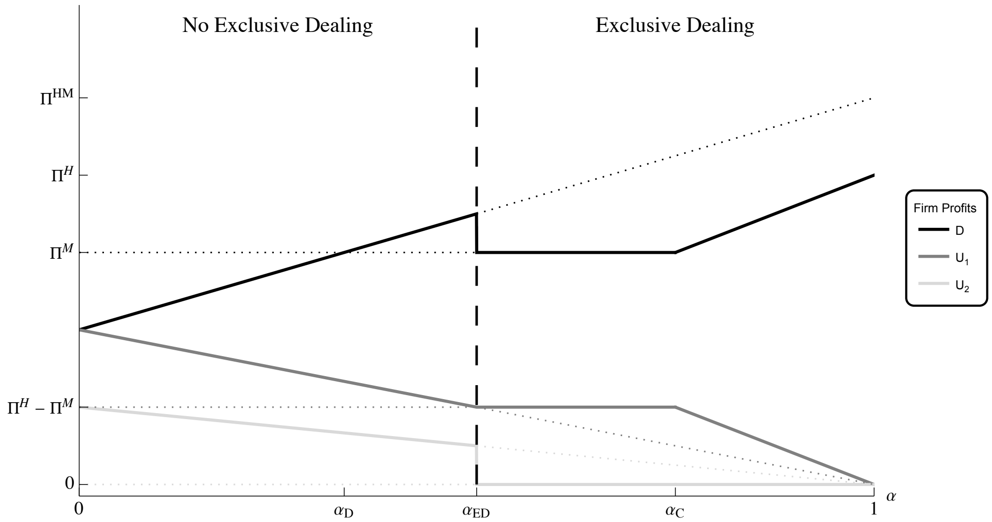

FIGURE 1. EXCLUSIVE DEALING IN THE PRESENCE OF BUYER POWER

Note: This figure is drawn under the following numerical values: $\Pi^H = 4$, $\Pi^M = 3$, $\Pi^{HM} = 5$. The x-axis represents D's bargaining weight $\alpha \in [0, 1]$. The y-axis corresponds to values for profits obtained by each manufacturer and D. The dotted lines represent the counterfactual profits of firms (i.e., firms' profits under exclusive dealing when $\alpha_{ED} > \alpha$ and firms' profits absent exclusive dealing when $\alpha > \alpha_{ED}$).

ILLUSTRATIVE EXAMPLE. — We consider a simple example to illustrate the insights drawn from Proposition 1. We set $\Pi^H = 4$, $\Pi^M = 3$, $\Pi^{HM} = 5$, implying that $\alpha_{ED} = 1/2$.[23] Figure 1 depicts how the profit of each firm is affected by D's bargaining weight α.

Consider first the case in which $\alpha_{ED} > \alpha$. Following Proposition 1, the Chicago School argument applies and exclusive dealing is not profitable. Solid lines in the figure represent the equilibrium profit of firms and dotted lines are what they would obtain under exclusive dealing. As previously described, the surplus division coincides with the "Nash-in-Nash" solution, which implies that the profit of D is strictly increasing in α (black line) while the profit of both U_1 (grey line) and U_2 (light grey line) are strictly decreasing in α. Consider now that $\alpha > \alpha_{ED}$. In this case, Proposition 1 highlights that exclusive dealing arises and U_2 is excluded from the market. Again, solid lines in the figure represent the equilibrium profit of firms and dotted lines are what they would obtain absent exclusive dealing. The emergence of exclusive dealing generates a discontinuity in D's profit: the gap between the solid and the dotted black line illustrates D's losses from exclusive dealing. In contrast, the gap between the solid and the dotted grey line illustrates the profitability of exclusive dealing for U_1. When $\alpha_C > \alpha > \alpha_{ED}$, D's threat to replace H with M is credible and induces U_1

[23]In Appendix G, we show that this illustrative example can be derived from a quasi-linear quadratic utility model (Shubik and Levitan, 1980) with an appropriate choice of parameter values.

to provide (at least) a profit of Π^M to D (i.e., the constraint in (4) is binding meaning that absent such a threat D would have obtained a lower profit). As a result, the profits of D (black line) and U_1 (grey line) remain constant with respect to α. The kink arising in the profits of D and U_1 when $\alpha = \alpha_C$ depicts the situation in which D's option to deal with U_2 instead of U_1 is no longer a credible threat to exercise. Hence, when $\alpha > \alpha_C$, the surplus division yields the same outcome as the (asymmetric) Nash bargaining solution, implying that D's (resp., U_1's) profit is increasing (resp., decreasing) in α.

III. Upstream Bundling

Consider now that U_1 offers both H and L whereas U_2 still offers M. Among the three available products, we make the assumption that D can purchase and distribute at most two of them. This aims at capturing the limited stocking capacity of retailers which is a pre-requisite for the exclusionary concerns of bundling practices in vertical markets. In what follows, we solve the subgames in which U_1 chooses a component and a bundling selling strategy and then analyze the profitability of bundling.

A. *Component strategy*

Consider first that U_1 chooses a component selling strategy by offering H and L separately. In this case, D may either select the assortment HM, HL, or ML due to its limited stocking capacity. As described in Section II, however, the presence of a third available product may be used by D to exercise threats of replacement and gain bargaining leverage with respect to its current upstream trading partner(s). This requires that each product in D's assortment generates greater bilateral surplus than any product used as a replacement threat, taking as given all other agreements (see Proposition 2 of Ho and Lee, 2019). Under Assumption A1, the unique product assortment which satisfies this stability condition is HM. Hence, D always engages in bilateral negotiations with U_1 for H and U_2 for M when a component strategy is chosen by U_1. The NNTR solution thus determines the fixed fee negotiated between D and U_2 for M as follows:

$$\begin{aligned} &\max_{\tilde{F}_2^{HM}} \left(\Pi^{HM} - \tilde{F}_1^{HM} - \tilde{F}_2^{HM} - (\Pi^H - \tilde{F}_1^{HM})\right)^{\alpha} \left(\tilde{F}_2^{HM}\right)^{(1-\alpha)} \\ &\text{such that} \quad \Pi^{HM} - \tilde{F}_1^{HM} - \tilde{F}_2^{HM} \geq \Pi^{HL} - \tilde{f}_1 \end{aligned} \tag{6}$$

where $\Pi^{HM} - \tilde{F}_1^{HM} - \tilde{F}_2^{HM} - (\Pi^H - \tilde{F}_1^{HM})$ and $\tilde{F}_2^{HM}$ correspond to the gains from trade of D and U_2 respectively. The constraint $\Pi^{HM} - \tilde{F}_1^{HM} - \tilde{F}_2^{HM} \geq \Pi^{HL} - \tilde{f}_1$ reflects that D's profit must at least be equal to what it would obtain by replacing M with L at U_1's reservation tariff (holding fixed the outcome determined in the other negotiation). This tariff, denoted by $\tilde{f}_1$, is equal to the surplus U_1 would be willing to accept to replace M and deal with D for L. Given that U_1 already receives a surplus of $\tilde{F}_1^{HM}$ from its negotiation with D for H, we have $\tilde{f}_1 = \tilde{F}_1^{HM}$.

When bargaining with U_1 for H, we consider that D's option to replace H with L cannot be exercised as both H and L are owned by U_1.[24] Taking as given the bargaining outcome between D and U_2 for M, the fixed fee negotiated between D and U_1 for H is thus derived as follows:

$$\max_{\tilde{F}_1^{HM}} \left(\Pi^{HM} - \tilde{F}_1^{HM} - \tilde{F}_2^{HM} - (\Pi^M - \tilde{F}_2^{HM})\right)^{\alpha} \left(\tilde{F}_1^{HM}\right)^{(1-\alpha)} \tag{7}$$

where $\Pi^{HM} - \tilde{F}_1^{HM} - \tilde{F}_2^{HM} - (\Pi^M - \tilde{F}_2^{HM})$ and $\tilde{F}_1^{HM}$ are the gains from trade of D and U_1 respectively. Solving (6) and (7), we obtain that $\tilde{F}_1^{HM} = (1-\alpha)(\Pi^{HM} - \Pi^M)$ and $\tilde{F}_2^{HM} = \min\left\{(1-\alpha)(\Pi^{HM} - \Pi^H), \Pi^{HM} - \Pi^{HL}\right\}$. Hence, the equilibrium profits of D, U_1 and U_2 are respectively given by:

$$\begin{aligned} \tilde{\pi}_D^{HM} &= \max\left\{(2\alpha - 1)\Pi^{HM} + (1-\alpha)(\Pi^H + \Pi^M),\right. \\ &\qquad \left.\Pi^{HL} - (1-\alpha)(\Pi^{HM} - \Pi^M)\right\}; \\ \tilde{\pi}_1^{HM} &= (1-\alpha)(\Pi^{HM} - \Pi^M); \\ \tilde{\pi}_2^{HM} &= \min\left\{(1-\alpha)(\Pi^{HM} - \Pi^H), \Pi^{HM} - \Pi^{HL}\right\}. \end{aligned} \tag{8}$$

B. *Bundling strategy*

Consider now that U_1 chooses a bundling strategy by offering H and L only in a package. In this case, D may either engage in a bilateral negotiation with U_1 for HL or U_2 for M. The analysis is thus equivalent to the exclusive dealing case in Section II.B, replacing product H by the bundle of products HL. The NNTR solution determines U_1's fixed fee for the bundle HL as follows:

$$\max_{\tilde{F}_1^{HL}} \left(\Pi^{HL} - \tilde{F}_1^{HL}\right)^{\alpha} \left(\tilde{F}_1^{HL}\right)^{(1-\alpha)} \quad \text{such that} \quad \Pi^{HL} - \tilde{F}_1^{HL} \geq \Pi^M - \tilde{f}_2 \tag{9}$$

where the gains from trade of D and U_1 are $\Pi^{HL} - \tilde{F}_1^{HL}$ and $\tilde{F}_1^{HL}$ respectively. The constraint $\Pi^{HL} - \tilde{F}_1^{HL} \geq \Pi^M - \tilde{f}_2$ reflects that D's gains from trade must at least be equal to what it would get by replacing HL with M at U_2's reservation tariff $\tilde{f}_2$. Having no alternative downstream partner to deal with, U_2 is willing to accept any nonnegative payment to distribute M, implying that $\tilde{f}_2 = 0$. From (9),

[24] While it is intuitive that a downstream firm cannot play off an upstream trading partner against itself (i.e., threatening to replace one of its products with another), we motivate this modeling assumption by relying on the fact that it emerges as the equilibrium outcome of the NNPCS model developed in Section VI (see Chambolle and Molina, 2020 for a comprehensive analysis) as well as the bargaining model considered in Beckert, Smith and Takahashi (2021). It is worth noting that Ho and Lee (2019) focus on hospital-insurer bargaining over reimbursement rates implying that they do not consider the case of multi-product upstream firms.

we obtain that U_1's fixed fee for HL equals $\tilde{F}_1^{HL} = \min\left\{(1-\alpha)\Pi^{HL}, \Pi^{HL} - \Pi^M\right\}$. Hence, the equilibrium profit of D, U_1 and U_2 are respectively given by:

$$\begin{aligned} \tilde{\pi}_D^{HL} &= \max\left\{\alpha\Pi^{HL}, \Pi^M\right\}; \\ \tilde{\pi}_1^{HL} &= \min\left\{(1-\alpha)\Pi^{HL}, \Pi^{HL} - \Pi^M\right\}; \\ \tilde{\pi}_2^{HL} &= 0. \end{aligned} \tag{10}$$

When $\alpha > \tilde{\alpha}_C \equiv \Pi^M/\Pi^{HL}$, D obtains a large fraction of the industry profit from its negotiation with U_1, making D's threat to replace the bundle of products HL with M not credible. In contrast, when $\tilde{\alpha}_C > \alpha$, D's threat of replacement becomes credible and ensures that its profit is at least equal to Π^M.

C. *Buyer power and the profitability of bundling*

Comparing U_1's profit in (8) and (10), we obtain the following proposition:

PROPOSITION 2: *Bundling arises in equilibrium when the buyer power of the retailer vis-à-vis manufacturers is high:* $\alpha > \alpha_B \equiv \left(\Pi^{HM} - \Pi^{HL}\right) / \left(\Pi^{HM} - \Pi^M\right)$. *Bundling harms the rival manufacturer, the retailer and the industry profit.*

PROOF:

See Appendix A. While the harm for the rival manufacturer and the industry profit is straightforward, we show in Appendix B that bundling also harms the retailer.

In the same vein as for the exclusive dealing restrictions, the Chicago School critique to the "leverage theory" of bundling states that a multi-product manufacturer cannot find profitable to bundle its products for exclusionary motives because it would have to pay the retailer a prohibitive compensation for giving up the opportunity to sell the rival product whenever this is efficient for the industry. Initially framed in the polar case $\alpha = 0$, Proposition 2 extends the Chicago School argument to situations in which the retailer has some bargaining power vis-à-vis manufacturers. The insight is similar to that described in Proposition 1.

When $\alpha > \alpha_B$, however, Proposition 2 highlights that a bundling strategy leading to an inefficient exclusion becomes profitable, which breaks down the logic of the Chicago School argument. Again, the reason is similar to that described in Proposition 1. The amount of compensation received by D depends on its ability to threaten U_1's bundle of replacement with U_2's product. Such ability, however, weakens as D gets stronger in its bargaining with U_1 (the compensation paid by U_1 is decreasing in α). When $\alpha > \alpha_B$, the compensation paid by U_1 is low enough to make bundling a profitable strategy. This result is even more straightforward when $\alpha > \tilde{\alpha}_C$ as U_1 has no compensation to pay for ensuring that D does not deal with U_2. In this case, U_1's profit under bundling equals $(1-\alpha)\Pi^{HL}$ which, by Assumption A2, is greater than what it can get under a component selling strategy, that is $(1-\alpha)\left(\Pi^{HM} - \Pi^M\right)$. Proposition 2 thus restores the "leverage theory" of bundling by highlighting that the presence of a powerful retailer which is able to negotiate trading terms with manufacturers facilitates the emergence of anticompetitive bundling. Through the buyer power parameter α, our model thus shows how one can go from the Chicago School argument to the "leverage theory" of bundling.

Although Propositions 1 and 2 are very close in spirit, there are results which are specific to the bundling analysis. In particular, the following corollary characterizes two other conditions for the profitability of bundling:

COROLLARY 2: *Bundling is more likely to arise in equilibrium when:*

(i) products M and L are closer substitutes,

(ii) product H is a must-stock item.

First, when M and L become closer substitutes, Π^{HL} increases toward Π^{HM} which decreases α_B and implies that a bundling strategy is more likely to arise in equilibrium.[25] In that case, however, bundling is less damaging for the industry profit. Second, when H is a must-stock item, it generates most of the industry profit implying that Π^H tends to Π^{HL} or Π^{HM} which decreases α_B and facilitates the emergence of a bundling strategy. However, the following remark shows that the presence of a must-stock item is not a necessary condition for the profitability of bundling:

REMARK 1: *Proposition 2 holds when $\Pi^{HL} > \Pi^M > \Pi^H$.*

PROOF:

See Appendix C.

For the sake of exposition and motivated by the case law in footnotes 2 and 3, we have considered that $\Pi^H > \Pi^M$ (Assumption A1). However, when $\Pi^M > \Pi^H$, Proposition 2 still holds as long as $\Pi^{HL} > \Pi^M$ (i.e., the bundle of products generates a higher industry profit than the rival's product). In that case, bundling excludes the product generating the highest surplus which is even more detrimental for the industry profit.

Proposition 2 states that anticompetitive upstream bundling may arise under the case of independent or imperfect substitutes products (Assumption A2). The following remark shows that this result carries over to the case of complementary products extensively analyzed in the bundling literature (Whinston, 2001):

REMARK 2: *Proposition 2 still holds when M and L are complements to H and the complementarity between M and H is limited: $\Pi^{HX} > \Pi^H + \Pi^X$ with $X \in \{M, L\}$ and $\Pi^{HL} + \Pi^M \geq \Pi^{HM}$.*

[25]Note that the greater substitution between M and L can result from a reduction in their quality gap or their cost differential.

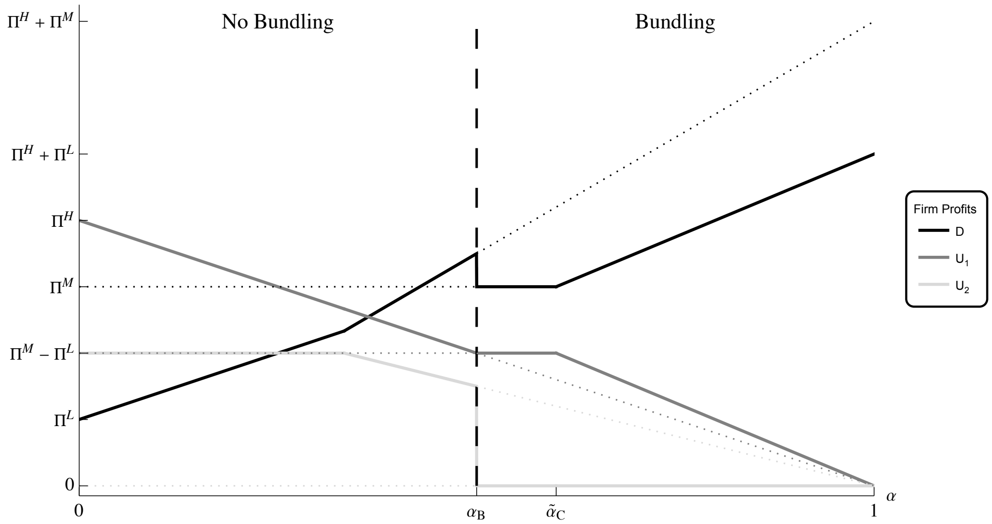

Figure 2. Bundling in the presence of buyer power

Note: This figure is drawn under the following numerical values: $\Pi^H = 4$, $\Pi^M = 3$, $\Pi^L = 1$. The x-axis represents D's bargaining weight $\alpha \in [0, 1]$. The y-axis corresponds to values for profits obtained by each manufacturer and D. The dotted lines represent the counterfactual profits of firms (i.e., firms' profits under bundling when $\alpha_B > \alpha$ and firms' profits absent bundling when $\alpha > \alpha_B$).

PROOF:

See Appendix D.

This result highlights that our buyer power argument provides a new rationale to the "leverage theory" of bundling whether products are substitutes, independent, or complements. To apply the NNTR solution, however, we must restrict the degree of complementarity between H and M.[26] Indeed, the complementarity makes the marginal contribution of every product to the industry profit greater when other agreements have been formed, which implies that the sum of tariffs determined by the NNTR solution and paid by D may be greater than the value of the industry profit. In particular, if $\Pi^{HL} + \Pi^M \geq \Pi^{HM}$ does not hold, we show in Appendix D that D rejects one of its agreements at the NNTR tariffs.[27]

Illustrative example with independent products. — We consider a simple example to illustrate the insights drawn from Proposition 2. In particular, we focus on the case of independent products in which only Assumption A1 matters as it implies that Assumption A2 holds. We set $\Pi^H = 4$, $\Pi^M = 3$, $\Pi^L = 1$,

[26]More precisely, the condition $\Pi^{HL} + \Pi^M \geq \Pi^{HM}$ ensures that $\tilde{\pi}_D^{HM} = \Pi^{HM} - \tilde{F}_1^{HM} - \tilde{F}_2^{HM} > 0$. This relates to the feasibility assumption in Collard-Wexler, Gowrisankaran and Lee (2019) which is used to guarantee the existence of a "Nash-in-Nash" equilibrium.

[27]It is worth noting that this condition rules out cases where products are perfect complements or where H is essential for all uses of M as in Section 3 of Whinston (1990).

implying that $\alpha_B = 1/2$ and $\tilde{\alpha}_C = 3/5$.[28] Figure 2 depicts how firms' profits are affected by D's bargaining weight α.[29] Consider first the case in which $\alpha_B > \alpha$. Following Proposition 2, the Chicago School critique applies and bundling is not profitable. Solid lines in the figure represent the equilibrium profit of firms and dotted lines are what they would obtain under bundling. Consider now that $\alpha > \alpha_B$. In this case, Proposition 2 highlights that bundling arises and U_2 is excluded from the market. Solid lines in the figure represent the equilibrium profit of firms and dotted lines are what they would obtain under a component selling strategy. The gap between the solid and the dotted grey line thus illustrates the profitability of U_1's bundling strategy. Note that, when $\tilde{\alpha}_C > \alpha > \alpha_B$, D credibly threatens U_1's bundle of replacement with U_2's product. This induces U_1 to concede a surplus equal to Π^M, implying that D's profit (black line) and U_1's profit (grey line) remain constant with respect to α. When $\alpha > \tilde{\alpha}_C$, however, D's threat of replacement is no longer credibly exercised.

IV. Welfare Implications

To discuss the welfare implications of exclusive dealing and bundling, we denote by CS^X the consumer surplus when the product assortment X is offered on the market and assume that:

ASSUMPTION A3: $CS^{HML} > CS^{HM} > CS^H > CS^M > CS^L$.

Assumption A3 is satisfied when preferences exhibit a taste for variety. Among others, this arises under most linear demand systems for differentiated products (see Choné and Linnemer, 2020, for a comprehensive overview). We thus obtain the following corollary:

COROLLARY 3: *Under Assumption A3, exclusive dealing and bundling harm consumers surplus and total welfare.*

This result offers a new perspective on the commonly held view that vertical restrictions imposed by a dominant manufacturer are more likely to raise anti-competitive concerns absent powerful retailers. Instead, our theory suggests that the presence of buyer power makes the emergence of vertical restrictions more likely to the detriment of both consumers and welfare. This is in stark contrast with the EC guidelines on vertical restraints according to which: "Buying power is relevant, as important buyers will not easily be forced to accept tying without obtaining at least part of the possible efficiencies. Tying not based on efficiency is therefore mainly a risk where buyers do not have significant buying

[28] Again, Appendix G shows that this illustrative example can be derived from a quasi-linear quadratic utility model (Shubik and Levitan, 1980) with an appropriate choice of parameter values.

[29] Note that the market outcome when $\alpha = 0$ directly relates to the textbook examples of the Chicago School critique to the "leverage theory" of bundling as developed in Choi (2006) and Fumagalli, Motta and Calcagno (2018).

power."[30] Moreover, as highlighted in Remark 1, bundling can also arise when $\Pi^{HL} > \Pi^{M} > \Pi^{H}$. In this case, we may have $CS^M > CS^H$ which exacerbates the harmful effect of bundling practices on welfare as the product generating both the highest industry profit and consumer surplus is excluded from the market.

Despite the presence of buyer power, it is worth noting that our theory does not challenge the fact that a manufacturer must hold a dominant position to impose an exclusive dealing or a bundling requirement. Indeed, a key condition for the profitability of these vertical restrictions is that U_1 owns a "must-have" product or product portfolio: exclusive dealing (resp. bundling) cannot be profitable if H (resp. HL) generates less profit than M. Instead, we stress that buyer power is unlikely to help preventing the use of such anticompetitive practices.

V. Discussion

We discuss now the timing and commitment assumptions required in our buyer power theory and relate them to previous work in the literature (Section V.A). We then extend our theory to the cases where D has a different bargaining weight vis-à-vis U_1 and U_2 (Section V.B) and where D is able to strategically choose the number of products to distribute (Section V.C).

A. *Timing and commitment*

Timing. — In our model, we assume that manufacturers can impose a vertical restraint prior to contract negotiations. While this aims at capturing the long-term nature of exclusive dealing and bundling contracts which may typically cover several years, we rely on two distinct literature to further motivate this timing assumption. First, we build on a recent stream of articles that develop game theoretical frameworks in which a network formation protocol is followed by a surplus sharing rule conditional upon the realized network (see, e.g., Liebman, 2018; Nocke and Rey, 2018; Ho and Lee, 2019; Rey and Vergé, 2020). Similar to our framework in which the vertical restraint affects the product assortment that D can select (network formation), the timing considered in these articles involves a commitment to a buyer-seller network before bargaining take place. Second, the assumption that manufacturers choose their contractual form (e.g., exclusive dealing or territories, resale price maintenance) in an initial stage is customary in the vertical restraints literature (see, e.g., Rey and Tirole, 1986; Mathewson and Winter, 1987; Rey and Stiglitz, 1995; Martimort and Piccolo, 2010; Calzolari, Denicolò and Zanchettin, 2020). This also entails a certain degree of commitment that we discuss below.[31]

[30] See paragraph 221 of the EC guidelines on vertical restraints (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52010SC0411&from=EN).

[31] An alternative approach to our sequential structure is that manufacturers offer a menu of contracts (e.g., a two-part tariff with and without exclusivity) from which D can choose. In addition to frequently

Commitment. — Our timing assumption involves two types of commitment. First, we assume that U_1 is able to commit to exclusive dealing or bundling, implying that it engages not to offer H to D if the latter were to deal with U_2 for M. We motivate this commitment assumption on the ground that U_1 may build a reputation for enforcing a particular selling policy.[32] It is worth noting, however, that this requires a lower level of commitment than that in Whinston (1990) where bundling is profitable only to the extent that entry is deterred (see also Choi and Stefanadis, 2001; Carlton and Waldman, 2002).[33] Instead, along the lines of Peitz (2008), our Proposition 2 highlights that bundling is an optimal selling strategy in the presence of an actual (rather than a potential) rival.[34]

Second, we also assume that D is able to commit to a particular product assortment. As no agreement is formed in stage 1, it is noteworthy that this assumption is weaker than that in the "rent-extraction" theory (Aghion and Bolton, 1987) and the "naked-exclusion" theory (Rasmusen, Ramseyer and Wiley, 1991; Segal and Whinston, 2000).[35] Once an exclusive dealing or bundling contract is signed with U_1 in stage 2, however, we rule out any Pareto-improving renegotiation leading D to also deal with U_2 while leaving the same profit to U_1 (thereby eliminating the inefficiency of U_1's vertical restraint).[36] The presence of prohibitive transaction costs (e.g., renegotiation efforts, delaying production, breach penalties) helps sustain this commitment. Moreover, as previously stated, U_1 is much likely to engage in costly judicial disputes to sustain its reputation in the enforcement of its selling policy.

create a multiplicity of Nash equilibria (see, e.g., Bernheim and Whinston, 1998; Calzolari, Denicolò and Zanchettin, 2020), incorporating a menu of contracts in a bargaining game is beyond the scope of this article.

[32]In practice, this "all-or-nothing" deal is often used by manufacturers which own "must-have' products. A prominent example can be found in United States vs Dentsply (2005) in which the artificial teeth manufacturer Dentsply (75–80 per cent of market shares) imposed an "all-or-nothing" deal stating that: "In order to effectively promote Dentsply/York products, dealers that are recognized as authorized distributors may not add further tooth lines to their product offering." (https://www.justice.gov/atr/case-document/us-v-dentsply-brief-united-states-redacted). See also The Coca-Cola Company (2005, page 8) in which the EC gathered evidence that: "TCCC and its bottlers refused to supply a customer with only one of their brands unless the customer was willing to carry other CSDs or non-CSD NABs of TCCC or its bottlers." (Case COMP/A.39.116/B2).

[33]More precisely, the fact that bundling is a suboptimal selling strategy absent entry implies that these alternative "leverage theories" only apply to technical bundling.

[34]As a consequence, our commitment assumption is also weaker than that in Aghion and Bolton (1987) and the ensuing literature which require the incumbent to commit on both the contractual form and the terms of trade with the retailer before the entrant shows up.

[35]As pointed out in Ide, Montero and Figueroa (2016), these theories rely on the assumption that the retailer contractually commits to exclusivity with the incumbent before the entrant shows up. In contrast, while bargaining with U_1, we consider that the retailer remains free to leave the negotiation table and deal with U_2 without having to pay any penalty for contractual breach.

[36]A similar commitment assumption is found in the "rent-extraction" literature (e.g., Aghion and Bolton, 1987; Marx and Shaffer, 1999). We refer to Spier and Whinston (1995) for an extensive discussion on the role of contract renegotiation.

B. Manufacturer-specific bargaining weights

So far, we have assumed that D has the same bargaining weight vis-à-vis each manufacturer. In what follows, we show that relaxing this assumption does not affect our results.

Let us denote by α_i the bargaining weight of D vis-à-vis U_i with $i = 1, 2$. Rewriting (1) and (4) accordingly, U_1's profit equals $(1-\alpha_1)\left(\Pi^{HM} - \Pi^{M}\right)$ absent exclusive dealing and $\min\left\{(1-\alpha_1)\Pi^{H}, \Pi^{H} - \Pi^{M}\right\}$ under exclusive dealing. Thus, exclusive dealing is profitable for U_1 whenever $\alpha_1 > \alpha_{ED}$. Similarly, rewriting (7) and (9), U_1's profit equals $(1-\alpha_1)\left(\Pi^{HM} - \Pi^{M}\right)$ under the component strategy and $\min\left\{(1-\alpha_1)\Pi^{HL}, \Pi^{HL} - \Pi^{M}\right\}$ under bundling. As a result, bundling is profitable for U_1 whenever $\alpha_1 > \alpha_B$.

Interestingly, these profitability conditions for U_1's vertical restrictions do not depend on D's bargaining weight vis-à-vis U_2. Indeed, α_2 only increases D's losses caused by U_1's restrictions.[37] Hence, U_1 does not find less profitable to exclude M from the market even if it is sold at cost by a competitive fringe or if U_2 is vertically integrated with D ($\alpha_2 = 1$). Conversely, the use of vertical restrictions are not more profitable for U_1 when U_2 is powerful ($\alpha_2 = 0$).

C. Endogenous product assortment size

Following Ho and Lee (2019), a downstream firm may have an incentive to strategically narrow its product assortment to strengthen its bargaining leverage with respect to upstream firms (see also, among others, Inderst and Shaffer, 2007; Marx and Shaffer, 2010*b*). Moreover, one may also consider that the downstream firm can widen its product assortment to prevent any harmful effect of bundling practices. We explore both strategies by allowing D to choose the number of products to distribute on the market.

Exclusive dealing. — Consider first the framework of exclusive dealing as developed in Section I and solved in Section II. In stage 1, we now allow D to select either HM or H when manufacturers do not impose any exclusive dealing requirement.[38] If D selects the assortment HM, the equilibrium outcome is given by (3). Instead, if D selects the assortment H, it gets the same profit as under exclusive dealing given by (5). Comparing D's profit in (3) and (5) we obtain that, absent exclusive dealing, D chooses to narrow its product assortment to H when $\alpha_D \equiv \left(\Pi^{HM} - \Pi^{H}\right) / \left(2\Pi^{HM} - \Pi^{H} - \Pi^{M}\right) > \alpha$ (see Figure 1 for an illustrative example). As $\alpha_{ED} > \alpha_D$, D's strategy to narrow its product assortment has no effect on U_1's incentive to impose an exclusive dealing, implying

[37] More specifically, D's losses from U_1's exclusive dealing or bundling are increasing in α_2 at a rate $\Pi^{HM} - \Pi^{H}$ (the marginal contribution of U_2's product to the industry profit).

[38] Considering that D can also select M is irrelevant as it is not a stable product assortment under Assumption A1.

that Proposition 1 still holds. This result highlights, however, a close relationship between D's product assortment size and its bargaining power in negotiations with manufacturers. When D is strong in its bargaining (α is high), its threats of replacement are not credible to exercise. The sharing of profit is thus determined by the "Nash-in-Nash" solution where the surplus captured by each manufacturer is proportional to its marginal contribution to the industry profit. Hence, by expanding its product assortment to HM, D not only increases the industry profit to be divided but also decreases the marginal contribution of each manufacturer. This strategy strengthens D's bargaining position which extracts a larger share of a larger pie. In contrast, when D is weak in its bargaining (α is low), it has an incentive to narrow its product assortment to intensify upstream competition by playing manufacturers off against each other. Although such a strategy shrinks the industry profit to H, it ensures a profit of Π^M to D even when α tends to 0.

Bundling. — A similar reasoning applies to the case of upstream bundling. While D may have an incentive to narrow its assortment to a single product when α is low, this strategy is unlikely to affect U_1's incentive to bundle its products which only arises when α is high. One may consider, however, that D has an incentive to expand its product assortment to annihilate any harmful effect of bundling. To explore such a strategy, we consider the framework of upstream bundling and modify stage 1 in Section I as follows. When U_1 chooses a bundling strategy, D is now able to select either HML or HL; otherwise, D can select either HML or HM.[39] In what follows, we sketch the solution of this game and refer to Appendix E for a formal analysis.

First, regardless of U_1's selling strategy, if D selects HML the surplus division in the vertical chain is determined by the "Nash-in-Nash" solution. The equilibrium fixed fees are thus given by $\tilde{F}_1^{HML} = (1-\alpha)\left(\Pi^{HML} - \Pi^{M}\right)$ and $\tilde{F}_2^{HML} = (1-\alpha)\left(\Pi^{HML} - \Pi^{HL}\right)$ and D's profit equals $\tilde{\pi}_D^{HML} = \Pi^{HML} - \tilde{F}_1^{HML} - \tilde{F}_2^{HML}$. Alternatively, if D selects HL (resp., HM) when U_1 chooses a bundling (resp., component) strategy, the equilibrium outcome is given by (10) (resp., (8)). Comparing $\tilde{\pi}_D^{HML}$ and $\tilde{\pi}_D^{HL}$ we obtain that, if U_1 has opted for a bundling strategy, D chooses to expand its product assortment to HML when $\alpha > \min\left\{\tilde{\alpha}_C, \tilde{\alpha}_D\right\}$ where $\tilde{\alpha}_D \equiv \left(\Pi^{HML} - \Pi^{HL}\right) / \left(2\Pi^{HML} - \Pi^{HL} - \Pi^{M}\right)$. This strategy offsets the harmful effect of bundling to the benefit of D and the industry profit. In contrast, when $\min\left\{\tilde{\alpha}_C, \tilde{\alpha}_D\right\} > \alpha$, narrowing its product assortment to HL remains an appealing rent-extraction mechanism for D through the use of threats of replacement. Similarly, comparing $\tilde{\pi}_D^{HML}$ and $\tilde{\pi}_D^{HM}$ we obtain that, if U_1 opts for a component strategy, D chooses to expand its product assortment to HML when $\alpha > \min\left\{\left(\Pi^{HL} - \Pi^{H}\right) / \left(\Pi^{HM} - \Pi^{H}\right), \tilde{\alpha}'_D\right\}$ where $\tilde{\alpha}'_D \equiv \left(\Pi^{HML} - \Pi^{HM}\right) / \left(2\Pi^{HML} - \Pi^{HL} - \Pi^{HM}\right)$.

[39] Again, considering any other assortment of two products is irrelevant as none of them is stable under Assumption A1.

To analyze the profitability of bundling, we compare U_1's profit under both selling strategies and obtain that bundling arises in equilibrium when $\min\left\{\left(\Pi^{HL}-\Pi^{H}\right)/\left(\Pi^{HM}-\Pi^{H}\right),\tilde{\alpha}'_D\right\} > \alpha > \alpha_B$. While the condition from Proposition 2 still holds (that is, $\alpha > \alpha_B$), this result shows that bundling practices are less likely to arise when D is able to expand its product assortment. In the following illustrations, we show that this strategy does not always neutralize U_1's bundling practices (see Appendix E for a general analysis). Consider two simple examples with independent products. In the example already analyzed in Section III, we have $\Pi^H = 4$, $\Pi^M = 3$, and $\Pi^L = 1$, implying that $\min\left\{\left(\Pi^{HL}-\Pi^{H}\right)/\left(\Pi^{HM}-\Pi^{H}\right),\tilde{\alpha}'_D\right\} = 1/4$ and $\alpha_B = 1/2$. In this case, the expansion of D's product assortment prevents the emergence of bundling practices. Considering now that $\Pi^M = 3/2$, we have $\min\left\{\left(\Pi^{HL}-\Pi^{H}\right)/\left(\Pi^{HM}-\Pi^{H}\right),\tilde{\alpha}'_D\right\} = 2/5$ and $\alpha_B = 1/8$, implying that bundling arises in equilibrium when $2/5 > \alpha > 1/8$. Moreover, we have that bundling excludes U_2 from the market when $3/13 > \alpha > 1/8$.[40]

Summary. — A consequence of the above analysis is that exclusive dealing is more likely to raise anticompetitive concerns than bundling practices as D is never able to counteract the harmful effect of such a vertical restraint. For instance, whenever U_1 finds profitable to impose an exclusive dealing requirement to D for distributing H and L only, M is always excluded from the market. If instead U_1 sells H and L as a bundle, we have shown that D may (if doable) find profitable to expand its stocking capacity and distribute the assortment HML.

VI. Alternative Microfoundation for NNTR

Throughout this article, we rely on the NNTR bargaining solution to reconsider the Chicago School critique of exclusive dealing and the leverage doctrine in a bargaining context. To motivate this surplus division rule, Ho and Lee (2019) have offered a noncooperative foundation for the NNTR solution which hinges on two key elements. First, the downstream firm can commit to engage in negotiations with a particular network of upstream firms. Second, each delegated agent sent by the downstream firm to negotiate on its behalf is able to go "back and forth" between upstream firms inside and outside its network (thereby playing them off against one another during negotiations). Following the same purpose, we introduce the "Nash-in-Nash with Prior Competition for Slots" (NNPCS) model in which the downstream firm is auctioning a limited number of slots before negotiating wholesale contracts with upstream firms according to the "Nash-in-Nash"

[40] As previously mentioned, allowing D to narrow its product assortment to a single product when U_1 opts for a component strategy is unlikely to affect the profitability of bundling practices. Indeed, if U_1 opts for a component strategy, it can be shown that D selects H instead of HML or HM only when $1/8 > \alpha$.

solution.[41] We show that the NNPCS model provides an alternative microfoundation for the NNTR solution.

For the sake of exposition, we consider the same market structure as in Section II where U_1 and U_2 supply products H and M respectively.[42] To distribute these products on the market, D has a stocking capacity of either one or two slots.[43] In addition to Assumptions A1 and A2, we consider the NNPCS model which can be described by the following three-stage game:

- Stage 1: U_1 and U_2 simultaneously offer slotting fees (non-negative lump sump payments) to secure a slot. Then, D publicly announces its product assortment decision.[44]
- Stage 2: Given D's product assortment decision, trade takes place. Terms of trade are determined through bilateral negotiations and take the form of two-part tariffs. If D purchases from both manufacturers, negotiations take place simultaneously and secretly.
- Stage 3: D sets its price(s) and sells to consumers.

Competition for slots and bargaining protocol. — As pointed out by the Federal Trade Commission (2001, page 30), slotting fees: "may serve as devices for retailers to auction their shelf space and efficiently determine its highest-valued use." The "auction" for slots conducted by D in stage 1 is modelled as an asymmetric Bertrand competition, which is known to have a multiplicity of Nash equilibria. To select among equilibria, we rely on Selten's (1975) concept of trembling hand perfection. Furthermore, instead of the NNTR solution, we use the "Nash-in-Nash" bargaining solution to determine terms of trade in stage 2. Proceeding backwards, we solve the above NNPCS model.

Bargaining stage. — As already discussed in Section I, bilateral efficiency prevails implying that stages 2 and 3 can be gathered in a unique stage where each pair $D - U_i$ bargains over a fixed fee to divide the integrated industry profit. If D has selected the product assortment HM, each manufacturer deals with D and the surplus obtained by each firm from bilateral negotiations is given by (3). Alternatively, if D has selected the product assortment $X \in \{H, M\}$, only one

[41] It is worth noticing that this framework is closely related to Marx and Shaffer (2010*b*). However, in contrast to us, they consider that bilateral negotiations take place sequentially.

[42] Considering a more sophisticated market structure as in Section III does not affect the analysis. We refer to a previous version of this article for further details (see Chambolle and Molina, 2020).

[43] As in Marx and Shaffer (2010*b*), we consider that the sale of a product requires exactly one slot (that is, a slot enables a manufacturer to satisfy any amount of consumer demand for its product).

[44] Slotting fees are used here in their broad sense. As mentioned by the Federal Trade Commission (2003), researchers use the term "slotting fees" to describe both "introduction fees" which are paid for new products and "pay-to-stay fees" which are paid to maintain shelf presence for continuing products.

bilateral negotiation takes place and the corresponding fixed fee $\hat{F}_i^X$ is determined by the (asymmetric) Nash bargaining solution as follows:

$$\max_{\hat{F}_i^X} \left(\Pi^X - \hat{F}_i^X\right)^\alpha \left(\hat{F}_i^X\right)^{1-\alpha} \tag{11}$$

where the gains from trade of D and U_i are $\Pi^X - \hat{F}_i^X$ and $\hat{F}_i^X$ respectively. From (11), we find that the surplus obtained by D and U_i from this bilateral negotiation is respectively given by $\hat{\pi}_D^X = \alpha\Pi^X$ and $\hat{\pi}_i^X = \hat{F}_i^X = (1-\alpha)\Pi^X$.

Competition for slots.. — The competition for slots in stage 1 depends on D's stocking capacity. Consider the case in which D has two slots. As a slot is available for each product and D is strictly better off distributing both products rather than just one ($\pi_D^{HM} > \hat{\pi}_D^X$), the product assortment HM is always offered. Hence, regardless of its rival's slotting fee, a manufacturer has no incentive to offer a positive slotting fee to secure one slot for its product. Note also that a manufacturer has no incentive either to offer a positive slotting fee to monopolize D's slots (see Appendix F.F1 for a proof). Therefore, absent any restriction on D's stocking capacity, each manufacturer offers a slotting fee equal to $S_i^{HM} = 0$ with $i = 1, 2$.

Consider now that D has only one slot. To secure the slot, each manufacturer can at most offer what it would gain from trading with D in the bargaining stage, that is $\hat{\pi}_1^H$ for U_1 and $\hat{\pi}_2^M$ for U_2. As $\hat{\pi}_D^H + \hat{\pi}_1^H > \hat{\pi}_D^M + \hat{\pi}_2^M \Leftrightarrow \Pi^H > \Pi^M$, U_1 can always offer a slotting fee to secure D's slot for H. As the competition for slots is tantamount to an asymmetric Bertrand competition, U_1 offers a slotting fee such that D is indifferent between selecting H or replacing it with M, that is $\hat{\pi}_D^H + S_1 = \hat{\pi}_D^M + \hat{\pi}_2^M \Leftrightarrow S_1 = \max\left\{\Pi^M - \alpha\Pi^H, 0\right\}$.[45] U_1's slotting fee is thus equivalent to the compensation C paid to D for not selling M instead of H as described in Section II. This slotting fee is positive whenever D's bargaining power vis-à-vis manufacturers is sufficiently weak ($\alpha_C > \alpha$).

The solution of the NNPCS model yields the following proposition:

PROPOSITION 3: *The equilibrium surplus division in the NNPCS model coincides with the NNTR bargaining solution.*

PROOF:

When D has a single slot, the NNPCS model yields a profit equal to $\hat{\pi}_D^H + S_1^H = \max\left\{\alpha\Pi^H, \Pi^M\right\} = \pi_D^H$ for D, $\hat{\pi}_1^H - S_1^H = \min\left\{(1-\alpha)\Pi^H, \Pi^H - \Pi^M\right\} = \pi_1^H$ for U_1, and $\hat{\pi}_2^H = 0 = \pi_2^H$ for U_2. When D has two slots, the NNPCS model yields a profit equal to π_D^{HM} for D, π_1^{HM} for U_1, and π_2^{HM} for U_2.

[45] While there exist other pure-strategy Nash equilibria, we show in Appendix F.F2 that these alternative equilibria are not trembling-hand perfect.

In the NNPCS model, D always selects the product that generates the highest industry profit (here H).[46] This efficiency result provides theoretical grounds for the stability condition required in the NNTR solution. Moreover, the NPPCS model enables to explain why in the NNTR bargaining solution the downstream firm can threaten its upstream trading partner to deal with an excluded alternative one at its reservation tariff.[47] Hence, leveraging on recent microfoundations for the "Nash-in-Nash" solution (Collard-Wexler, Gowrisankaran and Lee, 2019; Rey and Vergé, 2020), Proposition 3 implies that the NNPCS model provides a noncooperative foundation for the NNTR bargaining solution. Consider now that D's stocking capacity is not exogenous but determined in an *ex ante* stage (Stage 0). Assuming that in stage 0 manufacturers may adopt an exclusive dealing requirement, we derive the following corollary that replicates Proposition 1's result:

COROLLARY 4: *Under the NNPCS model, exclusive dealing is profitable for U_1 when $\alpha > \alpha_{ED}$.*

Assuming instead that, in stage 0, D may choose to reduce its stocking capacity to one slot, we find that D profitably narrows its product assortment when $\alpha_D > \alpha$ which replicates the result of Section V.C.

Using the NNTR bargaining solution in Sections II and III, we have shown that our exclusionary mechanism is well suited to industries in which a downstream firm is able to play off upstream firms against one another by going "back and forth" between them during negotiations as, for instance, in the health care sector (Ho and Lee, 2019). Corollary 4 further shows that it can also apply to markets in which firms behave according to the NNPCS framework. For instance, this reflects well the conduct of firms in the retail industry where manufacturers frequently provide retailers with upfront payments for the carriage of their products.[48] Hence, in addition to offering a new theoretical foundation for the NNTR solution, the NNPCS framework developed in this section extends the scope of our exclusionary mechanism to industries where upfront payments (e.g., slotting fees) are prevalent.[49]

VII. Conclusion

This article offers a unified theory to the analysis of exclusive dealing and exclusionary bundling. We consider a framework with two competing manufacturers

[46]The manufacturer of the most efficient product is indeed always able to offer a slotting fee such that D selects its product.

[47]More specifically, it might not be obvious why in the NNTR bargaining solution an excluded upstream firm has no bargaining power vis-à-vis the downstream firm when being used as a threat of replacement.

[48]For instance, Hristakeva (2020) estimate that such payments correspond to 20 percent of retailers' variables profits in the U.S. grocery yogurt market. Elberg and Noton (2021) also provide empirical evidence on the substantial magnitude of upfront payments in the Chilean supermarket industry.

[49]For instance, our "leverage theory" of bundling fits particularly well with the EC claim in The Coca-Cola Company (TCCC) case (see footnote 4).

which interact with a powerful retailer in a three-stage game. First, manufacturers choose whether or not to impose a vertical restriction on the retailer's purchases (exclusive dealing or bundling) which then selects its product assortment accordingly. Second, trade takes place following the "Nash-in-Nash with Threat of Replacement" bargaining protocol à la Ho and Lee (2019). Third, the retailer sets prices and sells to consumers. Assuming that one manufacturer holds a "must-have" product or brand portfolio, we show that the presence of buyer power facilitates the use of exclusive dealing or bundling which leads to the exclusion of the other manufacturer at the expense of the retailer, the industry profit and consumers. Our main contribution is thus to provide a unifying framework which, through a single parameter capturing the retailer's buyer power, either supports or rejects the Chicago School argument for both exclusive dealing and bundling practices.

From a competition policy perspective, our theory highlights that a large buyer power which countervails the exercise of upstream market power paradoxically favors the emergence of anticompetitive practices by manufacturers. This results sharply contrasts with the classic competition policy view on the procompetitive effects of buyer power as stated, for instance, in the EC guidelines on vertical restraints. More generally, our article provides guidance for the antitrust treatment of buyer power which has become a major issue these last decades.

Finally, we introduce a game-theoretic framework, referred to as "Nash-in-Nash with Prior Competition for Slots" (NNPCS), in which manufacturers compete for getting access to the retailer's limited number of slots before bargaining takes place. We argue that the NNPCS offers a new noncooperative foundation for the NNTR solution as well as a tractable building block which provides interesting perspectives for future research.

Proof of Propositions 1 and 2

Proof of Proposition 1. — Absent exclusive dealing, U_1 always obtains a profit equal to $(1-\alpha)(\Pi^{HM}-\Pi^{M})$. Under exclusive dealing, U_1 obtains a profit equal to $(1-\alpha)\Pi^{H}$ when $\alpha > \alpha_C$. Under Assumption A1, it is straightforward that exclusive dealing is always profitable in this case. When $\alpha_C > \alpha$, U_1 obtains a profit equal to $\Pi^{H}-\Pi^{M}$ under exclusive dealing, which is profitable whenever $\alpha > \alpha_{ED}$. Note that $\alpha_C \geq \alpha_{ED} \Leftrightarrow \Pi^{M}(\Pi^{HM}-\Pi^{M}) \geq \Pi^{H}(\Pi^{HM}-\Pi^{H}) \Leftrightarrow (\Pi^{H}-\Pi^{M})(\Pi^{H}+\Pi^{M}-\Pi^{HM}) \geq 0$ which is always satisfied under Assumptions A1 and A2.

Proof of Proposition 2. — Under a component strategy, U_1 always obtains a profit equal to $(1-\alpha)(\Pi^{HM}-\Pi^{M})$. Under bundling, U_1 obtains a profit equal to $(1-\alpha)\Pi^{HL}$ when $\alpha > \tilde{\alpha}_C$. Under Assumption A2, it is straightforward that bundling is always profitable in this case. When $\tilde{\alpha}_C > \alpha$, U_1 obtains a profit equal to $\Pi^{HL}-\Pi^{M}$ under bundling, which is profitable whenever $\alpha > \alpha_B$. Note that $\tilde{\alpha}_C \geq \alpha_B \Leftrightarrow \Pi^{M}(\Pi^{HM}-\Pi^{M}) \geq \Pi^{HL}(\Pi^{HM}-\Pi^{HL}) \Leftrightarrow (\Pi^{HL}-\Pi^{M})(\Pi^{HL}+\Pi^{M}-\Pi^{HM}) \geq 0$ which is always satisfied under Assumptions A1 and A2.

Exclusive dealing and bundling harm the downstream firm

This section shows that D is always harmed whenever U_1 imposes an exclusive dealing or a bundling restriction. To this end, we demonstrate that U_1 and D always bargain to share a (weakly) lower joint profit under exclusive dealing or bundling. As a result, whenever exclusive dealing or bundling is profitable for U_1, it must be to the detriment of D.

Exclusive dealing. — Absent exclusive dealing, the amount of surplus divided between D and U_1 is given by $\Pi^{HM}-F_2^{HM} = \alpha\Pi^{HM}+(1-\alpha)\Pi^{H}$. Under exclusive dealing, this surplus equals Π^{H}. By Assumption A1, we obtain that the surplus shared between D and U_1 is strictly lower under exclusive dealing.

Bundling. — When U_1 chooses a component selling strategy, the amount of surplus divided between D and U_1 is given by $\Pi^{HM}-\tilde{F}_2^{HM} = \alpha\Pi^{HM}+(1-\alpha)\Pi^{H}$ if $\alpha > \left(\Pi^{HL}-\Pi^{H}\right)/\left(\Pi^{HM}-\Pi^{H}\right)$ and $\Pi^{HM}-\tilde{F}_2^{HM} = \Pi^{HL}$ otherwise. When U_1 chooses instead a bundling strategy, this surplus equals Π^{HL}. If $\left(\Pi^{HL}-\Pi^{H}\right)/\left(\Pi^{HM}-\Pi^{H}\right) > \alpha$, the surplus shared between D and U_1 is not affected by U_1's selling strategy. If $\alpha > \left(\Pi^{HL}-\Pi^{H}\right)/\left(\Pi^{HM}-\Pi^{H}\right)$, however, it is straightforward that the surplus shared between D and U_1 is strictly lower when U_1 chooses a bundling strategy.

Proof of Remark 1

In this section, we prove that Proposition 2 holds if the first part of Assumption A1 ($\Pi^H > \Pi^M > \Pi^L > 0$) is replaced by $\Pi^{HL} > \Pi^M > \Pi^H > \Pi^L > 0$. To this end, we first show that bargaining outcomes determined by (6), (7), and (9) are unaffected. As previously discussed, two conditions are required for applying the NTTR solution to these bilateral negotiations: (i) firms involved in each negotiation have positive gains from trade taking as given their other agreements (if any), (ii) each product for which the tariff is negotiated generates a higher bilateral surplus than any product used by D as a replacement threat taking as given all other agreements (if any). Under the negotiation described by (6), the first condition requires that $\Pi^{HM} > \Pi^H$ and $\Pi^{HL} > \Pi^H$ (Assumption A2) and the second condition requires that $\Pi^{HM} > \Pi^{HL}$ (second part of Assumption A1). Similarly, under the negotiation described by (7), the first condition requires that $\Pi^{HM} > \Pi^M$ (Assumption A2). Finally, under the negotiation described by (9), the first condition requires that $\Pi^{HL} > 0$ and $\Pi^M > 0$ (Assumption A1) and the second condition requires $\Pi^{HL} > \Pi^M$ (first part of Assumption A1). Hence, reversing the ranking between Π^H and Π^M does not affect any bargaining outcome.

Furthermore, from the comparison of U_1's profit in (8) and (10), Proposition 2 requires that $\Pi^{HM} > \Pi^{HL}$ (second part of Assumption A1) and $\Pi^{HM} > \Pi^M$ (Assumption A2). Consequently, relaxing the first part of Assumption A1 by using the weaker condition on M's surplus ($\Pi^{HL} > \Pi^M > \Pi^H > \Pi^L > 0$) does not affect any of our results.

Proof of Remark 2: Bundling of complementary products

In this section, we show that bundling may arise in equilibrium when M and L are complements to H. To this end, let us keep Assumption A1 unchanged and modify Assumption A2 as follows:

ASSUMPTION A2': *Products M and L are imperfect complements to H and independent or imperfect substitutes to each other:*

$$\Pi^{HX} > \Pi^H + \Pi^X > \Pi^H \ \textit{with}\ X \in \{M, L\}$$
$$\Pi^M + \Pi^L \geq \Pi^{ML} > \Pi^M$$

Moreover, we introduce the following restriction on the form of product complementarity:

ASSUMPTION A4: *The complementarity between products H and M is limited as follows:*

$$\Pi^{HL} + \Pi^M \geq \Pi^{HM}$$

The presence of complementarity across products implies that the marginal contribution of a manufacturer's product to the industry profit is greater when other agreements have been formed (e.g., $\Pi^{HM} - \Pi^{M} > \Pi^{H}$). As highlighted in Collard-Wexler, Gowrisankaran and Lee (2019), this may prevent the existence of an equilibrium in which all agreements are formed at tariffs determined by the "Nash-in-Nash" solution because some agreements would be rejected.[50] Indeed, as shown below, D may have an incentive to reject one of its agreement at the NNTR tariffs in the component strategy case. By limiting the form of complementarity between products, Assumption A4 plays the same role as the feasibility assumption in Collard-Wexler, Gowrisankaran and Lee (2019) and ensures that D always prefers maintaining all of its agreements at the NNTR tariffs.

As in Section III, we solve the subgames in which U_1 chooses a component and a bundling strategy before analyzing the profitability of bundling.

COMPONENT STRATEGY. — Consider first the case in which U_1 chooses a component strategy, implying that D may either select the assortment HM, HL, or ML. The use of Assumption A2' instead of Assumption A2 does not affect the result that HM is the unique stable product assortment (see Appendix C for a detailed discussion on the stability conditions in this case). Hence, D always engages in bilateral negotiations with U_2 for M and U_1 for H when the latter chooses a component selling strategy. These negotiations are determined by the NNTR solution as in (6) and (7) respectively, implying that the surplus division is similar to (8). However, the fact that the marginal contribution of H (resp., M) to the industry profit is greater when M (resp., H) is also offered implies that D may obtain a negative profit. Indeed, (8) shows that $\pi_D^{HM} = \Pi^{HM} - \tilde{F}_1^{HM} - \tilde{F}_2^{HM} = \max\left\{(2\alpha-1)\Pi^{HM} + (1-\alpha)\left(\Pi^{H} + \Pi^{M}\right), \Pi^{HL} - (1-\alpha)\left(\Pi^{HM} - \Pi^{M}\right)\right\}$ which, under Assumptions A1 and A2', is increasing in α (i.e., $\partial\pi_D^{HM}/\partial\alpha > 0$). When $\alpha = 0$, we have that $\pi_D^{HM} = \Pi^{HL} - \Pi^{HM} + \Pi^{M}$ which may be negative in the presence of a large complementarity between H and M. Thus, by limiting the degree of complementarity, Assumption A4 ensures that D always gets a positive profit from dealing with both U_1 and U_2 at tariffs determined by the NNTR solution.

BUNDLING STRATEGY. — Consider now the case in which U_1 chooses a bundling strategy, implying that D may either select the assortment HL or M. Again, the use of Assumption A2' instead of Assumption A2 does not affect the result that HL is the unique stable product assortment (see also Appendix C). Hence, D always engages in a bilateral negotiation with U_1 for HL when the latter chooses a bundling strategy. Such a negotiation is determined by the NNTR solution as in (9) and the surplus division is similar to (10).

[50]More precisely, this violates the weak conditional decreasing marginal contribution assumption of Collard-Wexler, Gowrisankaran and Lee (2019).

The comparison of U_1's profit in (8) and (10) leads to Proposition 2 in a setting with bundling of complementary products. The proof is as follows. Under a component strategy, U_1 always obtains a profit equal to $(1-\alpha)\left(\Pi^{HM}-\Pi^{M}\right)$. Under bundling, U_1 obtains a profit equal to $(1-\alpha)\Pi^{HL}$ when $\alpha > \tilde{\alpha}_C$. From Assumption A4, it is straightforward that bundling is always profitable in this case. When $\tilde{\alpha}_C > \alpha$, U_1 obtains a profit equal to $\Pi^{HL}-\Pi^{M}$ under bundling, which is profitable whenever $\alpha > \alpha_B$. Note that $\tilde{\alpha}_C > \alpha_B \Leftrightarrow (\Pi^{HL}-\Pi^{M})(\Pi^{HL}+\Pi^{M}-\Pi^{HM}) \geq 0$ which is always satisfied under Assumptions A1, A2', and A4.

Endogenous product assortment size

In this section, we extend our "leverage theory" of bundling by allowing D to strategically expand its product assortment to counteract the harmful effect of U_1's bundling practices (the exclusive dealing case is entirely treated in Section V.C). Consider the same framework as developed in Section I and solved in Section III with the following three-stage game. In stage 1, U_1 decides whether or not to impose a bundling requirement to D. Then, D publicly announces its product assortment which may be expanded to include all products. Stages 2 and 3 remain as in Section I.

Component strategy. — Consider first that U_1 chooses a component selling strategy. In this case, D either selects the assortment HML or HM. If D selects HML, it engages in bilateral negotiations with U_1 for HL and U_2 for M, implying that the NNTR solution yields the same outcome as the "Nash-in-Nash" solution. The fixed fee negotiated between D and U_1 is thus determined as follows:

$$\text{(E1)} \qquad \max_{\tilde{F}_1^{HML}} \left(\Pi^{HML}-\tilde{F}_1^{HML}-\tilde{F}_2^{HML}-(\Pi^{M}-\tilde{F}_2^{HML})\right)^{\alpha}\left(\tilde{F}_1^{HML}\right)^{1-\alpha}$$

where $\Pi^{HML}-\tilde{F}_1^{HML}-\tilde{F}_2^{HML}-(\Pi^{M}-\tilde{F}_2^{HML})$ and $\tilde{F}_1^{HML}$ correspond to the gains from trade of D and U_1 respectively.[51] Similarly, the fixed fee between D and U_2 is determined as follows:

$$\text{(E2)} \qquad \max_{\tilde{F}_2^{HML}} \left(\Pi^{HML}-\tilde{F}_1^{HML}-\tilde{F}_2^{HML}-(\Pi^{HL}-\tilde{F}_1^{HML})\right)^{\alpha}\left(\tilde{F}_2^{HML}\right)^{1-\alpha}$$

where $\Pi^{HML}-\tilde{F}_1^{HML}-\tilde{F}_2^{HML}-(\Pi^{HL}-\tilde{F}_1^{HML})$ and $\tilde{F}_2^{HML}$ correspond to the gains from trade of D and U_2 respectively. From (E1) and (E2), we obtain that

[51] We assume here that there is a unique fixed fee negotiated for both H and L as in the bundling case. An alternative modeling approach would be to consider that D and U_1 engage in two separate and simultaneous negotiations for each product (i.e., each firm sends two delegates to negotiate fixed fees on their behalf). This would imply, however, that U_1 competes against itself, thereby conferring a higher status quo payoff to D which would decrease U_1's profit.

U_1's fixed fee equals $\tilde{F}_1^{HML} = (1-\alpha)\left(\Pi^{HML} - \Pi^{M}\right)$ and U_2's fixed fee equals $\tilde{F}_2^{HML} = (1-\alpha)\left(\Pi^{HML} - \Pi^{HL}\right)$. As a result, the equilibrium profit of D, U_1, and U_2 are respectively given by:

$$\text{(E3)} \quad \tilde{\pi}_D^{HML} = \Pi^{HML} - \tilde{F}_1^{HML} - \tilde{F}_2^{HML}; \quad \tilde{\pi}_1^{HML} = \tilde{F}_1^{HML}; \quad \tilde{\pi}_2^{HML} = \tilde{F}_2^{HML}.$$

Alternatively, if D selects HM, it engages in bilateral negotiations with U_1 for H and U_2 for M and the equilibrium outcome is given by (8). Comparing D's profit in (8) and (E3), we obtain that D selects the assortment HML when $\alpha > \min\left\{\left(\Pi^{HL} - \Pi^{H}\right)/\left(\Pi^{HM} - \Pi^{H}\right), \tilde{\alpha}'_D\right\}$ where $\tilde{\alpha}'_D \equiv \left(\Pi^{HML} - \Pi^{HM}\right)/\left(2\Pi^{HML} - \Pi^{HL} - \Pi^{HM}\right)$. Otherwise, D selects HM.

Bundling strategy. — Consider now that U_1 chooses a bundling strategy. In this case, D either selects the assortment HML or HL. If D selects HML, it engages in bilateral negotiations with U_1 for HL and U_2 for M and the equilibrium outcome is given by (E3). Instead, if D selects HL, it engages in a bilateral negotiation with U_1 for HL and the equilibrium outcome is given by (10). Comparing D's profit in (10) and (E3), we obtain that D selects the assortment HML when $\alpha > \min\left\{\tilde{\alpha}_C, \tilde{\alpha}_D\right\}$ where $\tilde{\alpha}_D \equiv \left(\Pi^{HML} - \Pi^{HL}\right)/\left(2\Pi^{HML} - \Pi^{HL} - \Pi^{M}\right)$. Otherwise, D selects HL.

Profitability of bundling. — Given D's product assortment choice, we analyze U_1's incentive to bundle its products:

(i) When $\min\left\{\tilde{\alpha}_C, \tilde{\alpha}_D, \left(\Pi^{HL} - \Pi^{H}\right)/\left(\Pi^{HM} - \Pi^{H}\right), \tilde{\alpha}'_D\right\} > \alpha$, D selects HM if U_1 chooses a component strategy and HL if U_1 chooses a bundling strategy. Comparing U_1's profit in (8) and (10), we obtain that U_1 chooses a bundling strategy if $\alpha > \alpha_B$.

(ii) When $\min\left\{\left(\Pi^{HL} - \Pi^{H}\right)/\left(\Pi^{HM} - \Pi^{H}\right), \tilde{\alpha}'_D\right\} > \alpha > \min\left\{\tilde{\alpha}_C, \tilde{\alpha}_D\right\}$, D selects HM if U_1 chooses a component strategy and HML if U_1 chooses a bundling strategy. Comparing U_1's profit in (8) and (E3), we obtain that U_1 always chooses a bundling strategy.

(iii) When $\min\left\{\tilde{\alpha}_C, \tilde{\alpha}_D\right\} > \alpha > \min\left\{\left(\Pi^{HL} - \Pi^{H}\right)/\left(\Pi^{HM} - \Pi^{H}\right), \tilde{\alpha}'_D\right\}$, D selects HML if U_1 chooses a component strategy and HL if U_1 chooses a bundling strategy. Comparing U_1's profit in (10) and (E3), U_1 has an incentive to choose a bundling strategy only if $\alpha > \left(\Pi^{HML} - \Pi^{HL}\right)/\left(\Pi^{HML} - \Pi^{M}\right) > \tilde{\alpha}_D$ which contradicts the initial condition. Hence, when $\min\left\{\tilde{\alpha}_C, \tilde{\alpha}_D\right\} > \alpha > \min\left\{\left(\Pi^{HL} - \Pi^{H}\right)/\left(\Pi^{HM} - \Pi^{H}\right), \tilde{\alpha}'_D\right\}$, U_1 always chooses a component strategy.

(iv) When $\alpha > \max\left\{ \min\left\{\tilde{\alpha}_C, \tilde{\alpha}_D\right\}, \min\left\{ \left(\Pi^{HL} - \Pi^{H}\right) / \left(\Pi^{HM} - \Pi^{H}\right), \tilde{\alpha}'_D\right\}\right\}$, D select HML regardless of U_1's selling strategy, which implies that the latter is indifferent between opting for a component or a bundling strategy.[52]

Given (i) and (ii), bundling arises in equilibrium when $\min\left\{ \left(\Pi^{HL} - \Pi^{H}\right) / \left(\Pi^{HM} - \Pi^{H}\right), \tilde{\alpha}'_D\right\} > \alpha > \alpha_B$. Moreover, given (i), such a selling strategy excludes U_2 from the market when $\min\left\{\tilde{\alpha}_C, \tilde{\alpha}_D, \left(\Pi^{HL} - \Pi^{H}\right) / \left(\Pi^{HM} - \Pi^{H}\right), \tilde{\alpha}'_D\right\} > \alpha > \alpha_B$.

Equilibrium slotting fees in the "Nash-in-Nash with Prior Competition for Slots" model

F1. *Equilibrium slotting fees absent restriction on D's stocking capacity*

When D has two slots, we show that there exists a unique equilibrium in which $S_1^{HM} = S_2^{HM} = 0$.

No deviation towards monopolization of D's slots. — We show that a manufacturer has no incentive to deviate in offering a positive slotting fee to monopolize D's slots with its product. In stage 2, U_1 would be better off if D carries only its product H instead of HM. Indeed, $\hat{\pi}_1^H - \pi_1^{HM} = (1-\alpha)\,\Pi^H - (1-\alpha)\left(\Pi^{HM} - \Pi^{M}\right) > 0$ under Assumption A2. Hence, U_1 may attempt to monopolize D's slots with its product H. To this end, U_1 has to offer a fee at least equals to $\pi_D^H + \tilde{S}^H = \pi_D^{HM} + S_2^{HM} \Leftrightarrow \tilde{S}^H = \pi_D^{HM} - \pi_D^H + S_2^{HM}$. When $S_2^{HM} = 0$, this fee boils down to $\tilde{S}^H = (1-\alpha)\,\Pi^M - (1-2\alpha)\left(\Pi^{HM} - \Pi^{H}\right)$. Under Assumption A2, however, the deviation profit $\hat{\pi}_1^H - \tilde{S}^H$ is lower than π_1^{HM}. Similarly, in stage 2, U_2 is better off if D carries only M instead of HM. By the same reasoning, however, it is not profitable for U_2 to pay a slotting fee to monopolize D's slots with its product M.

No deviation towards positive slotting fees. — Consider that $S_i > 0$. As $\pi_D^{HM} + S_i > \hat{\pi}_D^X + S_i$, D always selects both products in its assortment even if U_i's rival does not offer a positive slotting fee.

F2. *Equilibrium slotting fees under a restriction on D's stocking capacity*

As previously mentioned, when D has a unique slot, the first stage in the NNPCS framework is modelled as an asymmetric Bertrand competition which has a multiplicity of pure-strategy Nash equilibria. Indeed, it can be shown that D keeps selecting H even if U_2 offers any slotting fee $\breve{S}_2 \in \left]S_2, \hat{\pi}_1^H + \hat{\pi}_D^H - \hat{\pi}_D^M\right]$

[52] Absent any gain from bundling, we consider that U_1 chooses a component strategy as a tie-breaking rule.

and U_1 offers $\breve{S}_1 = \breve{S}_2 + \hat{\pi}_D^M - \hat{\pi}_D^H$. However, these alternative equilibria rely on weakly dominated strategies and the equilibrium $S_1 = \max\left\{\Pi^M - \alpha\Pi^H, 0\right\}$ and $S_2 = \hat{\pi}_2^M$ can be obtained from the trembling-hand selection criterion.

Quasi-linear quadratic utility specification

In this section, we show that our illustrative examples developed in Sections II and III can be obtained from a generalized version of the quasi-linear quadratic utility model pioneered by Shubik and Levitan (1980). Following the notations of Choné and Linnemer (2020), we consider a representative consumer whose utility from consuming $n+1$ products is specified as follows:

$$U(\mathbf{q}, q_0) = \mathbf{a}^\top \mathbf{q} - \frac{1}{2}\mathbf{q}^\top \mathbf{B}\mathbf{q} + q_0 \tag{G1}$$

where q_0 is the quantity consumed of the numéraire good, $\mathbf{q}$ is a n-dimensional vector of quantity consumed of each of the n other products, $\mathbf{a}$ is a n-dimensional vector of parameters capturing the marginal quality of each of these products, and $\mathbf{B}$ is a $n \times n$ positive definite matrix of parameters capturing the pattern of substitution among these products. We consider that the diagonal elements of $\mathbf{B}$ equal 1 while the off-diagonal elements equal b_{XY} with $X \neq Y$ (these elements capture the pattern of substitutability and complementarity among products). Based on (G1), the representative consumer maximizes his utility of follows:

$$\max_{\mathbf{q}, q_0} U(\mathbf{q}, q_0) \quad \text{such that} \quad \mathbf{p}^\top \mathbf{q} + p_0 q_0 = m \tag{G2}$$

where $\mathbf{p}$ is a n-dimensional vector of prices, p_0 is the price of the numéraire that we normalize to 1, and m denotes the consumer's wealth. Alternatively, (G2) can be written as: $\max_{\mathbf{q}} U(\mathbf{q}) - \mathbf{p}^\top \mathbf{q} + m$, which yields the following vector of direct demand: $\mathbf{q}(\mathbf{p}) = \mathbf{B}^{-1}(\mathbf{a} - \mathbf{p})$.

Exclusive dealing. — In the framework developed in Section II, there are at most two products offered on the market. Hence, we have $\mathbf{q} = (q_H, q_M)^\top$, $\mathbf{p} = (p_H, p_M)^\top$, $\mathbf{a} = (a_H, a_M)^\top$, and $\mathbf{B} = \begin{pmatrix} 1 & b_{HM} \\ b_{HM} & 1 \end{pmatrix}$ when the assortment HM is offered. Otherwise, we have $\mathbf{q} = q_X$, $\mathbf{p} = p_X$, $\mathbf{a} = a_X$, and $\mathbf{B} = 1$ with $X \in \{H, M\}$. The vector of direct demand when HM is offered is given by:

$$\begin{pmatrix} q_H \\ q_M \end{pmatrix} = \frac{1}{1 - b_{HM}^2} \begin{pmatrix} a_H - p_H - b_{HM}(a_M - p_M) \\ a_M - p_M - b_{HM}(a_H - p_H) \end{pmatrix}$$

and the direct demand when only $X \in \{H, M\}$ is offered is given by: $q_X = a_X - p_X$. Maximizing $\mathbf{p}^\top \mathbf{q}(\mathbf{p})$ with respect to $\mathbf{p}$, the industry profit is given by

$\Pi^{HM} = \left(a_H^2 - 2b_{HM}a_Ha_M + a_M^2\right) / \left(4 - 4b_{HM}^2\right)$ when HM is offered and $\Pi^X = a_X^2/4$ when X is offered.[53] The parameter values $b_{HM} = \left(2\sqrt{3} - \sqrt{2}\right)/5$, $a_H = 4$, and $a_M = 2\sqrt{3}$ lead to $\Pi^{HM} = 5$, $\Pi^H = 4$, and $\Pi^M = 3$.

Bundling. — In the framework developed in Section III, there are also at most two products that can be offered on the market. When either HM or X is offered, the expression for the vector of direct demand and the industry profit are as in the exclusive dealing framework described above. When YL is offered with $Y \in \{H, M\}$, we have $\mathbf{q} = (q_Y, q_L)^\top$, $\mathbf{p} = (p_Y, p_L)^\top$, $\mathbf{a} = (a_Y, a_L)^\top$, and $\mathbf{B} = \begin{pmatrix} 1 & b_{YL} \\ b_{YL} & 1 \end{pmatrix}$. The vector of direct demand is thus given by:

$$\begin{pmatrix} q_Y \\ q_L \end{pmatrix} = \frac{1}{1 - b_{YL}^2} \begin{pmatrix} a_Y - p_Y - b_{YL}(a_L - p_L) \\ a_L - p_L - b_{YL}(a_Y - p_Y) \end{pmatrix}$$

Maximizing $\mathbf{p}^\top \mathbf{q}(\mathbf{p})$ with respect to $\mathbf{p}$, the industry profit is given by $\Pi^{YL} = \left(a_Y^2 - 2b_{YL}a_Ya_L + a_L^2\right) / \left(4 - 4b_{YL}^2\right)$ when YL is offered. The parameter values $a_H = 4$, $a_M = 2\sqrt{3}$, and $a_L = 2$ lead to $\Pi^H = 4$, $\Pi^M = 3$, and $\Pi^L = 1$. Furthermore, the case of independent products can be obtained by setting $b_{HM} = b_{HL} = b_{ML} = 0$.

[53]Without loss of generality, we set the marginal cost of each product to 0.

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