Buyer Power, Upstream Bundling, and Foreclosure *

Claire Chambolle† Hugo Molina‡

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Abstract

This article provides a new rationale for the "leverage theory" of bundling in vertical markets. We analyze a framework with a capacity-constrained retailer and uncover that buyer power explains the emergence of bundling practices by a multi-product manufacturer to foreclose a more efficient upstream rival. We further show that the retailer may counteract this adverse effect by expanding its stocking capacity. Finally, we highlight that a ban on bundling practices may restore the retailer's incentives to restrict its stocking capacity which generates detrimental effects for welfare.

Keywords: vertical relations, buyer power, exclusionary bundling, slotting fees, endogenous network, antitrust policy.

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†Université Paris-Saclay, INRAE, UR ALISS, 94205, Ivry-sur-Seine, France; CREST, École polytechnique; claire.chambolle@inrae.fr; http://chambolle.io

‡Université Paris-Saclay, INRAE, UR ALISS, 94205, Ivry-sur-Seine, France; hugo.molina@inrae.fr; https://sites.google.com/site/hugomolinaresearch/

1 Introduction

Selling products in packages can be a convenient strategy for a multi-product manufacturer to impose its brand portfolio on the market. Often referred to as bundling or full-line forcing, such arrangements are widely used in vertical markets as reported by numerous antitrust investigations. For example, the European Commission (EC) in 2005 provided evidence that: "[...] The Coca-Cola Company (TCCC) and its bottlers refused to supply a customer with only one of their brands unless the customer was willing to carry other carbonated soft drinks (CSDs) [...]".[1] Similarly, in the U.S. case law *Cablevision v. Viacom* (2013), Cablevision complained against Viacom's commercial practices which made the distribution of its popular channels conditional upon the purchase of less popular channels.[2] Inquiries conducted by the EC in 2018 revealed that Google engaged in analogous practices vis-à-vis Android mobile devices manufacturers and was condemned to pay a record fine of €4.34 billion.[3] The use of full-line forcing practices has also been documented in other sectors such as the U.S. video rental industry (see Ho, Ho and Mortimer, 2012*a*,*b*).

From a competition policy perspective, the main concern about bundling practices is the risk of rivals' foreclosure. As pointed out by the EC in the TCCC case: "making the supply of the strongest TCCC brands conditional upon the purchase of less-selling CSDs and non-CSDs leads to foreclosure of rival suppliers [...] reduces the variety for final consumers and avoids downward pressure on prices". The risk of foreclosure is indeed particularly worrisome when retailers have a limited stocking capacity. The EC further states that: "[...] this has the effect of making sales space in outlets harder to obtain for rival suppliers and of raising sale space prices for those suppliers." The anti-competitive effects of bundling practices are also largely debated in merger cases (see e.g. Guiness-Grand Metropolitan, 1997; Procter and Gamble-Gillette, 2004; Pernod Ricard-Allied Domecq, 2004).[4]

[1] Case COMP/A.39.116/B2 – Coca-Cola: http://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=1_39116.

[2] No. 13 Civ. 1278: https://casetext.com/case/cablevision-sys-corp-v-viacom-intl-inc.

[3] Case AT.40099 – Google Android: http://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=1_40099.

[4] Case No IV/M. 938 - Guinness/Grand Metropolitan: https://eur-lex.europa.eu/

Our article offers a new perspective on the "leverage theory" which points out that a multi-product firm has the incentive to leverage its monopoly power in one market to foreclose a more efficient rival in a competitive market through bundling practices. Starting in the 1950s, the Chicago School has dismissed this leverage doctrine in arguing that bundling is unprofitable because the multi-product firm must forgo part of its monopoly profit to compensate the buyer for giving up the opportunity to purchase the rival product.[5] We show that buyer power provides a means to reduce this compensation and thus restore the profitability of exclusionary bundling.

To formalize our argument and analyze its underlying logic, we develop a framework of vertical relations in which products can either be independent or imperfect substitutes. We consider a multi-product manufacturer which offers a leading brand (H) and a secondary brand (L) and competes with a single-product rival which offers a more efficient secondary brand (M). Manufacturers supply their products through a monopolist retailer (D) with a limited stocking capacity of $k = 2$ slots, implying that only two among the three existing products can be distributed to consumers. First, we assume that the multi-product manufacturer chooses whether or not to bundle its products H and L. Then, to secure one slot for their product(s), manufacturers simultaneously compete in slotting fees (i.e., upfront fixed payments).[6] Finally, given its product assortment choice, D engages in simultaneous and secret bilateral negotiation(s) to determine wholesale contract(s) with manufacturer(s).[7]

We show that D's ability to play off manufacturers against each other and receive surplus from slotting fees erodes with its buyer power. More specifically, as its bargaining power in the negotiation stage increases, D is able to obtain a larger amount of

eli/dec/1998/602/oj; Case No COMP/M.3732 - Procter & Gamble / Gillette: http://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=2_M_3732; Case No COMP/M.3779 - Pernod Ricard / Allied Domecq: http://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=2_M_3779.

[5]Initially framed by Director and Levi (1956); Bowman (1957); Posner (1976); Bork (1978) when products are perfect complements, this reasoning also applies to the independent products case.

[6]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. The FTC further mentions that such fees: "[...] may serve as devices for retailers to auction their shelf space and efficiently determine its highest-valued use."

[7]We show that the last two stages of this game yield an outcome similar to a bargaining stage in which D exercises threats of replacement as in Ho and Lee (2019).

surplus from products in its assortment, implying that threats to replace them in the competition for slots are less credible which reduces the amount of slotting fees offered by manufacturers.[8] As a result, the compensation paid by the multi-product manufacturer (through slotting fees) to induce D to select its bundle instead of M decreases in the presence of buyer power, which restores the profitability of bundling practices and provides a new rationale for the leverage hypothesis. Interestingly, we also show that an increase in buyer power may be detrimental for D as this facilitates the emergence of bundling practices.

As the scarcity of shelf space is a pre-requisite to the exclusionary effect of bundling, we further explore the incentive of a retailer to strategically restrict its stocking capacity. We thus extend our baseline model by considering an *ex ante* stage in which D chooses its number of available slots k. We first show that, absent bundling practices, D chooses to restrict its capacity to either two or one slot when its bargaining power in negotiations is low because it can credibly exercise threats of replacement and extract additional rent from manufacturers through slotting fees. We then analyze the interplay between bundling practices and D's stocking capacity choice and highlight that a stocking capacity expansion can be used as a defensive strategy against bundling. We finally derive policy implications of a ban on bundling practices *vs* slotting fees.

Three main explanations are generally advanced in the literature for bundling practices: efficiency, discrimination, and exclusion.[9] Our article focuses on the exclusionary motive which is the subject of a long-standing debate in antitrust law. We depart from a large body of the literature which, since the seminal work of Whinston (1990), relies on the presence of scale economies to rationalize the leverage hypothesis.[10] Instead, our buyer power argument relates to a stream of articles stressing that the incentive

[8] We relate this feature of our setting to the "outside option principle" in bargaining theory.

[9] We refer to Nalebuff (2008) and Fumagalli, Motta and Calcagno (2018) for an overview of the literature on the efficiency and price discrimination rationales for bundling.

[10] When scale economies stem from fixed costs of entry, it has been shown that bundling can serve as an entry-deterrent strategy in an oligopolistic market (Whinston, 1990; Peitz, 2008) or in multiple markets (Choi and Stefanadis, 2001; Carlton and Waldman, 2002; Nalebuff, 2004). Alternatively, the exclusionary effect of bundling practices has been highlighted in settings with scale economies in R&D activities (Choi, 1996, 2004). It is worth noting that most of the "leverage theories" developed in these articles hinge on a commitment mechanism (e.g., Whinston, 1990; Choi, 1996; Choi and Stefanadis, 2001; Carlton and Waldman, 2002) which is also not required in our analysis (i.e., our theory does not limit to physical or technical bundling).

to leverage market power through bundling arises when the multi-product firm cannot perfectly extract the rent from the sale of its monopolized product.[11] Importantly, we develop a "leverage theory" of bundling in vertical markets. Closest to us in this strand are de Cornière and Taylor (2019) who, motivated by the Google-Android case, provide a novel rationale for the "leverage theory" in the presence of contractual frictions that generate double-marginalization.[12] In contrast, we consider a setting with efficient contracting in which imperfect rent extraction stems from the presence of buyer power.[13] The exclusionary effect of bundling is also examined by Ide and Montero (2019) in a setting of vertical relations but entirely relies on retail competition and shopping costs.[14]

We also contribute to a growing literature that analyzes the formation of buyer-seller networks in vertically related markets. Several articles demonstrate that retailers having an exogenous stocking capacity may offer an inefficient product assortment to consumers for buyer power motives (e.g., Inderst and Shaffer, 2007; Marx and Shaffer, 2007*a*; Chambolle and Villas-Boas, 2015). Another strand of research further points out that buyer power can also affect the size of the distribution network.[15] In particular, Marx and Shaffer (2010) show that a retailer may strategically restrict its stocking capacity to intensify the competition for slots between manufacturers and extract a larger share of a lower industry profit.[16] More recently, Ho and Lee (2019) have de-

[11]As pointed out in Fumagalli, Motta and Calcagno (2018), imperfect rent extraction may arise due to regulated pricing, demand uncertainty (Greenlee, Reitman and Sibley, 2008), or future quality upgrades (Carlton and Waldman, 2012).

[12]See also Choi and Jeon (2020) who develop a "leverage theory" of bundling in two-sided markets and provide a theory of harm associated with recent antitrust cases (including the Google-Android case). Their argument relies on the presence of non-negative price constraints which generates imperfect rent extraction and creates incentives to engage in bundling practices.

[13]Moreover, we focus on the cases of independent and imperfect substitute products, implying that bundling induces a more aggressive response by the rival manufacturer as in Whinston (1990). Instead, de Cornière and Taylor (2019) show that bundling softens competition for slots when products are complement.

[14]Further away to our approach are Vergé (2002) and Fumagalli and Motta (2019) who extend Carlton and Waldman (2002) to a setting of vertical relationships.

[15]Note that other factors affecting the buyer-seller network have also been emphasized in the literature. For example, Shepard (2016) highlights that adverse selection may discourage insurers from choosing high-quality hospitals in their networks. In a setting where the formation of links between an upstream and a downstream player involves mutual consent, Rey and Vergé (2019) show that the buyer-seller network structure crucially depends on the intensity of retail competition (see also Nocke and Rey, 2018; Ramezzana, 2019).

[16]Note that this stocking capacity restriction as a source of bargaining power relates more broadly to

veloped an appealing bargaining concept, referred to as "Nash-in-Nash with threat of replacement" (NNTR), to analyze the hospital network of an insurer. Under this bargaining protocol, the insurer is able to engage in bilateral bargains while threatening to replace each hospital included in its network with excluded alternative ones. As a result, the insurer may have the incentive to narrow the size of its network to extract further rent from hospitals.[17] Our article contributes to this endogenous network literature and highlights insightful connections between the competition for slots in Marx and Shaffer (2010) and the mechanism of threats of replacement developed in Ho and Lee (2019). More specifically, leveraging on recent microfoundations for the "Nash-in-Nash" bargaining (Collard-Wexler, Gowrisankaran and Lee, 2019; Rey and Vergé, 2019), we show that our game-theoretic framework can provide grounds to the NNTR bargaining solution.

Finally, our article is also related to the literature on slotting fees.[18] In particular, we analyze the interaction between slotting fees and bundling practices which both derive from the competition for scarce shelf space (see also Jeon and Menicucci, 2012; de Cornière and Taylor, 2019).

The remainder of our article is organized as follows. Section 2 provides a simple example illustrating the main insights of our "leverage theory". Section 3 introduces the baseline model and notations. Section 4 analyzes anti-competitive bundling practices and highlights that the main essence of our leverage mechanism stems from the presence of buyer power. Section 5 extends our model to analyze D's stocking capacity choice and its interplay with bundling practices. Section 6 discusses antitrust policy implications. Section 7 concludes.

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a mechanism uncovered by Montez (2007) in which bargaining power arises from control over a scarce resource.

[17]The use of network size restrictions for a buyer power motive is also analyzed in Liebman (2018) and Ghili (2019) under alternative frameworks. As in Ho and Lee (2019), however, 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.

[18]As in Marx and Shaffer (2010), we show that the retailer may require slotting fees to access its scarce shelf space. Alternative rationales for the use of slotting fees have been put forward in the literature such as imperfect risk sharing, screening device, or the distortion of retail competition (e.g., Shaffer, 1991; Marx and Shaffer, 2007*b*; Miklós-Thal, Rey and Vergé, 2011; Rey and Whinston, 2013).

2 A simple example

To present the main insights of our leverage mechanism, we develop a numerical illustration based on textbook examples that formalize the Chicago School argument (see e.g. Choi, 2006; Fumagalli, Motta and Calcagno, 2018). Consider two independent markets and a buyer who is willing to purchase one unit of product on each market. In one market, manufacturer U_1 is a monopolist and offers product H at no cost. The buyer is willing to pay 6 for H. In the other market, U_1 offers product L at cost 2 and competes with manufacturer U_2 which offers product M at no cost. The buyer is willing to pay 3 for either M or L (homogeneous products). We consider the following sequence of play. First, U_1 decides whether or not to bundle its products H and L. Second, prices are simultaneously determined by U_1 and U_2 either unilaterally or through bilateral negotiations with the buyer.

Absent buyer power. Suppose that the buyer is price taker. Consider first that U_1 does not bundle its products. On the monopolistic market, U_1 charges the monopoly price for H and earns 6. On the competitive market, U_2 charges a price for M at L's unit cost and the buyer purchases M.[19] Consider now that U_1 bundles its products H and L for which the buyer is willing to pay 9. Competition thus takes place between the bundle and M. To ensure that the buyer never obtains more surplus by purchasing M, U_1 charges a price of 6 for its bundle. The buyer purchases the bundle and U_1 earns $6-2=4<6$. We thus recover the standard Chicago School argument. To compensate the buyer for not purchasing M, U_1 must leave a surplus of 3 to the buyer which is greater than the surplus generated by L. Hence, U_1 has to forgo part of its monopoly profit which makes bundling unprofitable.

With buyer power. Suppose now that prices are determined via bilateral negotiations. For the sake of simplicity, we consider a bargaining protocol in which the buyer chooses the manufacturer to bargain with and splits equally the surplus generated by its prod-

[19] We apply the standard tie-breaking rule that if the buyer is indifferent between two products he purchases the product with the highest surplus.

uct. When competition between manufacturers takes place, the buyer chooses to bargain with the manufacturer with which he anticipates to get the highest surplus. Still, the opportunity to trade with the alternative manufacturer acts as an *outside option* that the buyer may invoke during the course of negotiations to obtain additional surplus.[20] Consider first that U_1 does not bundle its products. On the monopolistic market, U_1 and the buyer split equally the surplus generated by H and U_1 earns 3. On the competitive market, the buyer may bargain with U_2 and obtain half of the surplus generated by M. As the buyer cannot obtain more by purchasing L, the outside option of trading with U_1 does not play any role and the buyer purchases M. Consider now that U_1 bundles its products and competes with M. The buyer may bargain with U_1 and obtain half of the surplus generated by the bundle, that is $\frac{7}{2}$. As the buyer cannot obtain more by purchasing M, the outside option of trading with U_2 does not play any role and the buyer purchases the bundle. U_1 thus earns $\frac{7}{2} > 3$.

Hence, absent buyer power, U_1 perfectly extracts the surplus from the sale of H but has to pay the buyer a compensation of 3 to impose its bundle. In the presence of buyer power, U_1 already leaves a surplus of 3 to the buyer in its negotiation for H, implying that it has no further compensation to pay to impose its bundle. This restores the profitability of bundling that leads to the foreclosure of an efficient rival. The insight for our "leverage theory" of bundling is thus as follows. The presence of buyer power explains the profitability of bundling because the compensation paid by U_1 to impose its bundle to a powerful buyer is much smaller than the compensation paid to a powerless buyer. We now establish this result in a more general framework.

3 The model

3.1 Setup

Consider an industry with two manufacturers at the upstream level, U_1 and U_2, which supply their products through a monopolist retailer at the downstream level, D. As in Section 2, U_1 supplies products H and L, and U_2 supplies product M. Products

[20] We refer to Section 3.3 for further details on the role of outside options in bargaining theory.

are differentiated and indexed by $X, Y \in \{H, M, L\}$. We assume that D can purchase and distribute at most two of the three available products, meaning that it has $k = 2$ slots.[21] This modeling assumption aims at capturing the limited stocking capacity faced by retailers, which is a pre-requisite for the foreclosure concerns of bundling practices in vertical markets. While D takes its stocking capacity as given (i.e., it cannot further restrict or expand its capacity to $k = 1$ or $k = 3$ slots), we subsequently consider a more general framework in which D chooses its number of slots (see Section 5).

Industry Profits. The primitive profit functions which represent the industry profit (i.e., the profit of a fully integrated firm) generated by each assortment of products are denoted as follows: Π^X when only product X is offered on the market and Π^{XY} when products X and Y are respectively offered on the market (where $Y \neq X$). We make the following assumptions:

Assumption A1 *Among all assortments of one product, H generates the highest industry profit:*

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

Assumption A2 *Among all assortments of two products, HM generates the highest industry profit:*

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

Assumption A3 *Products are either imperfect substitutes or independent:*

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

3.2 The game

We consider that U_1 chooses between two selling strategies to supply its products on the market: a component strategy or a bundling strategy. If U_1 chooses a component strategy it offers either H, or L, or H and L as a bundle (which is similar to a mixed

[21]As in Marx and Shaffer (2010), we assume that the sale of one product requires one slot of shelf space: a slot enables a manufacturer to satisfy consumers' demand for its product and, without this slot, it cannot make any sale.

bundling strategy). If instead U_1 chooses a bundling strategy it offers only H and L as a bundle (which is similar to a pure bundling strategy).

Timing and information. After U_1 has publicly announced its selling strategy (i.e., component or bundling), we assume that firms interact according to the following sequence of play:

- Stage 1: Manufacturers simultaneously compete in slotting fees (i.e., non-negative lump-sum payments) to secure an indivisible slot per product. If U_1 has chosen a component strategy, it offers an independent slotting fee for stocking either H or L, and a slotting fee for the bundle HL, i.e., (S^H, S^L, S^{HL}). Alternatively, if it has chosen a bundling strategy, a unique slotting fee is offered for the bundle HL, i.e., $(\emptyset, \emptyset, S^{HL})$. U_2 also offers a slotting fee S^M to secure a slot for M.
  D's acceptance decisions are public. If D accepts a slotting fee, it commits to include the corresponding product(s) in its assortment.

- Stage 2: Given its product assortment decision, D engages in simultaneous bilateral negotiations with the corresponding manufacturer(s) to determine wholesale contract(s). Contracts are secret and take the form of a two-part tariff (w_i, F_i) paid by D to U_i, where $i = 1, 2$.

- Stage 3: D sets its prices and sells to consumers.

Competition for slots and bargaining protocol. The competition for slots in stage 1 is equivalent to 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.

In the bargaining stage, terms of trade are determined by pairs of firms according to the Nash's axiomatic theory of bargaining (Nash, 1950), where $\alpha \in [0, 1]$ denotes the bargaining weight of D. If D selects the assortment HL, there is only one pair of firms that engages in a bilateral bargaining (that is, $D - U_1$) and we use the asymmetric

Nash bargaining solution as a surplus sharing rule. If, however, D selects the assortment HM or ML, two pairs of firms simultaneously engage into bargaining (that is, $D-U_1$ and $D-U_2$). In this case, the imperfect substitution among products generates contracting externalities, which requires further assumptions on the beliefs each pair of firms has towards the other pair's contract. We use the bargaining protocol à la Horn and Wolinsky (1988), commonly referred to as "Nash-in-Nash" bargaining solution.[22] This bargaining game can be formulated as a "delegated agent" model in which delegates are allocated by firms to each bilateral negotiation.[23] As wholesale contracts are secret, it is assumed that each pair of delegates has passive beliefs over deals reached elsewhere, i.e., if an unexpected outcome arises from a bilateral negotiation delegates involved in this transaction do not revise their beliefs about secret deals reached by the other pair (McAfee and Schwartz, 1994).[24] Any of these bilateral negotiations that result in an agreement are considered to be binding.[25]

Bilateral efficiency. The 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 irrespectively of the distribution of bargaining power in the vertical chain (e.g., Bernheim and Whinston, 1985; O'Brien and Shaffer, 2005).[26] As a result, bilateral efficiency (i.e., cost-based wholesale contracts) always prevails in our vertical structure regardless of U_1's selling strategy. This implies that, in stage 3, D always chooses prices that maximize the integrated industry profit Π^X and Π^{XY}. Based on this result, we consider throughout our article that, in stage 2, each pair $D-U_i$ sets the wholesale unit price w_i to marginal cost and bargains over the fixed fee F_i to share the integrated industry profit.

[22] This terminology has been coined by Collard-Wexler, Gowrisankaran and Lee (2019) as the solution of this bargaining model corresponds to a Nash equilibrium in prices negotiated by pairs of firms according to the Nash's axiomatic theory of bargaining (Nash, 1950).

[23] It implies that D behaves "schyzophrenically" in its bargaining with U_1 and U_2.

[24] In other words, delegated agents conjecture the equilibrium outcome for other negotiations in all circumstances.

[25] In contrast to other bargaining concepts such as those developed in Stole and Zwiebel (1996), Inderst and Wey (2003), or de Fontenay and Gans (2014), contract terms are neither revised nor contingent upon bargaining breakdowns that could occur in the buyer-seller network structure determined in the first stage.

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

3.3 Relation of our model to the bargaining literature and the "outside option principle"

In this section, we aim at providing insights on the mechanisms at work in our model. To this end, we relie on recent noncooperative foundations for the "Nash-in-Nash" solution and discuss features of our framework that relate to the treatment of outside options in two-person bargaining problems. More specifically, we argue that the two first stages of our game replicate the outcome of a "Nash-in-Nash" bargaining with threats of replacement as in Ho and Lee (2019).

Microfoundations for the "Nash-in-Nash" solution. In line with the "Nash program", strategic models of bargaining have been developed in the literature to provide support for the asymmetric Nash bargaining solution as a surplus sharing rule (e.g., Binmore, Rubinstein and Wolinsky, 1986). Recent strategic bargaining models have also offered microfoundations for the "Nash-in-Nash" bargaining solution that we use in stage 2. In particular, in a bilateral oligopoly setting with nonlinear wholesale tariffs (including two-part tariffs), Rey and Vergé (2019) show that the "Nash-in-Nash" solution replicates the equilibrium outcome of a noncooperative bargaining game with delegated agents and passive beliefs.[27] More precisely, they consider a random-proposer protocol in which: (i) for each bilateral negotiation, nature draws whether the retailer or the manufacturer gets to make a take-it-or-leave-it offer with a respective probability α and $1-\alpha$, and (ii) selected proposers simultaneously make secret offers to their trading partners whose acceptances or rejections are also simultaneous and secret.[28] Following this noncooperative interpretation, each recipient of an offer in stage 2 exercises a threat of bargaining breakdown as both firms within a pair end up with their status quo payoffs in case of rejection.

[27] Collard-Wexler, Gowrisankaran and Lee (2019) provide an alternative noncooperative foundation when bilateral negotiations occur over tariffs that do not affect the gains from trade between pairs of firms. Importantly, by relaxing restrictions imposed by delegation (i.e., firms behave "schizophrenically"), they show that a pure-strategy perfect Bayesian equilibrium with passive beliefs of a Rubinstein alternating offers game exists and converges to the "Nash-in-Nash" bargaining solution.

[28] See also Nocke and Rey (2018).

Bargaining with outside options. Our game-theoretic framework incorporates another type of threat. In stage 1, D may have incentives to play manufacturers off against each other through the use of threats of replacement (i.e., a threat to replace a manufacturer's product with an alternative one). This ability to unilaterally exercise such threats stems from its limited number of slots compared to the set of available products.[29] Stage 1 thus allows products that are not offered in equilibrium to play a role in the division of surplus within the supply chain.

As D may gain bargaining leverage from the presence of non-offered products, our surplus division mechanism follows the logic of the "outside option principle" established in the bargaining literature (e.g., Shaked and Sutton, 1984; Binmore, 1985; Binmore, Shaked and Sutton, 1989). According to this principle, the outside option of a bargainer is irrelevant to the surplus division unless it provides a higher payoff than what the bargainer can get from the negotiation. Formally, in a situation where two bargainers negotiate over the partition of a pie Π according to the asymmetric Nash bargaining solution, the bargainer having an outside option Π^o (where $\Pi > \Pi^o > 0$) is assigned a payoff equals to $\max\{\alpha\Pi, \Pi^o\}$, which is what Binmore, Shaked and Sutton (1989) refer to as the "deal-me-out" outcome.[30] Thus, there is a clear distinction between the status quo position of a bargainer which affects the term $\alpha\Pi$ and a bargainer's outside option which refers to his best alternative profit if he unilaterally opts out from the bargaining process, that is Π^o (see e.g. Proposition 6 of Binmore, Rubinstein and Wolinsky, 1986).[31]

The presence of outside options has often been treated as exogenous (Binmore, Shaked and Sutton, 1989) or interpreted as payoffs resulting from a vertical integration (e.g., Katz, 1987). Instead, Bolton and Whinston (1993) consider a setting where a firm with an exogenous limited capacity is able to choose with whom to bargain among two available trading partners, while using the other as an outside option. They show that the firm always chooses to bargain with the most efficient trading partner and that

[29] As D is in a monopoly position on the downstream market, it is noteworthy that such threats of replacement cannot be exercised by manufacturers.

[30] Note that this bargaining outcome coincides with the asymmetric Nash bargaining solution under the constraint that the bargainer having the outside option receives at least Π^o.

[31] For instance, if the bargainer with the outside option Π^o has also a status quo payoff Π^s (with $\Pi > \Pi^s > 0$), he would obtain a payoff equal to $\max\{\Pi^s + \alpha(\Pi - \Pi^s), \Pi^o\}$.

the surplus division coincides with the "deal-me-out" outcome of Binmore, Shaked and Sutton (1989) for which the firm's outside option is given as the total surplus that an agreement with the other trading partner would generate.[32] Ho and Lee (2019) further extend this modeling approach by allowing a downstream firm to (i) engage in multiple bilateral negotiations that generate externalities on one another and (ii) endogenously choose whether to have outside options by narrowing its network of trading partners. Building on the concept of "Nash-in-Nash" bargaining, they develop the NNTR bargaining solution which, for a given network, allows the downstream firm to gain bargaining leverage by threatening to replace each of its trading partners with an alternative one excluded from its network.[33] In what follows, we show that our three-stage game yields the same surplus division as the NNTR bargaining solution for any level of stocking capacity $k \in \{1, 2, 3\}$ and D's assortment decision. In particular, the two first stages of our game can be nested in a "Nash-in-Nash" bargaining stage with outside options stemming from D's threats of replacement (see Appendix C for an illustrative example).

4 Buyer power and the profitability of bundling

We look for the subgame-perfect equilibrium of our 3-stage game in which the assumed bargaining solution in stage 2 is embedded in the players' payoff functions. Section 4.1 analyzes the case in which U_1 chooses a component selling strategy. Section 4.2 considers the alternative case in which it chooses a bundling strategy. Section 4.3 goes backward to determine U_1's optimal selling strategy.

[32] Earlier development of two-person bargaining games in which one bargainer is free (subject to certain frictions) to opt out and deal with another player has been considered in Shaked and Sutton (1984) (see also chapter 9 of Osborne and Rubinstein, 1990). As in Bolton and Whinston (1993), the presence of outside options in these games relies on modeling assumptions that rule out one or several pairs of firms from reaching an agreement (e.g., a seller offering only one unit of a product faces multiple buyers).

[33] Note that the NNTR bargaining solution nests the form of the "deal-me-out" outcome obtained in Bolton and Whinston (1993) (see the illustrative example in p. 494 of Ho and Lee, 2019).

4.1 Component strategy

Proceeding backward, we consider the second stage of our game by analyzing each bilateral negotiation between D and manufacturer(s) for any assortment of two products that D may select: HM, ML, or HL. Because slotting fees paid by manufacturers in stage 1 are not conditional on agreements being reached, they play no role on the bargaining outcomes.

Assortment HM. We analyze the case in which D selects the assortment HM and thus engages in bilateral negotiations with U_1 for H and U_2 for M. We denote F_i^{XY} the fixed fee paid by D to U_i when the assortment XY is sold. Following Horn and Wolinsky (1988), 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. Consequently, 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 the expressions $\Pi^{HM} - F_1^{HM} - F_2^{HM} - (\Pi^M - F_2^{HM})$ and F_1^{HM} correspond respectively to the marginal gain of D and U_1 from reaching an agreement.[34] Similarly, the fixed fee negotiated between D and U_2 for 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 the following fixed fees:

$$\begin{aligned} F_1^{HM} &= (1-\alpha)\left(\Pi^{HM} - \Pi^M\right), \\ F_2^{HM} &= (1-\alpha)\left(\Pi^{HM} - \Pi^H\right). \end{aligned} \tag{3}$$

[34] The expression in parenthesis represents D's status quo payoffs in its negotiation with U_1 (i.e., D's profit resulting from the bilateral negotiation with U_2 if H is not offered on the market). Moreover, note that in case of a bargaining breakdown none of U_1's products would be offered on the market, implying that its status quo payoff is 0 here.

Henceforth, we denote the profits resulting from bilateral negotiations by π_D^{XY} for D and π_i^{XY} for U_i, where the superscript stands for the product assortment offered on the market. For the assortment HM, these profits are given by:

$$\pi_D^{HM} = \Pi^{HM} - F_1^{HM} - F_2^{HM}; \quad \pi_1^{HM} = F_1^{HM}; \quad \pi_2^{HM} = F_2^{HM}. \tag{4}$$

Assortment ML. We analyze the case in which D selects the assortment ML and engages in bilateral bargains with U_1 for L and U_2 for M. As previously, negotiations are determined according to the "Nash-in-Nash" bargaining solution, implying that fixed fees equal:

$$\begin{aligned} F_1^{ML} &= (1-\alpha)\left(\Pi^{ML} - \Pi^{M}\right), \\ F_2^{ML} &= (1-\alpha)\left(\Pi^{ML} - \Pi^{L}\right), \end{aligned} \tag{5}$$

and profits of firms are given by:

$$\pi_D^{ML} = \Pi^{ML} - F_1^{ML} - F_2^{ML}, \quad \pi_1^{ML} = F_1^{ML}, \quad \pi_2^{ML} = F_2^{ML}. \tag{6}$$

Assortment HL. In the case where D selects the assortment HL, there is only one pair of firms that engages in a bilateral negotiation (that is, D—U_1). Therefore, we apply the asymmetric Nash bargaining solution by solving the following maximization problem:

$$\max_{F_1^{HL}} \left(\Pi^{HL} - F_1^{HL}\right)^{\alpha} \left(F_1^{HL}\right)^{1-\alpha} \tag{7}$$

The equilibrium fixed fee is $F_1^{HL} = (1-\alpha)\Pi^{HL}$ and profits of firms are given by:

$$\pi_D^{HL} = \Pi^{HL} - F_1^{HL}, \quad \pi_1^{HL} = F_1^{HL}, \quad \pi_2^{HL} = 0. \tag{8}$$

Note that the modeling approach adopted here implies *de facto* a bargaining for the bundle HL. An alternative 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). Hence, this would imply that U_1 competes against itself, thereby conferring a higher status quo payoff to D which would decrease U_1's profit.[35] It is worth noting, however, that the choice of this modeling approach does not play any role on the leverage mechanism highlighted in this section.

To analyze the assortment decision of D in stage 1, we introduce the following simplifying assumption:

Assumption A4 *The marginal contribution of M to the industry profit Π^{HM} is (weakly) lower than its marginal contribution to the industry profit Π^{ML}:*

$$\Pi^{ML} - \Pi^{L} \geq \Pi^{HM} - \Pi^{H}.$$

which implies that $\pi_D^{HM} > \pi_D^{ML}$ and $\pi_2^{ML} > \pi_2^{HM}$.

A4 ensures that we obtain a unique equilibrium outcome.[36] The following lemma derives from the comparison of D's profit in (4), (6), and (8):

Lemma 1 *Absent slotting fees, D always selects the assortment HM when U_1 chooses a component selling strategy.*

Proof. From A2 and A3 we have $\pi_D^{HM} \geq \pi_D^{HL}$. Furthermore, under A4, we obtain that $\pi_D^{HM} > \pi_D^{ML}$. ■

However, in stage 1, U_1 is able to offer a menu of slotting fees $S_1 = (S^H, S^L, S^{HL})$ to affect D's assortment decision and supply both H and L on the market. Note that this is equivalent to a mixed bundling strategy as we allow S^{HL} to differ from the sum of slotting fees $S^H + S^L$.[37] Similarly, U_2 can offer a slotting fee denoted by $S_2 = S^M$ to secure one slot for M. As $k = 2$, D can accept at most two slotting fees.[38] Solving the competition for D's slots leads to the following lemma:

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[35] In this case, U_1 would obtain a profit of $(1-\alpha)(2\Pi^{HL} - \Pi^H - \Pi^L) \leq \pi_1^{HL}$ under A3.

[36] We relax A4 in Appendix H and show that our main results qualitatively hold.

[37] Considering mixed bundling rather than independent pricing is key to ensure the existence of a pure-strategy Nash equilibrium under A1 to A4. The nonexistence of equilibrium in pure strategies has been shown by Jeon and Menicucci (2012) in a related setting of competition for slots with independent products.

[38] In Appendix A, we analyze the case where manufacturers offer a tariff to monopolize D's shelf space with only one product and show that it never arises in equilibrium.

Lemma 2 *When U_1 chooses a component selling strategy, manufacturers offer:*

$$\begin{aligned} S_1^{HM} &= \left(0, 0, (1-\alpha)\left(\Pi^{HL} - \Pi^{HM} + \Pi^{M}\right)\right), \\ S_2^{HM} &= max\{0, \Pi^{HL} - \alpha\Pi^{HM} - (1-\alpha)\Pi^{H}\}, \end{aligned}$$

D selects the product assortment HM and receives the corresponding slotting fees. Equilibrium profits of firms are given by:

$$\Pi_D^{HM} = \begin{cases} \Pi^{HL} - (1-\alpha)\left(\Pi^{HM} - \Pi^{M}\right) & \text{if } \alpha_1 > \alpha \\ (1-\alpha)\left(\Pi^{H} + \Pi^{M}\right) - (1-2\alpha)\Pi^{HM} & \text{otherwise} \end{cases},$$

$$\Pi_1^{HM} = (1-\alpha)\left(\Pi^{HM} - \Pi^{M}\right),$$

$$\Pi_2^{HM} = \begin{cases} \Pi^{HM} - \Pi^{HL} & \text{if } \alpha_1 > \alpha \\ (1-\alpha)\left(\Pi^{HM} - \Pi^{H}\right) & \text{otherwise} \end{cases},$$

where $\alpha_1 \equiv \frac{\Pi^{HL} - \Pi^{H}}{\Pi^{HM} - \Pi^{H}}$.

Proof. We refer to Appendix A for a complete characterization of the range of equilibria and provide here a sketch of the proof. Let us consider first that $S^H = S^L = 0$ by relying on the following insights. As absent slotting fees D would choose the assortment HM, U_1 does not need to use any payment to secure a slot for H. Moreover, U_1 is not willing to pay a fee to secure a slot for L only (i.e., $S^L > 0$) as this could induce D to replace H by L. To secure one slot for both H and L, U_1 is willing to pay at most $\bar{S}^{HL}$ which is derived as follows: $\pi_1^{HL} - \bar{S}^{HL} = \pi_1^{HM} \Leftrightarrow \bar{S}^{HL} = (1-\alpha)\left(\Pi^{HL} - (\Pi^{HM} - \Pi^{M})\right)$. Similarly, U_2 is willing to pay at most $\bar{S}^{M}$ to secure a slot for M, which is given by: $\pi_2^{HM} - \bar{S}^{M} = \pi_2^{HL} \Leftrightarrow \bar{S}^{M} = (1-\alpha)\left(\Pi^{HM} - \Pi^{H}\right)$. To determine the outcome of the competition for D's slot, we thus need to compare: (i) D's profit from choosing the assortment HL (i.e., $\pi_D^{HL} + \bar{S}^{HL}$), and (ii) D's profit from choosing the assortment HM (i.e., $\pi_D^{HM} + \bar{S}^{M}$). As $\pi_D^{HM} + \bar{S}^{M} > \pi_D^{HL} + \bar{S}^{HL} \Leftrightarrow \Pi^{HM} > \Pi^{HL}$, U_2 wins the competition and can always secure a slot for M, implying that the assortment HM is always chosen by D. In equilibrium, U_1 offers $S_1^{HM} = \left(0, 0, (1-\alpha)\left(\Pi^{HL} - (\Pi^{HM} - \Pi^{M})\right)\right)$ and U_2 offers S_2^{HM} such that D is indifferent between selecting M or replacing it with L, that is:

$\pi_D^{HM} + S_2^{HM} = \pi_D^{HL} + \bar{S}^{HL} \Leftrightarrow S_2^{HM} = \max\{0, \Pi^{HL} - \alpha\Pi^{HM} - (1-\alpha)\Pi^H\}$. As in Section 2, we apply the standard tie-breaking rule that if D is indifferent between two products it selects the one that generates the highest surplus (here M). ■

Lemma 2 shows that the assortment HM is always selected by D in equilibrium. Given that $\Pi^{HM} > \Pi^{HL}$, U_2 is indeed always able to offer a mutually profitable transfer (through a slotting fee or a fixed fee) such that D selects M. Moreover, U_2 need not always pay a slotting fee. When $\alpha > \alpha_1$, D is indeed able to extract a large fraction of the industry profit from its negotiations. Therefore, it will seek to maximize the size of this profit by choosing the assortment HM without being able to credibly exercise threats of replacement.[39] As a result, manufacturers do not have to offer any fee to secure slots for H and M and the division of surplus within the supply chain yields the same outcome as the "Nash-in-Nash" bargaining solution. In contrast, when $\alpha_1 > \alpha$, D's bargaining power vis-à-vis manufacturers is weaker, implying that it obtains a smaller fraction of the industry profit from its negotiations. The use of threats of replacement becomes credible as it allows D to extract more surplus from manufacturers. In particular, D can increase its profit by threatening U_2 to replace M with L and receive the corresponding slotting fee for selecting H and L (which is defined as the maximum amount that U_1 is willing to concede for this replacement). Such a threat induces U_2 to offer a slotting fee that makes D indifferent between having M in its assortment or L instead. As a result, the presence of L affects the division of surplus to the benefit of D even if it is not offered on the market in equilibrium.

It is worth noting that the equilibrium payoffs described in Lemma 2 can also be obtained by applying the NNTR bargaining solution of Ho and Lee (2019) in which, after having selected the assortment HM, D engages in bilateral bargains with manufacturers using L as a replacement threat.[40] To clarify this connection, we provide

[39]For instance, when α tends to 1, only the comparison of industry profits generated by each product assortment is relevant and HM is always chosen because it generates the highest industry profit.

[40]Under A1 and A2, the assortment HM satisfies the notion of "stable network" from Proposition 2 of Ho and Lee (2019) as firms derive positive gains from trade in every bilateral negotiation and no product excluded from D's assortment (here L) generates greater surplus than any included product (here H and M). Hence, given such a stable network, the NNTR bargaining solution determines the fixed fee paid by the downstream firm to an upstream manufacturer included in its network according to the "Nash-in-Nash" bargaining solution when the threat of replacement is not credible, which is similar

in Appendix C.1 a "Nash-in-Nash" bargaining with outside options that generates our outcome.

4.2 Bundling strategy

When U_1 chooses a bundling strategy, D can select two product assortments: either HL or M. Proceeding similarly, we first consider the bilateral negotiations between D and manufacturers under each product assortment before analyzing D's assortment choice.

Assortment HL. When D selects the assortment HL, there is only one bilateral negotiation that occurs in stage 2 involving the pair $D - U_1$. The fixed fee paid by D is determined according to the asymmetric Nash bargaining solution and profits of firms are given by (8).

Assortment M. When D selects the assortment M, it also engages in only one bilateral negotiation with U_2 over the fixed fee F_2^M, which solves:

$$\max_{F_2^M} \left(\Pi^M - F_2^M\right)^\alpha \left(F_2^M\right)^{1-\alpha} \tag{9}$$

The equilibrium fixed fee is $F_2^M = (1-\alpha)\Pi^M$ and corresponding profits of firms are given by:

$$\pi_D^M = \Pi^M - F_2^M, \quad \pi_1^M = 0, \quad \pi_2^M = F_2^M. \tag{10}$$

The comparison of D's profit in (8) and (10) leads to the following lemma:

Lemma 3 *Absent slotting fees, D always selects the assortment HL when U_1 chooses a bundling strategy.*

to our model when the slotting fee of the included manufacturer is nil. When this threat is credible, the fee paid by the downstream firm is such that it is indifferent between forming an agreement with the included manufacturer or replacing it with an excluded manufacturer at its reservation price (i.e., the price that makes the excluded manufacturer indifferent between replacing the included manufacturer or not, taking as given its other agreements). In our setting, this price is defined as the negotiated fixed fee minus the slotting fee paid by the manufacturer of a selected product.

Proof. A2 and A3 imply that $\pi_D^{HL} > \pi_D^M$. ■

Absent slotting fees, Lemma 3 shows that U_2 is excluded from the market. Therefore, in stage 1, U_2 has incentives to affect D's assortment decision by offering a fee $S_2 = S^M$ to secure a slot for M. Similarly, U_1 is able to offer a slotting fee $S_1 = (\emptyset, \emptyset, S^{HL})$ to ensure that D selects HL. The outcome resulting from the competition for D's slots leads to the following lemma:

Lemma 4 *When U_1 chooses a bundling strategy, manufacturers offer:*

$$\begin{aligned} S_1^{HL} &= (\emptyset, \emptyset, max\{0, \Pi^M - \alpha \Pi^{HL}\}), \\ S_2^{HL} &= (1-\alpha)\Pi^M, \end{aligned}$$

D selects the assortment HL and receives the corresponding slotting fee. Equilibrium profits of firms are given by:

$$\Pi_D^{HL} = \begin{cases} \Pi^M & if \;\; \alpha_2 > \alpha \\ \alpha \Pi^{HL} & otherwise \end{cases}, \quad \Pi_1^{HL} = \begin{cases} \Pi^{HL} - \Pi^M & if \;\; \alpha_2 > \alpha \\ (1-\alpha)\Pi^{HL} & otherwise \end{cases}, \quad \Pi_2^{HL} = 0,$$

where $\alpha_2 \equiv \frac{\Pi^M}{\Pi^{HL}}$.

Proof. We refer to Appendix B and provide here a sketch of the proof. The maximum slotting fee that U_2 is willing to pay to replace HL and secure a slot for M is determined as follows: $\pi_2^M - \hat{S}^M \geq \pi_2^{HL} \Rightarrow \hat{S}^M = (1-\alpha)\Pi^M$. Similarly, U_1 is willing to offer at most a slotting fee $\pi_1^{HL} - \hat{S}^{HL} = 0 \Leftrightarrow \hat{S}^{HL} = (1-\alpha)\Pi^{HL}$ to secure slots for its bundle. Because $\pi_D^{HL} + \hat{S}^{HL} > \pi_D^M + \hat{S}^M \Leftrightarrow \Pi^{HL} > \Pi^M$, U_1 wins the competition for slots under A2 and A3. In equilibrium, U_2 offers its maximum slotting fee $\hat{S}^M$ and U_1 offers a slotting fee S_1^{HL} such that $\pi_D^{HL} + S^{HL} = \pi_D^M + \hat{S}^M \Rightarrow S_1^{HL} = (\emptyset, \emptyset, \max\{0, \Pi^M - \alpha\Pi^{HL}\})$. ■

The mechanism at play is similar in spirit to that described in Lemma 2. The assortment HL is always selected in equilibrium because $\Pi^{HL} > \Pi^M$ implying that U_1 is always able to offer a transfer (through a slotting fee or a fixed fee) to impose its bundle on D's slots. Again, U_1 need not always pay a slotting fee to do this. When $\alpha > \alpha_2$,

D is indeed able to extract a large fraction of the industry profit from its negotiation. Therefore, it will seek to maximize the size of its profit by choosing the assortment HL without exercising any threat of replacement. In contrast, when $\alpha_2 > \alpha$, the use of threats of replacement becomes credible as it allows D to extract additional surplus. U_1 has to offer a slotting fee to avoid being replaced by U_2's product. As a result, even if U_2 is always foreclosed from the market, its presence may influence the equilibrium sharing of profits.

Again, it can be shown that the surplus division described in Lemma 4 coincides with the NNTR bargaining solution of Ho and Lee (2019) given that D selects the assortment HL.[41] Moreover, it also corresponds to the "deal-me-out" outcome obtained in Bolton and Whinston (1993) where the outside option of one bargainer (here D) is equal to the entire surplus that an agreement with an alternative partner would generate (here Π^M). We refer to Appendix C.2 for further details.

It is worth noting that U_1's bundling strategy intensifies the competition for D's slots. Under the component selling strategy, U_1 is immune to threats of replacement for H. In contrast, when choosing a bundling strategy, U_1 can no longer escape such threats. Therefore, U_1 must compete more aggressively to impose its bundle on D's slots (i.e., the maximum slotting fee that U_1 is willing to offer for H and L is strictly higher under the bundling regime: $\hat{S}^{HL} > \bar{S}^{HL}$). Similarly, U_2 also engages in a fiercer competition under bundling because, if D selects M, it would be in a monopoly position on the market (i.e., the maximum slotting fee that U_2 is willing to offer is strictly higher under the bundling regime: $\hat{S}^M > \bar{S}^M$). This result contrasts with de Cornière and Taylor (2019) who show that, by offering a bundle of complementary products, a multi-product manufacturer can induce an upstream rival to compete less fiercely (implying $\hat{S}^M < \bar{S}^M$). It can be shown that such a difference stems from the fact that we focus on the case of (imperfect) substitutes and independent products.[42]

[41] A2 and A3 ensure that the assortment HL constitutes a "stable network" for applying the NNTR bargaining solution because the bilateral negotiation for HL provides gains from trade for both D and U_1, and M does not generate greater surplus (i.e., $\Pi^{HL} > \Pi^M$).

[42] Indeed, we have $\hat{S}^M = (1-\alpha)\Pi^M$ under the bundling regime and $\bar{S}^M = (1-\alpha)\left(\Pi^{HL} - \Pi^H\right)$ under the component regime. The comparison of these two expressions implies that $\hat{S}^M$ is strictly higher (resp. lower) under the bundling regime when products are either (imperfectly) substitutes or independent (resp. complements). Although we focus on the case of imperfect substitutes and independent products,

4.3 Equilibrium selling strategy

In what follows, we consider the preliminary stage in which U_1 publicly announces its selling strategy (component or bundling).[43] Based on Lemmas 2 and 4, the following proposition summarizes our result:

Proposition 1 *In equilibrium, U_1 chooses a bundling strategy if and only if:*

$$\alpha > min\{\alpha_2, \alpha_3\} \in \, [0, 1[\tag{11}$$

where $\alpha_2 \equiv \frac{\Pi^M}{\Pi^{HL}}$ and $\alpha_3 \equiv \frac{\Pi^{HM}-\Pi^{HL}}{\Pi^{HM}-\Pi^M}$. Otherwise, U_1 chooses a component selling strategy. A bundling equilibrium is thus more likely to arise when:

- *(i) D's buyer power is high,*
- *(ii) product L offered by U_1 is a close substitute to product M offered by U_2,*
- *(iii) product H offered by U_1 is a must-stock item.*

Proof. Because $\min\{\frac{\Pi^M}{\Pi^{HL}}, \frac{\Pi^{HM}-\Pi^{HL}}{\Pi^{HM}-\Pi^M}\} \in [0, 1[$ under A1 to A3, a bundling equilibrium never arises when α tends to 0, but always does so when α tends to 1. Furthermore, when M and L are close substitutes (that is, Π^{HL} tends to Π^{HM}) a bundling equilibrium arises for any $\alpha \in [0, 1]$. Finally, when H is a must-stock item, the marginal contribution of M and L to D's profit is reduced and, in the limit, Π^{HM} and Π^{HL} are close to Π^H. Again, a bundling equilibrium arises for any $\alpha \in [0, 1]$. ■

Proposition 1 first shows that, absent buyer power, the Chicago School argument initially applied to the case of complementary and independent products readily extends to the case of imperfect substitutes. Moreover, Proposition 1 highlights that the buyer power of D, through its bargaining weight α, is key to explain the profitability of bundling. The insight is as follows. Under the component regime, U_1 only offers H and pays no slotting fee to D regardless of the distribution of bargaining power in

our leverage mechanism could also be extended to the case of complementary products.

[43]We could alternatively assume that this choice occurs simultaneously with the slotting fee offers; in such a case a bundling equilibrium still exists.

the vertical chain. Under the bundling regime and when $\alpha > \alpha_2$, U_1 unambiguously obtains a higher profit because it supplies the bundle without offering any compensation (slotting fee) to D for not selecting M. In contrast, when $\alpha_2 > \alpha$, U_1 must pay D a compensation to secure slots for the bundle, which dampens the attractiveness of using a bundling strategy. In the extreme case where α tends to 0, U_1 must pay D a slotting fee up to Π^M implying that the bundling strategy is never profitable. As a result, Proposition 1 shows that the "leverage theory" of bundling is restored whenever the buyer power of retailers is high enough.

Since Whinston's (1990) seminal work, many scholars have addressed the Chicago School critique and reinvigorated the leverage hypothesis.[44] To do so, they have extensively relied on the presence of scale economies, commitment power, or first-mover advantages that are absent from our setting. Instead, we are in line with a strand of literature which has pointed out that the "leverage theory" holds when the multi-product firm cannot perfectly extract the rent from the sale of its monopolized product due to demand uncertainty (Greenlee, Reitman and Sibley, 2008), future quality upgrades (Carlton and Waldman, 2012), or inefficient contracting (de Cornière and Taylor, 2019; Choi and Jeon, 2020). Our result contributes to this line of research in shedding light that imperfect rent extraction arises from the ability of a powerful buyer to bargain with manufacturers.

Proposition 1 characterizes two other conditions for the profitability of bundling. When products M and L are closer substitutes (Π^{HL} increases toward Π^{HM}) both α_2 and α_3 decrease implying that a bundling equilibrium is more likely to arise. In contrast, an increase in Π^M, which in turn increases Π^{HM}, raises these thresholds and implies that a component selling strategy is more likely to arise in equilibrium. Besides, when H is a must-stock item, Π^H tends to Π^{HL} or Π^{HM} and α_2 and α_3 are lower, thereby facilitating 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 1 holds when* $\Pi^{HL} > \Pi^M > \Pi^H$.

[44] See Fumagalli, Motta and Calcagno (2018) for a comprehensive survey.

Proof. See Appendix D. ■

Motivated by the case law in Section 1 and for the sake of exposition, we have considered in A1 that $\Pi^H > \Pi^M$. However, when $\Pi^M > \Pi^H$, Proposition 1 still holds as long as $\Pi^{HL} > \Pi^M$ (i.e., the bundle generates a higher industry profit than the rival's product). In that case, the use of bundling practices forecloses the product that generates the highest surplus, which is even more detrimental for the industry profit.

Remark 2 *D is always better off when bundling practices are banned.*

Proof. See Appendix E. ■

We have seen from Proposition 1 that U_1 chooses a bundling strategy when D is powerful in its bargaining, implying that slotting fees only play a limited role in the surplus division. In the bargaining stage, the bundling strategy enables U_1 to increase D's gain from trade because, in case of a breakdown, D is left with a status quo payoff of 0. Such a strategy thus shifts the sharing of profits to the benefit of U_1 and D obtains a smaller share of a smaller pie (i.e., HL instead of HM).

We consider below two examples that illustrate insights drawn from Lemma 2, Lemma 4 and Proposition 1.

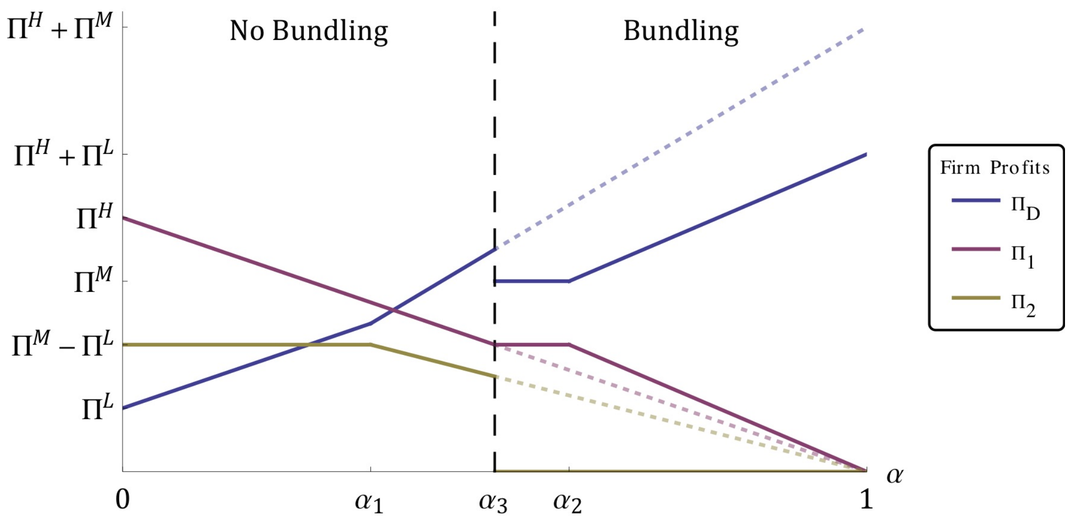
Example 1: Independent products. When products are independent, only A1 matters as it implies that A2 to A4 hold. In the following example, we set $\Pi^H = 4$, $\Pi^M = 3$, $\Pi^L = 1$ and the threshold defined in Proposition 1 equals $\min\{\alpha_2, \alpha_3\} = \alpha_3 = \frac{1}{2}$.[45]

Figure 1 depicts how firms profits are affected by the bargaining weight α. On the left-hand side, when $\alpha_3 > \alpha$, the component strategy is chosen by U_1.[46] The kink in Π_D and Π_2 lines arises as U_2 stops paying slotting fees to D. Indeed, when $\alpha_1 > \alpha$, U_2 has to pay a slotting fee to access D's slots and its profit is thus constant in α. Above this threshold, the industry profit is shared according to the "Nash-in-Nash" bargaining

[45] For this example we have: $\alpha_1 = \frac{\Pi^L}{\Pi^M} = \frac{1}{3}$, $\alpha_2 = \frac{\Pi^M}{\Pi^H+\Pi^L} = \frac{3}{5}$, and $\alpha_3 = \frac{\Pi^M-\Pi^L}{\Pi^H} = \frac{1}{2}$.

[46] The market outcome when $\alpha = 0$ corresponds 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) as well as in our numerical illustration in Section 2.

Figure 1: Equilibrium outcome with independent products

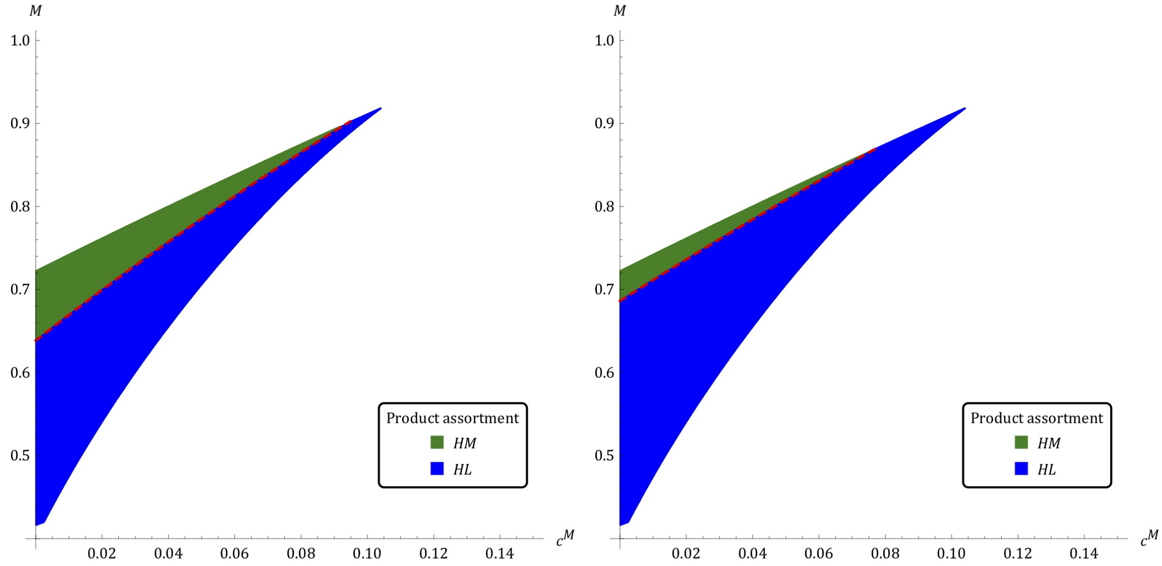


Notes: This figure is drawn for the following numerical values: $\Pi^H = 4$, $\Pi^M = 3$, $\Pi^L = 1$. The x-axis represents D's bargaining weight $\alpha \in [0,1]$. The y-axis corresponds to values for profits obtained by each manufacturer and D. The dotted lines represent the counterfactual profits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

solution and U_2's profit decreases in α. U_1's profit always decreases in α because it pays no slotting fee under the component regime. On the right-hand side, when $\alpha > \alpha_3$, the bundling equilibrium arises and U_2 is foreclosed. This generates a discontinuity that drops D's profit as highlighted in Remark 2: the gap to the blue dotted line illustrates D's losses compared to a situation in which bundling would be prohibited. When $\alpha_2 > \alpha$, U_1's profit is first constant in α because it pays a slotting fee to impose its bundle. When $\alpha > \alpha_2$, U_1 stops paying slotting fee to D and its profit is simply given by the asymmetric Nash bargaining solution which decreases in α. Note that the gap between the solid and dotted red lines illustrates the profitability of U_1's bundling practices.

Example 2: Imperfect substitutes products. Let us now discuss the insights drawn from Proposition 1 in a framework with imperfect substitutes. We consider that product $X \in \{H, M, L\}$ is produced at a constant marginal cost c^X where $c^H > c^M > c^L = 0$. As in the vertical differentiation model pioneered by Mussa and Rosen (1978), each consumer purchases at most one unit of a good. We specify the following linear consumer utility function: $U(\theta, X, p^X) = \theta X - p^X$, where $\theta \sim U(0,1)$ is the marginal willingness to pay

Figure 2: Equilibrium outcome with imperfect substitute products



(a) $\alpha = 0.2$ (b) $\alpha = 0.4$

Notes: These figures are drawn from a setting of vertical product differentiation with parameter values $c^H = 0.15$, $c^L = 0$, $H = 1$, $L = 0.4$. The x-axis represents the marginal cost of product M where $c^M \in [c^L, c^H]$. The y-axis corresponds to the quality of product M where $M \in [L, H[$.

for quality, and p^X is the price of product X. We define the corresponding industry profit outcomes in Appendix F.

The colored areas in Figure 2 represent the set of parameters for which A1 to A4 hold.[47] The bundling equilibrium arises in the blue area whereas the component equilibrium arises in the green area. Figures 2a and 2b illustrate the equilibrium of our game for different values of α. As stated in Proposition 1, the bundling area shrinks when D's buyer power weakens. Furthermore, Figure 2 illustrates that bundling practices never emerge when U_2's product quality level M is high compared to its production cost c^M. Indeed, in such a case, a bundling strategy is not profitable because U_1 would have to pay a high slotting fee to impose its bundle and monopolize the market.

[47]Note that the (small) missing area from the origin is due to A4.

5 Stocking capacity choice

We now consider an *ex ante* stage in which D publicly chooses the number of slots $k \in \{1,2,3\}$ available for the distribution of manufacturers' products. This stocking capacity choice can be interpreted as a long-run strategic decision of how much shelf space to allocate to a given product category. For instance, the relative shelf space dedicated to soft drinks or detergents might reflect a strategic positioning of a retail chain. It might also reflect the strategy of a retailer on its private labels (e.g., a large share of shelves dedicated to private labels restricts the space available for national brands in a given product category).[48] In addition to the previous assumptions, we consider that:

Assumption A5 *The largest industry profit is generated when all products are offered to consumers:* $\Pi^{HML} > \Pi^{HM}$.

The subgame in which D has a stocking capacity of $k = 2$ has already been studied in Section 4. Section 5.1 studies the alternative subgames $k = 1$ and $k = 3$. Section 5.2 shows that, when bundling practices are not feasible, D may restrict its stocking capacity to extract rent from manufacturers through the competition for slots. Section 5.3 then analyzes the interplay between D's stocking capacity decision and U_1's bundling strategy.

5.1 Bargaining and product assortment decision

Case k = 1. When having only one available slot, D must choose among three product assortments: H, M, or L. Hence, there is only one bilateral negotiation between the pair $D - U_i$ over the fixed fee of product $X \in \{H,M,L\}$ which is determined according to the asymmetric Nash bargaining solution as in (9). The equilibrium fixed fee is $F_i^X = (1-\alpha)\Pi^X$ and profits of firms are respectively given by: $\pi_D^X = \alpha\Pi^X$, $\pi_i^X = (1-\alpha)\Pi^X$, and $\pi_{-i}^X = 0$. Absent slotting fees and under A1, D always select H. In the

[48] Such a choice might also represent the adoption of a specific retail format (e.g., supermarket, hypermarket, or discounters) that directly affects the number of products offered to consumers.

competition for D's slot, however, U_1 offers a couple of slotting fees (S^H, S^L) whereas U_2 offers S^M. The following lemma summarizes our result:

Lemma 5 *When D chooses a stocking capacity equal to $k = 1$, U_1 and U_2 offer respectively:*

$$S_1^H = \left(max\{0, \Pi^M - \alpha\Pi^H\}, 0\right),$$
$$S_2^H = (1-\alpha)\Pi^M,$$

D selects the product assortment H and receives its corresponding slotting fee. Equilibrium profits of firms are given by:

$$\Pi_D^H = \begin{cases} \Pi^M & \text{if } \alpha_4 > \alpha \\ \alpha\Pi^H & \text{otherwise} \end{cases}, \quad \Pi_1^H = \begin{cases} \Pi^H - \Pi^M & \text{if } \alpha_4 > \alpha \\ (1-\alpha)\Pi^H & \text{otherwise} \end{cases}, \quad \Pi_2^H = 0,$$

where $\alpha_4 \equiv \frac{\Pi^M}{\Pi^H}$.

Proof. U_1 has no incentive to replace H by L as it gets a higher profit when selling H, which implies that $S^L = S^H = 0$. However, U_2 is willing to offer at most a slotting fee equals to $(1-\alpha)\Pi^M$ to replace H with M and secure D's unique slot. As U_1 can offer at most a slotting fee equals to $(1-\alpha)\Pi^H$, it always wins the competition for D's slot. Hence, there exists a unique equilibrium outcome in which U_1 offers $S_1^H = \left(\max\{0, \Pi^M - \alpha\Pi^H\}, 0\right)$, U_2 offers $S_2^M = (1-\alpha)\Pi^M$ and H is sold. ■

In addition to the mechanisms drawn from Lemma 4, it is worth noting that among the set of products excluded from D's slot only M may be used as a replacement threat to affect the division of surplus. The reasons are twofold. First, both H and L belong to U_1 which is able to internalize the effect that offering a slotting fee for L increases the threat to replace H. Second, under A1, M generates the second-highest profit and can thus serve as a more credible threat to replace H. This last feature is shared with the NNTR bargaining solution which, given that D selects the assortment H, generates a division of surplus similar to that described in Lemma 5.[49]

[49] Again, under A1, the assortment H constitutes a "stable network" according to Proposition 2 in Ho and Lee (2019).

Case $k = 3$. When D has a slot for each product, under A5, the product assortment that generates the highest industry profit is: HML. Hence, there is a simultaneous bilateral negotiations between the pair $D - U_1$ for HL and the pair $D - U_2$ for M. Following the "Nash-in-Nash" bargaining protocol, the fixed fee F_1^{HML} negotiated between D and U_1 solves:

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

and the fixed fee F_2^{HML} negotiated between D and U_2 solves:

$$\max_{F_2^{HML}} \left(\Pi^{HML} - F_1^{HML} - F_2^{HML} - (\Pi^{HL} - F_1^{HML})\right)^\alpha \left(F_2^{HML}\right)^{1-\alpha}$$

The equilibrium fixed fees are respectively given by $F_1^{HML} = (1-\alpha)\left(\Pi^{HML} - \Pi^M\right)$ and $F_2^{HML} = (1-\alpha)\left(\Pi^{HML} - \Pi^{HL}\right)$ and corresponding profits of firms are:

$$\pi_D^{HML} = \Pi^{HML} - F_1^{HML} - F_2^{HML}, \quad \pi_1^{HML} = F_1^{HML}, \quad \pi_1^{HML} = F_2^{HML}. \tag{12}$$

Every products being supplied on D's slots, manufacturers have no incentives to offer any slotting fee to D. We thus obtain the following lemma:

Lemma 6 *When D chooses a stocking capacity of $k = 3$, all products are offered in equilibrium and profits of firms are given by:*

$$\mathit{\Pi}_D^{HML} = \mathit{\Pi}^{HML} - F_1^{HML} - F_2^{HML}, \quad \mathit{\Pi}_1^{HML} = F_1^{HML}, \quad \mathit{\Pi}_2^{HML} = F_2^{HML}.$$

When slots are available for every product, the division of surplus in the vertical chain is always determined by the "Nash-in-Nash" bargaining solution. This result coincides with the NNTR bargaining solution when the downstream firm does not exclude any available trading partner from its network.

5.2 Stocking capacity choice when bundling is not feasible

We now analyze D's stocking capacity choice $k = \{1, 2, 3\}$. As previously stated, we first consider a case in which bundling practices are not feasible to exclusively focus on D's strategic decision. We solve this *ex ante* stage under the following additional assumption:

Assumption A6 *The marginal contribution of M to the industry profit Π^{HML} is (weakly) lower than its marginal contribution to the industry profit Π^{HM}:*

$$\Pi^{HM} - \Pi^{H} \geq \Pi^{HML} - \Pi^{HL}.$$

This technical assumption is in the same vein as A4 and ensures that, absent slotting fees, D always selects the assortment HML rather than HM.[50]

Absent slotting fees, D would always choose $k = 3$ among the three potential levels of stocking capacity and offer the assortment HML. However, we have shown in Lemmas 2 and 5 that D may receive positive slotting fees when $k = \{1, 2\}$. Comparing D's profit in the three different situations, we obtain the following proposition:

Proposition 2 *D has the incentive to restrict its stocking capacity to $k = 2$ or $k = 1$ when its bargaining power vis-à-vis manufacturers is low. Formally, D chooses:*

- $k = 1$ *if* $\min\{\alpha_1, \alpha_3, \alpha_4, \alpha_5\} > \alpha > 0$ *or* $\min\{\alpha_4, \alpha_5\} > \alpha > \alpha_1$,
- $k = 2$ *if* $\min\{\alpha_1, \alpha_4, \alpha_6\} > \alpha > \alpha_3$ *or* $\min\{\alpha_1, \alpha_6\} > \alpha > \alpha_4$,
- $k = 3$ *otherwise,*

where $\alpha_1 \equiv \frac{\Pi^{HL} - \Pi^{H}}{\Pi^{HM} - \Pi^{H}}$, $\alpha_3 \equiv \frac{\Pi^{HM} - \Pi^{HL}}{\Pi^{HM} - \Pi^{M}}$, $\alpha_4 \equiv \frac{\Pi^{M}}{\Pi^{H}}$, $\alpha_5 \equiv \frac{\Pi^{HML} - \Pi^{HL}}{2\Pi^{HML} - \Pi^{HL} - \Pi^{M}}$, $\alpha_6 \equiv \frac{\Pi^{HML} - \Pi^{HM}}{2\Pi^{HML} - \Pi^{HL} - \Pi^{HM}}$.

Proof. See Appendix G. The ranking of these thresholds under A1 to A6 is not straightforward. We provide below illustrations of this proposition in the specific cases of

[50] Although the assortment HM generates a lower industry profit under A5, D's relative gains from trade with each manufacturer might be reduced if A6 is not satisfied. Hence, D may have the incentive to select HM to strengthen its bargaining position vis-à-vis manufacturers and obtain a higher share of a lower pie. In practice, however, this technical assumption is relevant only for $\frac{1}{2} > \alpha$.

independent products (Example 1) and imperfect substitutes (Example 2). ■

Proposition 2 establishes a relationship between D's stocking capacity choice and its bargaining power in negotiations with manufacturers. In particular, it states that D restricts its stocking capacity only when its bargaining power is low (i.e., $k = 1$ when α tends to 0). The reason is as follows. Lemmas 2 and 5 have shown that when D is sufficiently powerful in its bargaining (i.e., when $\alpha > \alpha_1$ and $\alpha > \alpha_4$ respectively) it never extracts rent from manufacturer(s) through slotting fees as threats of replacement are not credible to exercise. Instead, the division of surplus in the vertical chain is entirely determined by the "Nash-in-Nash" bargaining solution in which the surplus captured by manufacturers are proportional to their marginal contribution to the industry profit (see for instance (3), (5) and (12)). Thus, by expanding its stocking capacity, D not only increases the industry profit to be divided but also decreases the marginal contribution of each manufacturer when their products are (imperfect) substitutes. This enables D to strengthen its bargaining position and extract a larger share of a larger pie. In contrast, when its bargaining power is lower, D has incentives to restrict its stocking capacity to intensify the competition for slots by playing manufacturers off against each other. Although such a strategy shrinks the industry profit to be split, it increases the amount of slotting fees offered by manufacturers and always ensures a positive profit for D, even when α tends to 0.[51]

This result builds a bridge between the competition for slots modeled in Marx and Shaffer (2010) and the bargaining protocol developed in Ho and Lee (2019). More specifically, as in Marx and Shaffer (2010), our mechanism by which a downstream firm plays off manufacturers against each other to gain bargaining leverage stems from the auctioning of a limited number of slots. Moreover, Proposition 2 shows that D may engage in stocking capacity restrictions to actually exclude products in equilibrium and obtain bargaining leverage. For any level of stocking capacity $k \in \{1, 2, 3\}$, Lemmas 2, 5, and 6 have further shown that the product assortment selected by D constitutes a "stable network" in the sense of Proposition 2 in Ho and Lee (2019) and that the

[51] Indeed, as shown in Lemmas 2 and 5, U_2 always offers a positive slotting fee to maintain (or attempt to maintain) M on D's slots whenever $k = \{1, 2\}$ and $\alpha_1 > \alpha$.

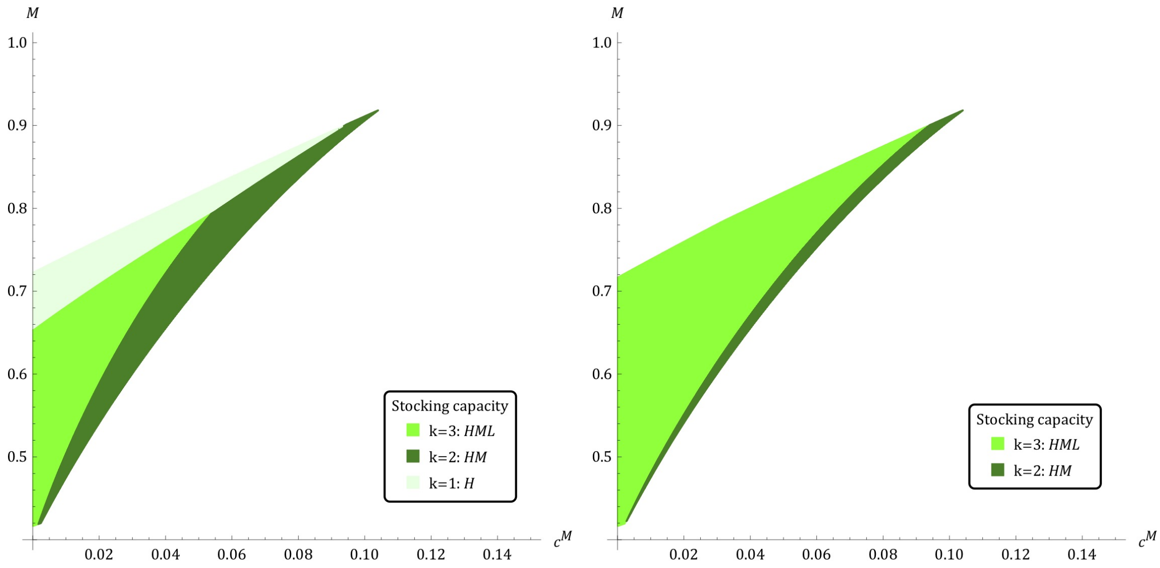
surplus division yields the same outcome as the NNTR bargaining solution. As a result, our framework provides a new foundation for the NNTR bargaining solution.[52]

Example 1 (continued). Assuming that $\Pi^H = 4$, $\Pi^M = 3$, $\Pi^L = 1$, we obtain a unique threshold: $\alpha_1 = \frac{1}{3}$. D chooses $k = 1$ when $\alpha_1 > \alpha > 0$ and $k = 3$ otherwise. Assuming instead that Π^M is closer to Π^L, that is $\Pi^M = \frac{3}{2}$, we now obtain two thresholds: $\alpha_3 = \frac{1}{8}$ and $\alpha_6 = \frac{2}{5}$. D chooses $k = 1$ when $\alpha_3 > \alpha > 0$, $k = 2$ when $\alpha_6 > \alpha > \alpha_3$, and $k = 3$ otherwise. Hence, as shown in Proposition 2, D always chooses $k = 3$ when α tends towards 1 and $k = 1$ when α tends towards 0. Furthermore, Lemma 5 shows that D is always guaranteed to secure a profit of Π^M when $k = 1$, implying that this level of stocking capacity is more attractive as Π^M gets closer to Π^H. In contrast, when Π^M decreases towards Π^L, D chooses $k = 2$ because U_2 has to pay a high slotting fee to maintain its product on D's slots (see Lemma 2).

Example 2 (continued). Figure 3a and Figure 3b illustrate results from Proposition 2 in the case of imperfect substitutes. Again, an increase in the bargaining weight from $\alpha = 0.2$ to $\alpha = 0.4$ undermines D's incentives to restrict its stocking capacity (the area in which the equilibrium HML emerges is larger in Figure 3b). Moreover, the stocking capacity is restricted to $k = 1$ when M is a close substitute to H, which arises either when the gap in qualities $(H - M)$ decreases and/or when the gap in marginal costs $(c^H - c^M)$ increases. Otherwise, D either chooses $k = 2$ or $k = 3$. More specifically, when M is a close substitute to L (c^M is high), D chooses $k = 2$ because U_2 has to pay a high slotting fee to maintain its product on D's slots (see Lemma 2). In contrast, when c^M is low, D cannot expect to receive a high slotting fee from U_2 and thus prefers to choose $k = 3$.

[52] The noncooperative extensive form game developed by Ho and Lee (2019) to motivate the NNTR bargaining solution hinges on modeling assumptions that differ from ours. In particular, they build on Manea (2018) and consider that delegates sent by the downstream firm to negotiate wholesale contracts on its behalf are able to play manufacturers off against one another by going back and forth between manufacturers inside and outside the downstream firm's network.

Figure 3: *D*'s stocking capacity choice with imperfect substitute products (absent bundling)



(a) $\alpha = 0.2$ (b) $\alpha = 0.4$

Notes: These figures are drawn from the setting of vertical product differentiation outlined in Section 4.3 with parameter values $c^H = 0.15$, $c^L = 0$, $H = 1$, $L = 0.4$. The x-axis represents the marginal cost of product M where $c^M \in [c^L, c^H]$. The y-axis corresponds to the quality of product M where $M \in [L, H[$.

5.3 Stocking capacity choice when bundling is feasible

We now allow U_1 to choose a bundling strategy after observing the stocking capacity choice of D.[53] It is worth noting that, among the three levels of stocking capacity $k \in \{1, 2, 3\}$, D's profit can only be affected by bundling practices under $k = 2$. Indeed, under alternative levels of stocking capacity, bundling is irrelevant to the equilibrium outcome because either one or all products are offered on the market. The following proposition sheds light on the interplay between U_1's selling strategy and D's stocking capacity choice:

Proposition 3 *Bundling practices mitigate D's incentives to restrict its stocking capacity to $k = 2$. Instead, D increases the level of its stocking capacity to $k = 3$ to annihilate the*

[53]Note that we could alternatively consider a game in which U_1 first announces its selling strategy before D's stocking capacity choice. Results would be similar in spirit to those presented in this section because a stocking capacity expansion would enable D to counteract U_1's bundling strategy.

harmful effects of bundling. Formally, D chooses:

- $k = 1$ *if* $min\{\alpha_1, \alpha_3, \alpha_4, \alpha_5\} > \alpha > 0$ *or* $min\{\alpha_4, \alpha_5\} > \alpha > \alpha_1$,
- $k = 2$ *if* $min\{\alpha_1, \alpha_2, \alpha_5, \alpha_6\} > \alpha > \alpha_3$,
- $k = 3$ *otherwise.*

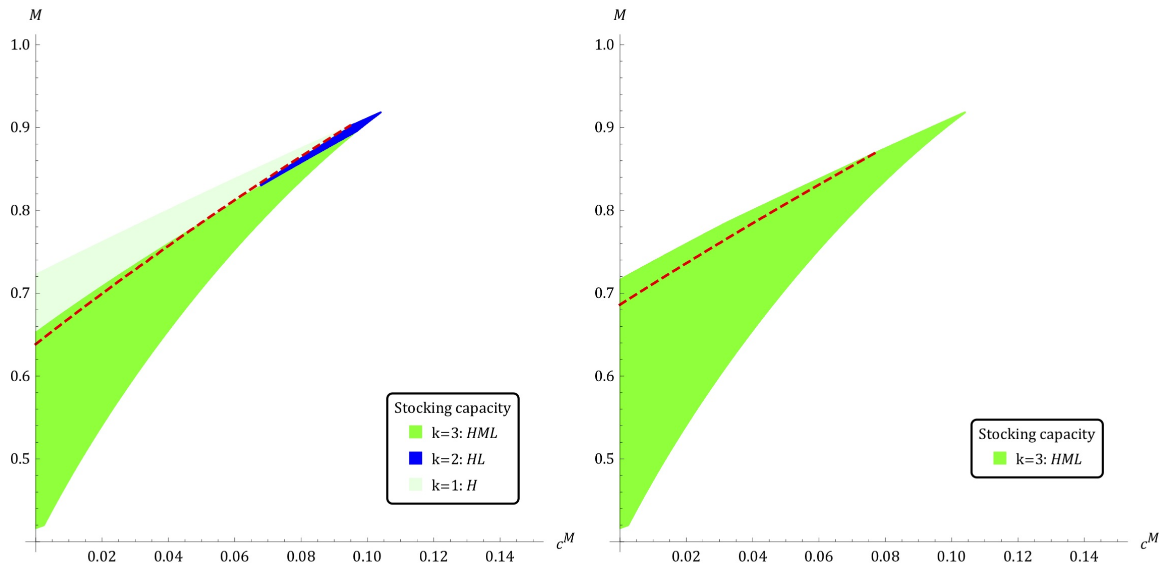
Proof. From the comparison of Propositions 2 and 3, we can see that D's decision to choose $k = 1$ remains unaffected. In contrast, the parameter space for which $k = 2$ arises shrinks because $\alpha_4 > \alpha_2$. See Appendix G for further details. ■

This result highlights that D's stocking capacity restrictions are less likely to arise in the presence of bundling practices. First, even though bundling harms D (Remark 2), D has no incentives to further restrict its stocking capacity from $k = 2$ to $k = 1$ because, by doing so, it would at best obtain the same profit Π^M. Instead, D has the incentive to expand its stocking capacity to $k = 3$ to offset the harmful effects of bundling practices. However, while D's incentives to choose $k = 2$ are reduced, such a level of stocking capacity may remain optimal because it is an appealing rent-extraction device when D's bargaining power vis-à-vis manufacturers is low. We make use of our previous examples below to illustrate this result and provide further insights.

Example 1 (continued). Assuming that $\Pi^H = 4$, $\Pi^M = \frac{3}{2}$, and $\Pi^L = 1$, we now obtain two thresholds: $\alpha_3 = \frac{1}{8}$ and $\alpha_5 = \frac{3}{10}$. D chooses $k = 1$ when $\alpha_3 > \alpha > 0$, $k = 2$ when $\alpha_5 > \alpha > \alpha_3$, and $k = 3$ otherwise. Interestingly, when $k = 2$, bundling practices always arise in equilibrium as $\min\{\alpha_2, \alpha_3\} = \alpha_3$. If, instead, bundling practices are not feasible D would choose $k = 2$ for all $\alpha_6 > \alpha > \alpha_3$, where $\alpha_6 > \alpha_5$. Therefore, when $\alpha_6 > \alpha > \alpha_5$, D expands its stocking capacity to $k = 3$ to prevent the harmful effects of bundling practices.

Example 2 (continued). Figures 4a and 4b depict respectively the equilibrium outcome of our game under $\alpha = 0.2$ and $\alpha = 0.4$. In both cases, the area below the red dashed curve indicates that a bundling equilibrium would arise if D chooses $k = 2$ (see Figure 2). Under $\alpha = 0.2$, Figure 4a shows that the area in which $k = 2$ shrinks compared

Figure 4: *D*'s stocking capacity choice with imperfect substitute products (with bundling)



(a) $\alpha = 0.2$ (b) $\alpha = 0.4$

Notes: These figures are drawn from the setting of vertical product differentiation described in Section 4.3 with parameter values $c^H = 0.15$, $c^L = 0$, $H = 1$, $L = 0.4$. The x-axis represents the marginal cost of product M where $c^M \in [c^L, c^H]$. The y-axis corresponds to the quality of product M where $M \in [L, H[$.

to Figure 3a, which considerably lessens the emergence of bundling in equilibrium. This again illustrates the result of Proposition 3 in which D expands its stocking capacity to avoid any adverse effects from bundling practices. Figure 4a also indicates that bundling may still arise in equilibrium. Finally, we can see from Figure 4b that when $\alpha = 0.4$ all products are offered to consumers and bundling practices become irrelevant.

6 Policy implications

The section analyzes the effect of banning the use of bundling practices as well as slotting fees and discusses antitrust policy implications. To examine the effect on consumer surplus, we restrict our analysis to the case of a uniform distribution of consumers' tastes introduced in our illustrative example. We denote CS^X the consumer surplus when the assortment X is offered and derive the following lemma:

Lemma 7 *Under A1 to A5, with vertical differentiation and a uniform distribution of consumers' taste for quality, consumers surplus are ranked as follows:*

$$CS^{HML} > CS^{HM} > CS^{HL} > CS^{H}.$$

Proof. See Appendix F. ■

Note that following Remark 1 we may have $CS^{M} > CS^{H}$ when $\Pi^{M} > \Pi^{H}$. In this case, the harmful effect of bundling practices is reinforced as the highest product quality M is excluded from the market.

6.1 Banning bundling practices

When D's stocking capacity is restricted to $k = 2$ as in Section 4, Proposition 1 clearly calls for a ban on bundling practices whenever D's buyer power is high as a bundling equilibrium is more likely to arise. When taking into account D's stocking capacity adjustment, however, the effect of banning bundling practices becomes ambiguous. Indeed, a comparison of Propositions 2 and 3 indicates that D has greater incentives to restrict its capacity to $k = 2$ when bundling is not feasible.[54] We thus derive the following proposition:

Proposition 4 *When $k = 2$, a ban on bundling practices ensures that the efficient assortment HM is always offered by D, which improves industry profit and consumer surplus. In contrast, when D can adjust its stocking capacity, a ban on bundling practices may restore D's incentives to restrict its stocking capacity, which in turn harms industry profit and consumer surplus.*

Proof. When $k = 2$, results are straightforward from A2 and Lemma 7. When the stocking capacity can be adjusted, results are straightforward from Propositions 2 and 3 as well as A5 and Lemma 7. ■

[54]This can also be seen directly from the comparison of Figure 3b and Figure 4b, or Figure 3a and Figure 4a.

Surprisingly, as bundling practices discipline D's incentives to restrict its stocking capacity, a policy that prohibits bundling may rather harm welfare. Hence, Proposition 4 advocates for "laissez-faire" when the downstream firm can easily expand its stocking capacity in the short-run.

Interestingly, on the one hand, buyer power induces D to expand its stocking capacity and, on the other hand, it increases the profitability of bundling practices for U_1. As a result, D's stocking capacity expansion provides a natural safeguard against the exclusionary effect of bundling practices.

6.2 Banning slotting fees

The use of slotting fees also constitutes a highly debated topic in antitrust law. Despite a thorough investigation of such practices (see Federal Trade Commission, 2003), the FTC refrains from issuing slotting allowance guidelines. In contrast, the EC's guidelines on vertical restraints advocate for a case by case analysis when both the manufacturer's and the retailer's market share exceed 30%.[55] This cautious attitude of competition authorities reflects the conflicting views on slotting fees which may have anti-competitive as well as efficiency-enhancing effects.

In our model, a ban on slotting fees has ambiguous implications. We first analyze the case in which D's stocking capacity is restricted to $k = 2$ as in Section 4. We know from Lemma 4 that D always selects the assortment HL when U_1 chooses a bundling strategy. Such a selling strategy may however be costly to implement because U_1 has to pay a slotting fee whenever D's bargaining power is low. Hence, a ban on slotting fees would make bundling practices costless for U_1. The effect of such policy is reversed when D is able to adjust its stocking capacity. Indeed, absent slotting fees, D is unable to exploit the rent from its shelf space scarcity. As a result, it has no longer incentives to restrict its stocking capacity and always selects the assortment HML. This, in turn, prevents U_1 from triggering any exclusionary effects through bundling practices. The following proposition summarizes these results:

[55] See paragraphs (203) to (208) of European Commission (2010).

Proposition 5 *When $k = 2$, a ban on slotting fees makes bundling always profitable for U_1 which decreases industry profit and consumer surplus. In contrast, when D can adjust its stocking capacity, a ban on slotting fees annihilates D's incentives to restrict its stocking capacity which, in turn, prevents anti-competitive bundling practices to the benefit of industry profit and consumer surplus.*

Proof. Straightforward from A2, A5 and Lemma 7. ■

Interestingly, bans on bundling practices and slotting fees have opposite welfare implications. When D cannot adjust its stocking capacity, a policy that forbids bundling practices is welfare improving whereas banning the use of slotting fees hurts welfare. Conversely, when D's stocking capacity can be adjusted, a ban on bundling practices is harmful whereas a ban on slotting fees efficiently defeats both stocking capacity restrictions and anti-competitive bundling practices.

7 Conclusion

This article analyzes bundling practices by a multi-product manufacturer in a vertical chain with a monopolist retailer. We uncover a new mechanism by which the presence of buyer power allows the emergence of bundling practices, which leads to the exclusion of an efficient rival supplier at the expense of both the retailer and the industry profit. This result contributes to the "leverage theory" of bundling and provides a novel circumstance under which the Chicago School argument does not apply. We further show that the anti-competitive concern of bundling practices is alleviated when the retailer can strategically adjust its stocking capacity.

As stressed in Marx and Shaffer (2010), the exploitation of a limited stocking capacity through slotting fees is often used by retailers vis-à-vis suppliers. We develop a game-theoretic framework that accounts for this feature and yields a surplus division which coincides with the NNTR bargaining solution of Ho and Lee (2019). Our setting thus provides a tractable building block which offers a new foundation for the NNTR solution as well as interesting perspectives for future research (e.g., downstream competition, multi-product bilateral oligopoly).

In terms of policy implications, we highlight that bundling and slotting fees practices are interrelated as both result from the retailers' limited stocking capacity. When retailers can adapt their stocking capacity, a ban on slotting fees efficiently defeats strategic stocking capacity restrictions as well as anti-competitive bundling practices to the benefit of consumers. Otherwise, our theory would rather call for a ban on bundling practices.

Appendix

A Proof of Lemma 2

Lemma 2 states that when U_1 opts for a component selling strategy the outcome of our game is described as follows. U_1 offers a menu of slotting fees $S_1^{HM} = \left(0, 0, (1-\alpha)(\Pi^{HL} - \Pi^{HM} + \Pi^{M})\right)$ and U_2 offers $S_2^{HM} = \max\{0, \Pi^{HL} - \alpha\Pi^{HM} - (1-\alpha)\Pi^{H}\}$. D selects the assortment HM and receives the corresponding fees. Firms subsequently bargain over F_1^{HM} and F_2^{HM} and payoffs are given by:

$$
\begin{aligned}
\Pi_D^{HM} &= \begin{cases} \Pi^{HL} - (1-\alpha)\left(\Pi^{HM} - \Pi^{M}\right) & \text{if } \alpha_1 > \alpha \\ (1-\alpha)\left(\Pi^{H} + \Pi^{M}\right) - (1-2\alpha)\Pi^{HM} & \text{otherwise} \end{cases}, \\
\Pi_1^{HM} &= (1-\alpha)\left(\Pi^{HM} - \Pi^{M}\right), \\
\Pi_2^{HM} &= \begin{cases} \Pi^{HM} - \Pi^{HL} & \text{if } \alpha_1 > \alpha \\ (1-\alpha)\left(\Pi^{HM} - \Pi^{H}\right) & \text{otherwise} \end{cases}.
\end{aligned}
$$

We first show that under A1 to A4 the equilibrium described above exists. We then analyze the uniqueness of this equilibrium outcome.

A.1 Existence

We analyze deviations from manufacturers' offers to secure slots for their products. Then, we consider D's deviations from the product assortment HM.

A.1.1 Deviation by U_1.

We show that U_1 has no incentive to deviate from the menu of slotting fees:

$$S_1^{HM} = \left(0, 0, (1-\alpha)(\Pi^{HL} - \Pi^{HM} + \Pi^{M})\right)$$

Deviation on one slotting fee. If U_1 deviates by offering a slotting fee $\tilde{S}^{H} > 0$, D would still select the assortment HM and U_1 would lose from this deviation because $\pi_1^{HM} - \tilde{S}^{H} < \pi_1^{HM}$.

If U_1 deviates toward $\tilde{S}^{L} > 0$, this could affect D's assortment choice by replacing H by L and the deviation profit obtained by U_1 would be $\pi_1^{ML} - \tilde{S}^{L} < \pi_1^{HM}$ by A2. Such a deviation is not profitable.

If U_1 deviates by offering a slotting fee $\tilde{S}^{HL} > (1-\alpha)\Pi^{HL} - (1-\alpha)\left(\Pi^{HM} - \Pi^{M}\right)$, D would accept the offer and select the assortment HL, and U_1's deviation profit would be $\pi_1^{HL} - \tilde{S}^{HL} < \pi_1^{HM}$. As a result, it has no incentive to deviate by offering a higher slotting fee. Furthermore, there is also no incentive for

U_1 to deviate by offering a lower slotting fee because D would still select the assortment HM and U_1's payoffs would remain unchanged.

Deviation on several slotting fees. U_1 offers a menu of slotting fees and may deviate simultaneously on several fees from S_1^{HM}.

There is no rational for U_1 to simultaneously deviate toward $\tilde{S}^H > 0$ and $\tilde{S}^L > 0$. The two offers would simply compete with each other as they cannot be accepted simultaneously. Indeed, to favor the assortment HL, U_1 could deviate toward $\tilde{S}^{HL} > (1-\alpha)(\Pi^{HL} - \Pi^{HM} + \Pi^M)$.

Moreover, if U_1 deviates toward $\tilde{S}^H > 0$ and $\tilde{S}^L > 0$, it would not be profitable neither if HL is accepted nor if HM is accepted as slotting fees paid by U_1 will be too high. For instance, if $\tilde{S}^H > 0$ U_1 would be willing to offer at most $\tilde{S}^{HL} = \pi_1^{HL} - \pi_1^{HM} + \tilde{S}^H = (1-\alpha)(\Pi^{HL} - \Pi^{HM} + \Pi^M) + \tilde{S}^H$. In that case, D would select the assortment HL and U_1 would obtain a profit $(1-\alpha)\left(\Pi^{HM} - \Pi^M\right) - \tilde{S}^H$, which is strictly lower than Π_1^{HM}.

A.1.2 Deviation by U_2.

We show that U_2 has no incentive to deviate from its slotting fee:

$$S_2^{HM} = \max\{0, \Pi^{HL} - \alpha\Pi^{HM} - (1-\alpha)\Pi^H\}$$

If U_2 deviates by offering a slotting fee $\tilde{S}^M > \max\{0, \Pi^{HL} - \alpha\Pi^{HM} - (1-\alpha)\Pi^H\}$, D would still select the assortment HM and U_2's profit from this deviation would be lower.

If U_2 deviates by offering a slotting fee $0 < \tilde{S}^M < \Pi^{HL} - \alpha\Pi^{HM} - (1-\alpha)\Pi^H$, D would reject the offer and select the assortment HL, and U_2's deviation profit would be 0.

A.1.3 Deviation toward monopolization with a single product.

Although we solve our game under the assumption that manufacturers can at most secure one slot per product, we conduct a robustness check of our equilibrium by allowing manufacturers to monopolize the market with only one of their products (i.e., offering a slotting fee to secure all slots).

Absent slotting fees, U_1 would be better off if D carries only its product H instead of HM. Indeed, $\pi_1^H - \pi_1^{HM} = (1-\alpha)\,\Pi^H - (1-\alpha)\left(\Pi^{HM} - \Pi^M\right) > 0$ under A3. Hence, U_1 may attempt to monopolize the market 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 $S_2^{HM} = 0$ (i.e., $\alpha > \alpha_1$), this fee boils down to $\tilde{S}^H = (1-\alpha)\,\Pi^M - (1-2\alpha)\left(\Pi^{HM} - \Pi^H\right)$. However, U_1 is willing to offer a slotting fee up to $\pi_1^H - \pi_1^{HM}$ which is lower than $\tilde{S}^H$ under A3. When $S_2^{HM} > 0$ (i.e., $\alpha_1 > \alpha$), the monopolization is costlier for U_1. U_1 is unable to profitably monopolize the market with H.

When $\Pi^M + \Pi^L > \Pi^{HM}$, absent slotting fees, U_1 is better off if D carries only its product L instead of HM, that is, $\pi_1^L - \pi_1^{HM} = (1-\alpha)\Pi^L - (1-\alpha)\left(\Pi^{HM} - \Pi^M\right) > 0$. To monopolize the market with L, U_1 has to offer a fee at least equals to $\tilde{S}^L = \pi_D^{HM} - \pi_D^L + S_2^{HM}$. When $S_2^{HM} = 0$ (i.e., $\alpha > \alpha_1$), this fee boils down to $\tilde{S}^L = (1-\alpha)\left(\Pi^H + \Pi^M\right) - (1-2\alpha)\Pi^{HM} - \alpha\Pi^L$. However, U_1 is willing to offer a slotting fee up to $\pi_1^L - \pi_1^{HM} = (1-\alpha)\left(\Pi^M + \Pi^L - \Pi^{HM}\right)$ which is lower than $\tilde{S}^L$ under A3 and A4. When $S_2^{HM} > 0$ (i.e., $\alpha_1 > \alpha$), the monopolization is costlier for U_1. U_1 is unable to profitably monopolize the market with L.

Absent slotting fees, U_2 is better off if D carries only M instead of HM. Indeed, $\pi_2^M - \pi_2^{HM} = (1-\alpha)\Pi^M - (1-\alpha)\left(\Pi^{HM} - \Pi^H\right) > 0$ under A3. To monopolize the market with M, U_2 has to offer a fee $\tilde{S}^M = \pi_D^{HL} - \pi_D^M + (1-\alpha)(\Pi^{HL} - \Pi^{HM} + \Pi^M) = \Pi^{HL} + (1-2\alpha)\Pi^M - (1-\alpha)\Pi^{HM}$. However, U_2 is willing to offer a slotting fee up to $\pi_2^M - \pi_2^{HM} + S_2^{HM}$. When $S_2^{HM} = 0$ (i.e., $\alpha > \alpha_1$), this fee boils down to $(1-\alpha)\left(\Pi^H + \Pi^M - \Pi^{HM}\right)$ which is lower than $\tilde{S}^M$ if $\Pi^{HL} > \Pi^M$ which is true under A1. When $S_2^{HM} > 0$ (i.e., $\alpha_1 > \alpha$), this fee equals $\bar{S}^M = (1-\alpha)\Pi^M + \Pi^{HL} - \Pi^{HM}$ which is lower than $\tilde{S}^M$ under A3. U_2 is unable to profitably monopolize the market with M.

A.1.4 Deviation in assortment choice by D.

Given S_1^{HM} and S_2^{HM}, we show that D has no incentive to deviate from the product assortment HM.

If D deviates toward HL, its deviation profit is $\pi_D^{HL} + (1-\alpha)(\Pi^{HL} - \Pi^{HM} + \Pi^M) = \Pi^{HL} - (1-\alpha)\left(\Pi^{HM} - \Pi^M\right)$. When $\alpha_1 > \alpha$, this deviation profit is similar to that obtained under HM. When $\alpha > \alpha_1$, it can be shown that D's profit are (weakly) higher under HM than HL. Consequently, it is not profitable for D to deviate and select the assortment HL.

If D deviates toward ML, its deviation profit is $\pi_D^{ML} + 0 + S_2^{HM}$. Under A4, we know from Lemma 1 that $\pi_D^{HM} > \pi_D^{ML}$. Therefore, $\pi_D^{HM} + 0 + S_2^{HM} \geq \pi_D^{ML} + 0 + S_2^{HM}$ because $S^L = S^H = 0$. It is thus not profitable for D to deviate and select the assortment ML.

A.2 Uniqueness

The above pure-strategy Nash equilibrium is not unique:

- U_1 can offer strictly positive values of S^L in equilibrium as long as this does not affect the assortment decision of D toward ML.
- U_1 can choose to offer $S^{HL} > \bar{S}^{HL}$ and U_2 a higher slotting fee $S^M \in]S_2^{HM}, \bar{S}^M]$ such that D is indifferent between the assortment HM and HL.

However, these alternative equilibria rely on weakly dominated strategies and the equilibrium described in Lemma 2 is obtained from the trembling-hand selection criterion. Moreover:

- There is no equilibrium with the assortment ML. Indeed, absent slotting fees, under A4, both D and U_1 strictly prefer HM to ML and U_2 strictly prefers ML to HM. However, slotting fees cannot be made contingent to which rival's product is offered by D and therefore U_2 cannot affect D's assortment decision. There is no equilibrium with assortment ML.

- There is no equilibrium with the assortment HL. Indeed, by offering a slotting fee π_2^{HM}, U_2 is always able to secure a slot for M and therefore there is no equilibrium with assortment HL.

B Proof of Lemma 4

Lemma 4 states that when U_1 opts for a bundling strategy, the outcome of the game is such that U_1 and U_2 offer respectively $S_1^{HL} = (\emptyset, \emptyset, \max\{0, \Pi^M - \alpha\Pi^{HL}\})$ and $S_2^{HL} = (1-\alpha)\Pi^M$ and D selects the assortment HL. U_1 then bargains over F_1^{HL} and payoffs are given by:

$$\Pi_D^{HL} = \begin{cases} \Pi^M & \text{if } \frac{\Pi^M}{\Pi^{HL}} > \alpha \\ \alpha\Pi^{HL} & \text{otherwise} \end{cases}, \quad \Pi_1^{HL} = \begin{cases} \Pi^{HL} - \Pi^M & \text{if } \frac{\Pi^M}{\Pi^{HL}} > \alpha \\ (1-\alpha)\Pi^{HL} & \text{otherwise} \end{cases}, \quad \Pi_2^{HL} = 0.$$

We first show that under A1 to A4 the equilibrium described above exists. We then analyze the uniqueness of this equilibrium outcome.

Deviations by U_1. We show that U_1 has no incentive to deviate from the slotting fee $S_1^{HL} = (\emptyset, \emptyset, \max\{0, \Pi^M - \alpha\Pi^{HL}\})$:

- If U_1 deviates toward $\tilde{S}^{HL} > \max\{0, \Pi^M - \alpha\Pi^{HL}\}$, D still selects HL rather than M and therefore U_1 weakly loses from paying a higher slotting fee.
- If U_1 deviates toward $\Pi^M - \alpha\Pi^{HL} > \tilde{S}^{HL} > 0$, D selects M and U_1 obtains no profit. Such a deviation cannot be profitable.

Deviations by U_2. We show that U_2 has no incentive to deviate from the slotting fee $S_2^{HL} = (1-\alpha)\Pi^M$:

- If U_2 deviates toward $\tilde{S}^M > S_2^{HL}$, D selects M and U_2 obtains a strictly negative profit as $0 > (1-\alpha)\Pi^M - \tilde{S}^M$.
- If U_2 deviates toward $S_2^{HL} > \tilde{S}^M$, D still selects HL and U_2 gets 0 profit.

Deviations by D. D cannot profitably deviate because it is indifferent between selecting HL or M and any other assortment choice is not possible under bundling.

There is a multiplicity of equilibria because U_2 can choose to offer $S^M > \hat{S}^M = (1-\alpha)\Pi^M$ and U_1 a higher slotting fee $S^{HL} \in]S_1^{HL}, \hat{S}^{HL}]$ such that D is indifferent between the assortment HL and M. Again, the equilibrium presented above can be obtained from the trembling-hand selection criterion.

C "Nash-in-Nash" bargaining with outside options

In this section, we show that the two first stages of our game can be formulated as a "Nash-in-Nash" bargaining under constraints representing D's ability to exercise threats of replacement and gain bargaining leverage from the presence of non-offered products.

C.1 Component strategy

Under the component regime, the equilibrium characterized in Lemma 2 is such that D negotiates wholesale tariffs with U_1 and U_2 for the assortment HM and uses product L as a replacement threat. This bargaining situation can be described by the following maximization problems:

$$\max_{F_1^{HM}} \left(\Pi^{HM} - F_1^{HM} - F_2^{HM} - (\Pi^M - F_2^{HM})\right)^{\alpha} \left(F_1^{HM}\right)^{(1-\alpha)}$$
$$s.t.\ \Pi^{HM} - F_1^{HM} - F_2^{HM} \geq \Pi^{ML} - F_1^{res} - F_2^{HM} \tag{13}$$

$$\max_{F_2^{HM}} \left(\Pi^{HM} - F_1^{HM} - F_2^{HM} - (\Pi^H - F_1^{HM})\right)^{\alpha} \left(F_2^{HM}\right)^{(1-\alpha)}$$
$$s.t.\ \Pi^{HM} - F_1^{HM} - F_2^{HM} \geq \Pi^{HL} - F_1^{res} \tag{14}$$

which are equivalent to the "Nash-in-Nash" bargaining problems given by (1) and (2) to which we have added constraints. Each constraint in (13) and (14) ensures that D must obtain at least as much profit as what it would get by taking its outside option. D's outside option in each bilateral negotiation is defined as replacing H or M by L and paying U_1 its reservation price F_1^{res} for such a replacement. This reservation price is equal to what U_1 would get in the equilibrium HM: $F_1^{res} = F_1^{HM}$, which is positive because U_1 is a multi-product manufacturer and therefore captures some profit from the sale of H. Note that this case is not analyzed in Ho and Lee (2019) who do not consider the presence of multi-product upstream firms. However, the reservation price may be positive in their setting due to the presence of alternative outlets.

As $F_1^{res} = F_1^{HM}$, the constraint in (13) never binds under A2 (i.e., the threat to replace H by L is not credible), implying that (13) can be reformulated as an unconstrained maximization problem. As a result, (13) and (14) boil down to:

$$\max_{F_1^{HM}} \left(\Pi^{HM} - F_1^{HM} - F_2^{HM} - (\Pi^M - F_2^{HM})\right)^{\alpha} \left(F_1^{HM}\right)^{(1-\alpha)} \tag{15}$$

$$\max_{F_2^{HM}} \left(\Pi^{HM} - F_1^{HM} - F_2^{HM} - (\Pi^H - F_1^{HM})\right)^{\alpha} \left(F_2^{HM}\right)^{(1-\alpha)}$$
$$s.t.\ \Pi^{HM} - F_1^{HM} - F_2^{HM} \geq \Pi^{HL} - F_1^{HM} \tag{16}$$

which gives:

$$F_1^{HM} = (1-\alpha)(\Pi^{HM} - \Pi^{M})$$
$$F_2^{HM} = \min\{(1-\alpha)(\Pi^{HM} - \Pi^{H}), \Pi^{HM} - \Pi^{HL}\}$$

Equilibrium profits thus coincide with Lemma 2.

C.2 Bundling strategy

Under the bundling regime, the equilibrium characterized in Lemma 4 is such that D negotiates wholesale tariffs with U_1 for the assortment HL and uses product M as a replacement threat. This bargaining situation can be described by the following maximization problem:

$$\begin{aligned} &\max_{F_1^{HL}} \left(\Pi^{HL} - F_1^{HL}\right)^{\alpha}\left(F_1^{HL}\right)^{(1-\alpha)} \\ &s.t.\ \Pi^{HL} - F_1^{HL} \geq \Pi^{M} - F_2^{res} \end{aligned} \tag{17}$$

which is equivalent to the Nash bargaining problem given by (7) to which we have added a constraint. This constraint ensures that D obtains a profit at least equal to what it would get by taking its outside option (that is, replacing HL by M at U_2's reservation tariff). U_2's reservation tariff for this replacement is given by $F_2^{res} = 0$ because U_2 makes no profit when the assortment HL is selected by D. The solution to (17) is given by:

$$F_1^{HL} = \min\{(1-\alpha)\Pi^{HL}, \Pi^{HL} - \Pi^{M}\}$$

and equilibrium profits coincides with Lemma 4.

D Proof of Remark 1

In any subgame equilibrium assortment HM, ML, or HL, the outcome of the bargaining stage summarized in Lemmas 1 and 3 are valid under A2 and A4. Furthermore, proofs of Lemma 2 and 4 in the Appendices A and B hold under A2 to A4 and $\Pi^{HL} > \Pi^{M}$. Consequently, relaxing A1 by using a weaker condition $\Pi^{HL} > \Pi^{M}$ instead of $\Pi^{H} > \Pi^{M}$ does not affect any of our results.

E Proof of Remark 2

Under the component regime, the joint profit generated by the pair $U_1 - D$ is given by $\Pi^{HM} - F_2^{HM} = \alpha\Pi^{HM} + (1-\alpha)\Pi^{H}$ whereas it is given by Π^{HL} under the bundling regime. Hence, the joint profit generated by the pair $U_1 - D$ is higher under the component regime when $\alpha > \frac{\Pi^{HL} - \Pi^{H}}{\Pi^{HM} - \Pi^{H}} = \alpha_1 > \alpha_3$, that is, when bundling practices arise according to Proposition 1. Given that the joint profit of the pair $U_1 - D$ always decreases when U_1 opts for a bundling strategy, it cannot be to the benefit of D (note also that, compared to the bundling regime, D obtains additional profit from its negotiation with U_2 under the component regime). D is thus better off under a ban on bundling practices.

F Proof of Lemma 7

In what follows, we determine the optimal industry profit under each market structure (i.e., the maximum profit for the vertically integrated structure).

When only one product $X \in \{H, M, L\}$ of respective quality $x \in \{h, m, l\}$ is sold to consumers, the primitive profit function Π^X is determined by solving the following maximization problem:

$$\max_{p^X} \left(p^X - c^X\right) Q^X$$

where p^X denotes the price of product X and $Q^X = (1 - \frac{p^X}{x})$ is the corresponding demand. We obtain the equilibrium profit $\Pi^X = \frac{(p - c^X)^2}{4x}$ and consumer surplus $CS^X = \frac{1}{2}\Pi^X$.

Similarly, when two products $\{X, Y\}$ of respective qualities $\{x, y\} \in \{h, m, l\}$ with $x > y$ are sold to consumers, the primitive profit function Π^{XY} is determined by solving the following maximization problem:

$$\max_{p^X, p^Y} \left(p^X - c^X\right) Q^X + \left(p^Y - c^Y\right) Q^Y$$

where $Q^X = 1 - \frac{p^X - p^Y}{x - y}$ and $Q^Y = \frac{p^X - p^Y}{x - y} - \frac{p^Y}{y}$. We obtain the equilibrium profit $\Pi^{XY} = \frac{y\left(y(x - 2c^X) + (q - c^X)^2\right) + c^Y(xc^y - 2yc^X)}{4y(x - y)}$ and consumer surplus $CS^{XY} = \frac{1}{2}\Pi^{XY}$.

When the three qualities are offered on the market, the primitive profit function Π^{HML} is determined by solving the following maximization problem:

$$\max_{p^H, p^M, p^L} \left(p^H - c^H\right) Q^H + \left(p^M - c^M\right) Q^M + \left(p^L - c^L\right) Q^L$$

where $Q^H = 1 - \frac{p^H - p^M}{h - m}$ and $Q^M = \frac{p^H - p^M}{h - m} - \frac{p^M - p^L}{m - l}$, and $Q^L = \frac{p^M - p^L}{m - l} - \frac{p^L}{l}$. We obtain the equilibrium profit $\Pi^{HML} = \frac{1}{4}(h + \frac{(c^L)^2}{l} + \frac{(c^H - c^M)^2}{(h - m)} + \frac{(c^M - c^L)^2}{(m - l)} - 2c^H)$ and consumer surplus $CS^{HML} = \frac{1}{2}\Pi^{HML}$.

G Proof of Proposition 2 and 3

Note that we have defined the following thresholds: $\alpha_1 \equiv \frac{\Pi^{HL}-\Pi^{H}}{\Pi^{HM}-\Pi^{H}}$, $\alpha_2 \equiv \frac{\Pi^{M}}{\Pi^{HL}}$, $\alpha_3 \equiv \frac{\Pi^{HM}-\Pi^{HL}}{\Pi^{HM}-\Pi^{M}}$, $\alpha_4 \equiv \frac{\Pi^{M}}{\Pi^{H}}$, $\alpha_5 \equiv \frac{\Pi^{HML}-\Pi^{HL}}{2\Pi^{HML}-\Pi^{HL}-\Pi^{M}}$, $\alpha_6 \equiv \frac{\Pi^{HML}-\Pi^{HM}}{2\Pi^{HML}-\Pi^{HL}-\Pi^{HM}}$.

We first study the case in which bundling is not feasible (Proposition 2):

- When $\min\{\alpha_4, \alpha_1\} > \alpha$, we have that D obtains $\Pi_D^H = \Pi^M$ under $k = 1$, $\Pi_D^{HM} = \Pi^{HL} - (1-\alpha)(\Pi^{HM} - \Pi^M)$ under $k = 2$, and Π_D^{HML} under $k = 3$. Hence, D chooses $k = 3$ when $\alpha > \max\{\alpha_5, \alpha_6\}$, $k = 2$ when $\alpha_6 > \alpha > \alpha_3$, and $k = 1$ when $\min\{\alpha_3, \alpha_5\} > \alpha$.
- When $\alpha_4 > \alpha > \alpha_1$, we have that D obtains $\Pi_D^H = \Pi^M$ under $k = 1$, $\Pi_D^{HM} = (1-\alpha)(\Pi^H + \Pi^M) - (1-2\alpha)\Pi^{HM}$ under $k = 2$, and Π_D^{HML} under $k = 3$. Hence, D chooses $k = 3$ when $\alpha > \alpha_5$ and $k = 1$ when $\alpha_5 > \alpha$. Note that $k = 2$ is never chosen in this case because $\Pi_D^{HML} > \Pi_D^{HM}$.
- When $\alpha_1 > \alpha > \alpha_4$, we have that D obtains $\Pi_D^H = \alpha\Pi^H$ under $k = 1$, $\Pi_D^{HM} = \Pi^{HL} - (1-\alpha)(\Pi^{HM} - \Pi^M)$ under $k = 2$ and Π_D^{HML} under $k = 3$. Hence, D chooses $k = 3$ when $\alpha > \alpha_6$ and $k = 2$ when $\alpha_6 > \alpha$. Note that $k = 1$ is never chosen in this case as $\Pi_D^{HM} > \Pi_D^H$.
- When $\alpha > \max\{\alpha_4, \alpha_1\}$, we have that D obtains $\Pi_D^H = \alpha\Pi^H$ under $k = 1$, $\Pi_D^{HM} = (1-\alpha)(\Pi^H + \Pi^M) - (1-2\alpha)\Pi^{HM}$ under $k = 2$, and Π_D^{HML} under $k = 3$. Hence, D always chooses $k = 3$ because $\Pi_D^{HML} > \Pi_D^{HM} > \Pi_D^H$.

We now study the case in which bundling is feasible (Proposition 3) and (11) is satisfied (when (11) is not satisfied, D's stocking capacity choice is given by Proposition 2):

- Note that D's choice to restrict its stocking capacity to $k = 1$ is not affected by U_1's bundling strategy. Indeed, there is no incentive for D to further restrict its stocking capacity from $k = 2$ to $k = 1$ because $\Pi_D^{HL} \geq \Pi_D^H = \Pi^M$ for any $\alpha \in [0, 1]$. Furthermore, as shown in Remark 2, there is no incentive for D to expand its stocking capacity from $k = 1$ to $k = 2$ because it is worse off under bundling (i.e., $\Pi_D^{HM} > \Pi_D^{HL}$).
- When $\alpha_4 > \alpha$, we have $\Pi_D^{HL} = \Pi^M = \Pi_D^H$. Comparing these profits with Π_D^{HML}, we find that D chooses $k = 3$ if and only if $\alpha > \alpha_5$. When $\alpha_5 > \alpha$, however, D is indifferent between $k = 2$ and $k = 1$. In such a case, we follow the Pareto criterion and consider that D selects $k = 2$.
- When $\alpha > \alpha_4$, it can be shown that $\Pi_D^{HML} > \Pi_D^{HL} = \alpha\Pi^{HL} > \Pi_D^H = \alpha\Pi^H$. As a result, D always chooses $k = 3$.

H Robustness to A4

As long as $\pi_D^{HM} > \pi_D^{ML}$, Lemmas 1 to 4 and Proposition 1 remain unchanged. When relaxing A4, Lemma 1 is modified as follows:

Lemma 1bis *Absent slotting fees, D may choose the assortment ML when U_1 opts for a component strategy.*

Proof. From A2 and A3, we have $\pi_D^{HM} > \pi_D^{HL}$ but, when $\alpha < \alpha' \equiv \frac{1}{2}\left(1 - \frac{\Pi^H - \Pi^L}{(2\Pi^{HM} - \Pi^H) - (2\Pi^{ML} - \Pi^L)}\right)$, we may obtain that $\pi_D^{ML} > \pi_D^{HM}$. ■

When, absent slotting fees, D selects ML instead of HM, U_1 would be better off selling H instead of L (and even better off selling HL). In what follows, we determine the equilibria focusing on the case in which $\pi_D^{ML} > \pi_D^{HM}$. We find that two types of equilibria may arise: (i) HM is sold in equilibrium, and (ii) HL is sold in equilibrium.

(i) HM is sold in equilibrium. The maximum slotting fee that U_1 is willing to pay to secure one slot for H is given by: $\pi_1^{HM} - \bar{S}^{H'} = \pi_1^{ML} \Leftrightarrow \bar{S}^{H'} = (1-\alpha)(\Pi^{HM} - \Pi^{ML})$. Furthermore, to replace L by H, D must obtain:

$$\pi_D^{HM} + S^H + S^M \geq \pi_D^{ML} + S^L + S^M.$$

Therefore, the optimal strategy for U_1 is to offer $S^{L'} = 0$ and $S^{H'}$ such that:

$$\pi_D^{HM} + S^{H'} = \pi_D^{ML}$$
$$\Leftrightarrow \quad S^{H'} = \pi_D^{ML} - \pi_D^{HM} > 0$$

It can be shown that $\bar{S}^{H'} > S^{H'}$. Thus, U_1 is always able to secure one slot for its product H instead of L.

Given $S^{H'}$, U_1 may also attempt to secure slots for H and L. The maximum slotting fee that U_1 is willing to offer is given by: $\pi_1^{HM} - S^{H'} = \pi_1^{HL} - \bar{S}^{HL'} \Leftrightarrow \bar{S}^{HL'} = (1-\alpha)\left(\Pi^{HL} - \Pi^{HM} + \Pi^M\right) + S^{H'}$. Similarly, the maximum slotting fee that U_2 is willing to pay to secure a slot for M is given by: $\pi_2^{HM} - \bar{S}^M = 0 \Leftrightarrow \bar{S}^{M'} = (1-\alpha)\left(\Pi^{HM} - \Pi^H\right)$. It can be shown that $\pi_D^{HM} + S^{H'} + \bar{S}^{M'} > \pi_D^{HL} + \bar{S}^{HL'}$, implying that U_2 wins the competition and can always secure a slot for M. In particular, U_2 offers $S^{M'}$ such that:

$$\pi_D^{HM} + S^{H'} + S^{M'} = \pi_D^{HL} + \bar{S}^{HL'}$$
$$\Leftrightarrow \quad S^{M'} = \max\{\Pi^{HL} - \alpha\Pi^{HM} - (1-\alpha)\Pi^H, 0\}$$

(ii) HL is sold in equilibrium. An alternative strategy for U_1 consists in attempting to secure a slot for its two products only. In that case, it sets $S^{H''} = S^{L''} = 0$ and attempts to impose HL rather than ML. To do so, the maximum slotting fee that U_1 is willing to pay is: $\bar{S}^{HL''} = \pi_1^{HL} - \pi_1^{ML}$, whereas the

maximum slotting fee that U_2 is willing to offer is: $\bar{S}^{M''} = \pi_2^{ML}$. Because $\Pi^{HL} > \Pi^{ML}$, U_1 always wins the competition with a tariff $S^{HL''}$ such that $S^{HL''} = \pi_D^{ML} - \pi_D^{HL} + \pi_2^{ML}$.

Comparing the profit obtained by U_1 in equilibria (i) and (ii), we find that both strategies may arise in equilibrium when relaxing A4. The following lemma summarizes our results:

Lemma 2bis *(i) When U_1 chooses a component selling strategy, there exists an equilibrium such that manufacturers offer:*

$$\begin{aligned} S_1^{HM'} &= \left(\pi_D^{ML} - \pi_D^{HM}, 0, (1-\alpha)(\Pi^{HL} - \Pi^{HM} + \Pi^{M}) + (\pi_D^{ML} - \pi_D^{HM})\right), \\ S_2^{HM'} &= S_2^{HM} = max\{\Pi^{HL} - \alpha\Pi^{HM} - (1-\alpha)\Pi^{H}, 0\}, \end{aligned}$$

D selects the assortment HM and receives the corresponding slotting fees. Equilibrium profits of firms are :

$$\begin{aligned} &\Pi_D^{HM'} = \Pi_D^{HM} + (\pi_D^{ML} - \pi_D^{HM}), \\ &\Pi_1^{HM'} = \Pi_1^{HM} - (\pi_D^{ML} - \pi_D^{HM}), \\ &\Pi_2^{HM'} = \Pi_2^{HM}. \end{aligned}$$

This equilibrium arises when $\Pi^{ML} - \Pi^{L} > \Pi^{HL} - \Pi^{H}$ or when $\Pi^{ML} - \Pi^{L} < \Pi^{HL} - \Pi^{H}$ and $\alpha > \alpha'' \equiv \frac{\Pi^{HL} - \Pi^{H} - \Pi^{ML} + \Pi^{L}}{\Pi^{HM} - \Pi^{H} - \Pi^{ML} + \Pi^{L}}$.

(ii) When U_1 chooses a component selling strategy, there exists another equilibrium such that manufacturers offer:

$$\begin{aligned} S_1^{HL''} &= \left(0, 0, (\pi_D^{ML} + \pi_2^{ML} - \pi_D^{HL})\right), \\ S_2^{HL''} &= \pi_2^{ML} \end{aligned}$$

D selects the product assortment HL and receives the corresponding slotting fees. Equilibrium profits of firms are given by:

$$\begin{aligned} &\Pi_D^{HL''} = \pi_D^{ML} + \pi_2^{ML}, \\ &\Pi_1^{HL''} = \Pi^{HL} - (\pi_D^{ML} + \pi_2^{ML}), \\ &\Pi_2^{HL''} = 0. \end{aligned}$$

This equilibrium arises when $\Pi^{ML} - \Pi^{L} < \Pi^{HL} - \Pi^{H}$ and $\alpha < \alpha''$.

Proof. A complete characterization of these equilibria is available upon request. ■

Comparing U_1's profit under both selling strategies, we obtain the following proposition:

Proposition 1bis *When relaxing A4, the incentive of U_1 to choose a bundling strategy is weakly reinforced.*

Proof. In type (ii) equilibrium, U_1 must choose between a mixed bundling strategy and a pure bundling strategy, but both lead to the inefficient assortment HL. In type (i) equilibrium, U_1 obtains a lower profit than in Lemma 2 under the component strategy because of the slotting fee paid for H. Besides, its profit under a bundling strategy is similar to Lemma 4. Therefore, U_1's incentives to bundle its products are weakly reinforced when relaxing A4. ■

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