A Theory of Foreclosure and Wholesale Bundling

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Abstract

We develop a framework to analyze the anticompetitive potential of bundled discounts in the context of business-to-business relationships. We characterize the equilibrium outcome of a simultaneous-move game in which a multi-product manufacturer competes against a single-product rival, and where distribution is carried out by potentially competing retailers. We show that the anticompetitive potential of “wholesale bundling” hinges on providing a positive answer to each of the following questions: Is retail competition intense? Do final consumers purchase multiple products? Is one-stop shopping pervasive in the retail market? We discuss the implications of our theory for competition policy and antitrust practice.

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1 Introduction

“While bundled rebates may be a common business practice, it is not clear that monopolists commonly bundle rebates for products over which they have monopolies with products over which they do not. The United States submits that, at this juncture, it would be preferable to allow the case law and economic analysis to develop further and to await a case with a record better adapted to development of an appropriate standard.”


In 2003, the U.S. Supreme Court had to decide whether to review the Third Circuit unanimous decision that found 3M guilty of exclusionary conduct in violation of Section 2 of the Sherman Act. Because the crux of the case was LePage’s claim against 3M’s bundled discounts program, under which 3M offered rebates to retailers contingent on purchases in multiple product lines, reviewing the case would have set precedent in a particularly intricate issue: how should antitrust law treat such complex discount schemes?

To decide whether to embark on such an endeavor, the Supreme Court asked the Solicitor General to express the views of the United States. As the quote above indicates, the United States argued that it would be preferable to wait and allow for further development of the economic analysis and case law before determining new guidance on the application of Section 2 to bundled rebates, a recommendation that was accepted by the Court.²

Offering discounts to buyers that purchase two or more unrelated products is a common business practice, but its implications for competition policy are still unclear (FTC/DoJ 2014). The reason is that, while in many instances these bundling arrangements help achieve efficiencies and/or intensify competition among market participants (Salinger 1995; Gans and King 2006; Thanassoulis 2007; Armstrong and Vickers 2010; Jeon and Menicucci 2012), in others they have been shown to be anticompetitive, allowing multi-product incumbents to deter the entry of more efficient single-product rivals (e.g., Nalebuff 2004; Peitz 2008; Greenlee, Reitman, and Sibley 2008).³

While insightful, the literature so far has focused exclusively on retail bundling. However, many of the relevant cases, 3M v. LePage’s included, are about bundling in business-to-business

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¹LePage’s Inc. v. 3M (Minnesota Mining and Manufacturing Company) (324 F.3d 141, 3d Cir. 2003). LePage’s Inc. accused 3M of monopolizing the transparent tape market by offering retailers (Walmart, Kmart, and Staples, among others) discounts linking products across six product lines.

²The need for further analysis was also shared by the Antitrust Modernization Commission (AMC), a bipartisan effort initiated in 2004 by the U.S. Congress to examine the need to update antitrust laws and enforcement. See Antitrust Modernization Commission (2007).

³Whinston’s (1990) model of tying could also be listed as an early precursor of this exclusionary-bundling literature. In other instances, bundling allows (monopoly) firms to better price discriminate final consumers (e.g., Stigler 1963; Adams and Yellen 1976; McAfee, McMillan, and Whinston 1989; Chen and Riordan 2013).
relationships. This paper aims to fill this gap by developing a new theory that takes into account elements specific to this wholesale context, and using this new theory to evaluate the anticompetitive potential of wholesale bundling.

First, we distinguish the driver behind retailers’ interest in carrying multiple product lines. Actual cases reveal that such interest can arise either because retailers serve consumers interested in many products, or because they serve many different groups of consumers with preferences for a smaller subset of products. Second, recognizing the prevalence of shopping costs in some consumer markets and being cognizant of their influence over retailers’ behavior, we allow for the possibility that final consumers might be forced to one-stop shop. Third and finally, we explore the implications of varying the level of retail competition, as its potential interaction with the possibility of upstream anticompetitive behavior has informally begun appearing in recent antitrust complaints, most notably in \textit{Cablevision v. Viacom}.

We incorporate the three elements above in a simultaneous-move game, in which a multi-product manufacturer and single-product rival compete in nonlinear pricing contracts to supply potentially competing retailers. The multi-product firm can produce two unrelated goods, $A$ and $B$, while the single-product rival produces only $B$, albeit at lower cost. Due to its broader portfolio of products, the multi-product firm can offer wholesale bundling arrangements by jointly conditioning the terms of trade over both product lines.

We are interested in equilibria that exhibit foreclosure, that is, equilibria in which all retailers contract exclusively with the multi-product firm for the procurement of both goods. In particular, we analyze under what circumstances, if any, such equilibria exist, and whether the existence of foreclosure relies on the ability of the multi-product manufacturer to offer wholesale bundling arrangements. Our goal, therefore, is to determine essential conditions for anticompetitive wholesale bundling to emerge in equilibrium, helping authorities to better distinguish anticompetitive arrangements from neutral or efficiency-enhancing ones.

Figure 1 summarizes our results and their policy implications. Wholesale bundling, if observed, should be of anticompetitive concern only when the following market conditions are simultaneously present: (i) retail competition is intense; (ii) a significant fraction of final consumers have a strictly positive valuation for both products; and (iii) final consumers incur

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5 See Chen and Rey (2012); Zhou (2014); Rhodes (2015); and Johnson (2017) for recent papers on retail competition with shopping costs.

6 Just as with retail bundling, there are also efficiency-enhancing rationales for wholesale bundling (as recognized by the Solicitor General in \textit{3M v. LePage’s}). In the online Appendix we provide one model. Hence, a case-by-case approach seems more appropriate than declaring outright that wholesale bundling is \textit{per se} illegal.
steep shopping costs when visiting multiple retailers, forcing them to one-stop shop.\footnote{In the absence of shopping costs, foreclosure can still emerge, though the multi-product manufacturer must be able to include contract provisions that generate similar one-stop shopping effects (see Section 5 for more details).} Moreover, wholesale bundling is a prerequisite for the existence of a foreclosure equilibrium; if the multi-product firm is forced to only condition terms on each product line individually, anticompetitive foreclosure is not an equilibrium of the game.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{diagram.png}
\caption{Summary of Policy Implications}
\end{figure}

Intuitively, when conditions (i), (ii), and (iii) hold, the multi-product firm can create a credible market-segmentation threat against any retailer that deviates to procure good $B$ from the rival manufacturer. With wholesale bundling (e.g., a full-line forcing contract involving a deep discount on good $A$ subject to exclusivity on good $B$), the multi-product firm can essentially force a retailer to give up good $A$ whenever she decides to purchase $B$ elsewhere. Consequently, even if the single-product rival offers substantially better terms for product $B$, intense downstream competition leaves the deviant retailer in a weak position to compete for consumers that value both goods and are forced to one-stop shop. With a much smaller set of potential consumers, namely, those few who only value $B$ and those who value both goods but $A$ not as much, little profit (if any) is left for the deviant retailer and rival manufacturer to make in the retail market. Interestingly, and against the common wisdom (e.g., Whinston 1990; Rasmusen, Ramseyer, and Wiley 1991; Nalebuff 2004), scale economies, while helpful, are not essential for this foreclosure strategy to work.

Put differently, the simultaneous presence of all three conditions highlighted in Figure 1 has made good $A$ a \textit{must-stock item}: an item that, in equilibrium, retailers have no choice but to carry. Our theory can thus be seen as a formal equilibrium foundation of a must-stock
good. Through the lens of this equilibrium notion, we then assess the validity of the different definitions commonly found in the antitrust domain and show, for instance, that the one used by the EU Commission seems too broad.

Relative to the existing literature on foreclosure, our exclusionary mechanism is novel. First, it is multi-product by nature. That is, our foreclosure mechanism cannot emerge in single-product environments. Moreover, it departs from most post-Chicago models (e.g., Aghion and Bolton 1987; Whinston 1990; Rasmusen, Ramseyer, and Wiley 1991; Segal and Whinston 2000; Simpson and Wickelgren 2007b; Choné and Linnemer 2016) in that we rule out any first-mover advantage for the dominant firm. As emphasized by Spector (2011) and Ide, Montero, and Figueroa (2016), assuming the firm targeted by the exclusionary strategy is momentarily absent at the contracting stage is at odds with the relevant case law, but nevertheless essential to generate foreclosure in all those models.8

Our mechanism does share with some recent post-Chicago models the important role played by retail competition in supporting foreclosure. Yet, ours differs significantly in that it does not rely on lump-sum payments to persuade retailers not to take a rival’s offer, regardless of whether these transfers are done ex-ante, as in the exclusive dealing arrangements of Simpson and Wickelgren (2007b), or ex-post, as in the loyalty rebates of Asker and Bar-Isaac (2014).9 At the other extreme, the reason why foreclosure fails when retail competition is weak (i.e., monopoly retailers) follows a logic similar to that described in the common agency literature (O’Brian and Shaffer 1997; Benheim and Whinston 1998), once adapted to multiple (unrelated) products and many retailers downstream: total industry profits are necessarily maximized in this setting if parties can offer nonlinear pricing schemes.

More generally, our theory can be viewed as an attempt to bridge two strands of the literature that, for the most part, have run in parallel. Post-Chicago models, on the one hand, have placed all the emphasis on business-to-business relationships at the cost of reducing the product space to a single product. Previous bundling models, on the other hand, considered distinct (unrelated) products but completely neglected the role of business-to-business relationships. Our paper pays explicit attention to both features, while addressing the methodological complications this entails.

The rest of the paper is organized as follows. We present the model in Section 2. Section 3 illustrates the workings of our foreclosure mechanism in the simplest possible way, by asking what it takes the multi-product firm to “fully monopolize” the market for both products. A more comprehensive analysis is left for Section 4. In Section 5, we allow for varying levels of

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8See Calzolari and Denicolo (2015) for an exception.

9The importance of downstream competition is also in Simpson and Wickelgren (2007a), but we depart from them in fundamental aspects. For example, (i) they restrict ex-ante manufacturers to offer linear prices, (ii) they allow offers to be made contingent on other retailers’ contracting decisions, and (iii) they only consider an equally efficient rival. It should be noted that their main result does not hold as soon as a slightly more efficient rival is considered, unless contracts involve (off-path) empty threats.
shopping costs. We conclude in Section 6 with implications for competition policy. Most proofs are provided in the Appendix and the online Appendix.

2 A Model of Wholesale Competition

We consider a model of a wholesale market in which a multi-product manufacturer competes with a single-product rival and distribution is carried out by potentially competing retailers. The baseline version of the model presented here and used throughout the text has the simplest possible structure that allows us to distill the essential market conditions for foreclosure to emerge. Because such a simple structure necessarily omits features that may be present in actual cases, at the end of the section we explain how the baseline model can be extended to accommodate these features. These extensions are formally covered in the online Appendix, which shows that the policy implications summarized in Figure 1 are robust and extend beyond the relatively simple setting we describe next.

2.1 Baseline model

We consider two manufacturers, two retailers, and a continuum of final consumers with heterogeneous preferences for manufacturers’ products.\(^{10}\)

Manufacturers. \(M\) is a multi-product manufacturer capable of producing goods \(A\) and \(B\), while \(S\) is a single-product manufacturer that produces only \(B\). We assume the different varieties of \(B\) to be perfect substitutes. As we are interested in the possibility of foreclosing a more efficient competitor, we assume that \(S\) is more efficient in producing \(B\).

Both the relevant literature (e.g., Whinston 1990; Rasmusen, Ramseyer, and Wiley 1991; Nalebuff 2004) and antitrust practice (e.g., EU Commission 2009, p. 10) have emphasized the importance of scale economies in achieving foreclosure. In order to study the validity of such claims in our setting, we normalize variable costs to zero and consider the extreme case in which efficiency differentials are due entirely to fixed costs of production. In particular, \(M\) must incur fixed costs \(0\) and \(F_M > 0\) to produce goods \(A\) and \(B\), respectively, while \(S\) must incur a fixed cost \(F_S \in [0, F_M)\) to produce \(B\).\(^{11}\)

Retailers. The manufacturers supply final consumers only indirectly, through two (risk-neutral) retail buyers, \(R_1\) and \(R_2\). For the sake of simplicity, retailers have no costs other than that of purchasing the goods from one or both manufacturers. We are interested in the potential interaction between retailers’ competition and anticompetitive behavior upstream.

\(^{10}\)Throughout the text, masculine pronouns refer to manufacturers and feminine pronouns refer to retailers.

\(^{11}\)Note that we entertain the possibility that \(S\) can produce good \(B\) for free (i.e., \(F_S = 0\)). This is perhaps consistent with an industry in which most investments are already sunk at the time of contracting with distributors. Interestingly, we will show that even then, foreclosure can emerge in equilibrium.
This issue is of particular importance, as it recently has begun appearing informally in antitrust complaints. Thus, we will consider the polar cases in which retailers are either (i) local monopolies, each serving half of the market, or (ii) Bertrand competitors.

**Consumers’ Valuations.** We consider a unit mass of consumers who value good $A$ in $v_A$, and an equal mass who value good $B$ in $v_B$. While $v_A$ is uniformly distributed in the unit interval, we assume $v_B$ to be the same across consumers and equal to $b \in (0, 1) > F_M$.

Understanding the driver behind retailers’ interest in carrying multiple product lines will prove to be important. Actual cases reveal that such interest may be due to two distinct (though not mutually exclusive) reasons: either because retailers want to attract consumers interested in many products, or because they want to attract many different groups of consumers, each with a preference for a smaller subset of products.

Making this distinction not only proves crucial in our theory, but it also serves to capture the variation we observe across actual cases. In *SmithKline v. Eli Lilly & Co.*, for example, $A$ and $B$ would correspond to two alternative antibiotics (cephalothin and cefazolin, respectively) used to treat a wide variety of bacterial infections. Since these antibiotics are not therapeutic equivalent, hospitals would need to carry both, but any given patient would care to use only one. In *Cablevision v. Viacom*, by contrast, households have heterogeneous preferences over bundle size. While some households want a large set of channels (that is, both $A$ and $B$), others would be satisfied with a smaller one (that is, either $A$ or $B$).

To capture these possibilities, we allow for different levels of overlap between the mass of consumers interested in product $A$ and the mass interested in $B$. In particular, we assume that with probability $\mu \in [0, 1]$, independent of $v_A$, a consumer who values $A$ also values $B$.

Besides tractability, the main advantage of this simple demand structure is that it rules out any price discrimination motive for bundling at the retail level. Therefore, total monopoly revenues to be made in this industry are simply the sum of the monopoly revenues in market $A$ (equal to $1/4$), and the monopoly revenues in market $B$ (equal to $b$).

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12 Take, for instance, *Cablevision v. Viacom*. Viacom, a major producer of media content and entertainment, was accused of bundling its highly popular “core” networks (Nickelodeon, Comedy Central) with less valuable “suite” networks (e.g., Centric, CMT PureCountry) to curtail the ability of downstream distributors to incorporate competing channels. A key component of the claim was the importance of downstream competition, as stated in the case: “...Cablevision operates in an intensely competitive environment against both established and new distributors of video services. If Cablevision’s video product offerings did not include Viacom’s tying networks, a substantial number of subscribers would likely abandon (or refuse to consider) Cablevision and instead choose to receive video services from one of Cablevision’s numerous competitors. Access to Viacom’s tying networks is commercially critical even at the high prices Viacom charges for access to those networks.”

13 SmithKline accused Lilly of writing bundling contracts with hospitals in an effort to extend its monopoly on Keflin (cephalothin), a patented antibiotic, to Kefzol (cefazolin), another antibiotic that had to compete with SmithKline’s Ancef, a perfect substitute.

14 With this formulation, we avoid any market-size effect. To see this, suppose goods are available at zero cost to a group of consumers, 100 of whom have preferences for $B$ and another 100 of whom have preferences for $A$. The total number of consumers in the group can vary from 200 to 100 as $\mu$ varies from 0 to 1, but the total number of units sold is invariant to $\mu$, 100 of each product.
Shopping Costs. The final feature of our model is the presence of one-stop shopping. We begin by assuming that final consumers incur a prohibitively high shopping cost for visiting a second retailer, and so must one-stop shop. This may reflect the opportunity cost of time spent in traffic and parking, selecting products, and so forth, or the increasing burden of dealing with multiple retailers, such as paying multiple bills, contacting different companies for customer service and technical support, among others.

Notice that consumers who value only one good and/or are served by a local retail monopoly visit one store, by definition. Hence, the one-stop shopping assumption applies only when retailers $R_1$ and $R_2$ compete, and some fraction of consumers have positive valuations for both goods. In Section 5 we study the implications of relaxing the one-stop shopping assumption by splitting consumers into two groups: one-stop shoppers and shoppers that can visit a second retailer at no cost.

Contracts. A stand-alone contract for product $k = A, B$ offered by manufacturer $h = M, S$ to retailer $i = 1, 2$, denoted $C^h_{ki}$, is defined by the two-part tariff $(w^h_{ki}, T^h_{ki})$, where $w^h_{ki} \geq 0$ is the wholesale price to be paid by $R_i$ to $h$ for each unit of product $k$, and $T^h_{ki} \geq 0$ is a fixed fee to be paid by $R_i$ to $h$ upon signing with him.\textsuperscript{15,16} We denote by $C_k$ the set of all stand-alone contracts for product $k = A, B$.

While the set of contracts available to $S$ corresponds to $C_B$, the set of available contracts to $M$ is larger than $C_A \cup C_B$. This is because $M$ can jointly condition the terms of trade over both product lines. When that is the case, we say that $M$ is offering a wholesale bundling arrangement. A full-line forcing contract is a wholesale bundling arrangement of particular importance in what follows. It is defined as a triplet $\{C^M_{Ai}, C^M_{Bi}, (\hat{C}^M_{Ai}, \hat{C}^M_{Bi})\}$, where $C^M_{Ai}$ and $C^M_{Bi}$ are stand-alone contracts for products $A$ and $B$, and $(\hat{C}^M_{Ai}, \hat{C}^M_{Bi})$ are the trading terms for $A$ and $B$ whenever retailer $i$ decides to obtain both inputs exclusively from $M$. In the next section we provide more details on, and motivation for, these schedules, arguing that full-line forcing contracts capture the essential features of the wholesale bundling arrangements we observe in practice.\textsuperscript{17}

Timeline. On date 1, manufacturers simultaneously (and publicly) announce contract offers. On date 2, retailers choose upon distribution agreements, signing them accordingly. An agree-

\textsuperscript{15}We rule out negative (up-front) fixed fees (i.e., $T^h_{ki} < 0$) for practical reasons; the fact that retailers could always accept them without the need of actually stocking a manufacturer’s product. Nevertheless, our results do not qualitatively hinge on this assumption (see footnote 27 and Appendix C).

\textsuperscript{16}In principle we could think of stand-alone contracts as the menu $\{(w^{he}_{ki}, T^{he}_{ki}), (w^{hc}_{ki}, T^{hc}_{ki})\}$, where $(w^{he}_{ki}, T^{he}_{ki})$ governs the terms of trade for product $k$ if $R_i$ commits to obtaining $k$ exclusively from $h$, and $(w^{hc}_{ki}, T^{hc}_{ki})$ determines the terms of trade otherwise. The difference between $(w^{he}_{ki}, T^{he}_{ki})$ and $(w^{hc}_{ki}, T^{hc}_{ki})$ is a single-product loyalty discount. However, as shown in the online Appendix allowing for these single-product discounts is irrelevant in our setting, so we can collapse $\{(w^{he}_{ki}, T^{he}_{ki}), (w^{hc}_{ki}, T^{hc}_{ki})\}$ into a single two-part tariff $(w^h_{ki}, T^h_{ki})$.

\textsuperscript{17}In Section 5 as we relax the existence of shopping costs, we discuss and analyze the emergence of a different type of wholesale bundling arrangement.
ment establishes the nature of the manufacturer-retailer relationship for each product and the schedules governing the terms of trade between the two parties. Only after these agreements are signed, manufacturers incur fixed costs and start production, an event that triggers the disbursement of any fixed fees established in the schedules. Thus, we are assuming that contractual commitments are of a similar time horizon as manufacturers’ decision to stay active in the industry. On date 3, and after observing contracting decisions, retailers buy from manufacturers according to the terms in their contracts and compete for final consumers by simultaneously setting prices. Finally, on date 4, and after observing all retail prices, final consumers decide where to shop and what to buy.

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<td>Manufacturers simultaneously make public offers</td>
<td>Retailers simultaneously choose distribution agreements</td>
<td>Retailers simultaneously set publicly observable prices</td>
<td>Final consumers decide where to shop and what to buy</td>
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Figure 2: Timeline

### 2.2 Beyond the Baseline Model

Many cases do not exactly fit the structure of the baseline model. Here we explain how we extend our model to accommodate these cases, leaving its formal analysis to the online Appendix.

(i) **Scale Economies and Marginal Costs.** Assuming that cost differentials for $B$ are well captured by differences in fixed costs of production fits some, but certainly not all, antitrust cases. This is reasonable, for instance, in *Cablevision v. Viacom*, where video-programming costs are largely independent of the number of viewers. However, it does not fit *Ortho Diagnostic v. Abbott Laboratories*, a dispute between manufacturers of blood-screening test, or *Cascade Solutions v. PeaceHealth*, a case involving healthcare providers in the state of Oregon. In these two cases, efficiency differentials are perhaps better captured by a combination of both variable and fixed costs. In the online Appendix, we provide a model that incorporates both

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18When needed, the following assumptions resolve any indifference that may arise from a retailer’s perspective: (i) each retailer has a negligible fraction $\xi \to 0+$ of “captive” consumers and (ii) a retailer chooses $M$’s contract if, taking into account the $\xi$ mass, she is indifferent between $M$’s and $S$’s contract and forced to choose only one of them. All these assumptions can be relaxed at the cost of some additional notation.

19To complete our description of the retail market, we use the following standard sharing rules: (i) consumers indifferent to choosing the bundle or a single good always purchase the bundle and (ii) consumers indifferent to purchasing $k \in \{A, B, AB\}$ from $i$ or from $j$ visit the retailer with the lowest unit cost. If unit costs are the same, they visit $i$ with probability $1/2$. All these assumptions can be relaxed at the cost of some additional notation.

20*Ortho* and *Abbott* were manufacturers of test products used in screening blood for the presence of viruses. *Abbott* was the larger of the two, capable of manufacturing five tests (HBsAg, HBe, HCV, HTLV, and HIV-1/2), while *Ortho* manufactured only three (HBsAg, HBe, and HCV). *Ortho* accused *Abbott* of violating Sections 1 and 2 of the Sherman Act when *Abbott* began offering buyers (BDC, plasma centers, and hospitals and laboratories) advantageous terms for the joint purchase of four or more tests.

21More details for this case are provided in Section 5.
types of costs.

(ii) Perfect Substitutability of $B$. Perfect substitutability fits well with SmithKline v. Eli Lilly & Co., since both Kefzol and Ancef are brand names for the same antibiotic, cefazolin. It also seems reasonable in 3M v. LePage’s, as the dispute revolved around the private-label segment of the transparent tape market, and retailers conceded that their purchasing decisions were mostly driven by price considerations (given the homogeneous quality of the product in question). This assumption, however, does not fit a number of other cases. In Cablevision v. Viacom, for instance, viewers’ preferences for less popular networks can vary widely, in both the vertical and horizontal dimensions. In the online Appendix, we provide extensions with varieties of $B$ that differ along these two dimensions.

(iii) Downstream Competition. Clearly, retail competition never falls exactly into either of the two polar structures considered in the baseline model. In the online Appendix, we establish the robustness of our results as we move away from these two extremes by analyzing cases in which retailers are almost local monopolists or almost Bertrand competitors.

(iv) Consumers’ Valuations. By assuming a constant valuation for product $B$, our baseline model rules out not only any heterogeneity in valuations for that product, but also any reason for retailers to price discriminate between final consumers. Since in practice, consumers differ in their valuations for any set of products and retailers often do price discriminate,22 in the online Appendix we analyze the case where $v_B$ is also distributed uniformly over the unit interval. Among other setups, we cover the standard square-city model (e.g., McAfee et al. 1989; Nalebuff 2004).

3 The Anticompetitive Potential of Wholesale Bundling

3.1 The Full-Monopolization Benchmark

Consider the market outcome when $M$ is the only manufacturer in the market. This benchmark not only characterizes the best outcome for which $M$ can strive when attempting to expel $S$ from the market, the full-monopolization outcome, but also serves to highlight some key aspects of the inner workings of our model.

Begin by considering the behavior of final consumers. They must decide where to shop and what to buy. Since in the case of monopoly retailers only the latter decision matters, we start by analyzing that case.

Take $\mu \in [0, 1]$ and suppose that the retail prices charged by the local (monopoly) retailer $R_i$, with $i = 1, 2$, are $p_{Ai}$, $p_{Bi}$, and $p_{ABi}$, where $p_{ki}$ for $k = A, B$, denotes the stand-alone price

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22See, for instance, Crawford and Yurukoglu (2012) for retail bundling and price discrimination in the video-programming industry.
for product \( k \), and \( p_{ABi} \leq p_{Ai} + p_{Bi} \) is the price for the joint purchase of both goods. Provided that \( p_{Ai} \leq 1 \) and \( p_{Bi} \leq b \), it is immediately apparent that consumers valuing only \( A \) will buy a total of \( (1 - \mu)(1 - p_{Ai})/2 \) units of \( A \), while those valuing only \( B \) will buy \( (1 - \mu)/2 \) units of \( B \).

Consumers interested in both goods, however, must decide between buying only \( A \), only \( B \), or both. Due to our simple demand structure, they will always purchase \( B \), implying that their actual choice is between buying only \( B \), or buying both \( A \) and \( B \). Consequently, since the consumer indifferent to these two options has valuation \( p_{ABi} - p_{Bi} \) for good \( A \), consumers with \( v_A \geq p_{ABi} - p_{Bi} \) will buy a total of \( \mu(1 - p_{ABi} + p_{Bi})/2 \) units of each good, while consumers with \( v_A < p_{ABi} - p_{Bi} \) will buy a total of \( \mu(p_{ABi} - p_{Bi})/2 \) units of product \( B \).

We now consider consumers’ decisions when retailers compete. Define \( p_k = \min\{p_{k1}, p_{k2}\} \), where \( k = A, B, AB \), and let \( R_k \) be the retailer offering the lowest price for choice \( k \). Those consumers who value only \( A \) will buy a total of \( (1 - \mu)(1 - p_{Ai}) \) units from retailer \( R_A \), while those who value only \( B \) will buy a total of \( (1 - \mu) \) units from \( R_B \). The decision of consumers who value both goods follows a logic similar to that above, except we now have to account for the existence of shopping costs. One-stop shopping forces these consumers to decide whether to buy both products from \( R_{AB} \) or just \( B \) from \( R_B \). Since the indifferent consumer will have valuation \( p_{AB} - p_B \) for good \( A \), consumers with \( v_A \geq p_{AB} - p_B \) will buy a total of \( \mu(1 - \mu) \) units of each good from \( R_{AB} \), while the remaining consumers will buy a total of \( \mu(p_{AB} - p_B) \) units of \( B \) from \( R_B \).

With these consumer demands, we now can obtain the maximum profits \( M \) can attempt to achieve when he is the only manufacturer in the market. Consider the case in which \( M \), \( R1 \), and \( R2 \) are vertically and horizontally integrated. Since there is no reason to differentiate among retailers, regardless of whether consumers are in the same or separate retail locations, the joint problem of \( M \) and the two retailers reduces to maximize

\[
\Pi_M = (1 - \mu)p_A(1 - p_A) + (1 - \mu)p_B + \mu p_{AB}(1 - p_{AB} + p_B) + \mu p_B(p_{AB} - p_B) - F_M
\]

subject to \( p_B \leq b \) and \( p_{AB} \leq p_A + p_B \). The solution is \( p_A^* = 1/2 \), \( p_B^* = b \), and \( p_{AB}^* = 1/2 + b \), resulting in a total payoff of \( \Pi_M^* \equiv 1/4 + b - F_M \). Regarding this monopoly solution it is important to notice that retail bundling does not emerge. As indicated earlier, we purposely look for a demand formulation that could deliver this property.

It remains to be seen whether \( M \) can implement the above outcome using wholesale contracts in the absence of integration, while simultaneously appropriating the totality of \( \Pi_M^* \). As shown in the next lemma, it turns out that stand-alone contracts are sufficient for that purpose, and are therefore optimal for \( M \) when he is the only manufacturer in the market:

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23 Appendix A provides a more formal and detailed derivation.
**Lemma 1.** Suppose $M$ offers the following symmetric stand-alone contracts to retailers $i = 1, 2$:

\[
\begin{align*}
&(w^M_{A_i} = 0, T^M_{A_i} = 1/8), (w^M_{B_i} = 0, T^M_{B_i} = b/2)) & \text{if retailers are local monopolies} \\
&(w^M_{A_i} = 1/2, T^M_{A_i} = 0), (w^M_{B_i} = b, T^M_{B_i} = 0)) & \text{if retailers are Bertrand competitors}
\end{align*}
\]

Then, irrespective of the level of downstream competition: (i) retailers accept the contracts, set downstream prices $p^*_A = 1/2$, $p^*_B = b$, and $p^*_{AB} = 1/2 + b$ for $i = 1, 2$, and obtain zero profits; and (ii) $M$ obtains a profit equal to $\pi_M = \Pi^*_M$.

**Proof.** The case of monopoly retailers is immediate since these are the retail prices set by a monopolist with zero marginal costs. When retailers compete, we can use Lemma A.1 or A.2 from Appendix A to conclude that those retail prices constitute the unique pure-strategy equilibrium in the retail market, following the presumed offers by $M$. From here, calculating $M$’s profits is straightforward. ■

Lemma 1 shows that in the absence of a competitive threat, wholesale bundling is redundant; it does not strictly emerge in equilibrium. Thus, in our baseline model, the only reason for wholesale bundling to emerge is foreclosure. We deliberately look for this redundancy. It helps highlighting what are the essential conditions for anticompetitive wholesale bundling to emerge in equilibrium. It is important to remark, however, that Lemma 1 should not be interpreted as saying that if we see wholesale bundling, then it must be exclusionary. As already mentioned, there are many efficiency-enhancing rationales for wholesale bundling to emerge (see the online Appendix).

**Definition 1 (Full-Monopolization).** We say that $M$ implements the full-monopolization outcome whenever (i) there is no retail bundling and final consumers pay standalone prices $1/2$ and $b$, for $A$ and $B$ respectively; and (ii) $M$ obtains a profit of $1/4 + b - F_M$.

### 3.2 Wholesale Bundling and Full-Monopolization

A natural way to begin understanding the alleged anticompetitive potential of wholesale bundling is by asking: Under what conditions, if any, can $M$ implement the full-monopolization outcome despite the presence of $S$? As already discussed, this is a natural benchmark to consider, as it represents the best outcome $M$ can strive for when trying to foreclose a more efficient rival from the market.

So consider the case in which retailers are Bertrand competitors, and suppose $M$ approaches
each with the same full-line forcing contract \( \{ C^M_{Ai}, C^M_{Bi}, (\hat{C}^M_{Ai}, \hat{C}^M_{Bi}) \} \):  

\[
C^M_{Ai} = (w^M_{Ai} = 1, T^M_{Ai} = 0), \quad C^M_{Bi} = (w^M_{Bi} = b, T^M_{Bi} = 0) \\
\hat{C}^M_{Ai} = (\hat{w}^M_{Ai} = 1/2, \hat{T}^M_{Ai} = 0), \quad \hat{C}^M_{Bi} = (\hat{w}^M_{Bi} = b, \hat{T}^M_{Bi} = 0)
\]

for \( i = 1, 2 \). A retailer must decide whether to sign (i) a contract allowing her flexibility to obtain inputs from both manufacturers or (ii) a contract committing her to obtain both inputs exclusively from \( M \). A retailer opting for the latter gets in return a discount of \( 1/2 \) off the otherwise list price of 1 in each unit of product \( A \).

These full-line forcing contracts, also known as multi-product loyalty rebates, are essentially the type of wholesale bundling arrangement that we observe in actual cases. *Cablevision v. Viacom*, for instance, is a prime example. Viacom, a major producer of media content and entertainment, was accused by Cablevision of bundling together its highly popular “core” networks (e.g., Nickelodeon, Comedy Central, BET, MTV) with the much less valuable “suite” networks (e.g., Centric, CMT Pure Country). Cablevision argued that if it declined to distribute Viacom’s suite networks and replaced them instead with alternative networks from other content producers, it would have to pay more per subscriber per month for the core networks (good \( A \) in our setting) than for the core and suite networks combined.

Now consider \( S \)'s optimal reaction if he expects retailers are being approached by \( M \) with the offer (2). The first thing to notice is that \( S \) anticipates that at most one retailer will accept his offer. Indeed, independently of the offers made by \( S \), it cannot be an equilibrium of the subgame beginning at \( t = 2 \) for both retailers to obtain product \( A \) from \( M \), and \( B \) from \( S \). If that were the case, at least one retailer must be making zero profit. But then that retailer would deviate to sign exclusively with \( M \), and exploit the fact that she would be the only retailer carrying product \( A \) at affordable prices. Hence, \( S \) can aim for one retailer, at best, to carry his product.\(^{25}\)

Suppose, then, that \( S \) approaches one retailer, say \( R_1 \), with the schedule \( (w^S_{B1} = b - \epsilon, T^S_{B1} = 0) \), where \( \epsilon \) is positive but relatively small. It can be shown that the continuation play then involves \( R_2 \) accepting \( M \)'s full-line forcing discount, and \( R_1 \) accepting \( S \)'s schedule for \( B \). As we formally show in the proof of Lemma\(^ {2}\) below, \( R_2 \) then will set prices \( p^*_{A2} = 3/4 \) and \( p^*_{B2} = b \) (with \( p^*_{AB2} \geq p^*_{A2} + p^*_{B2} \)), while \( R_1 \) will set \( p^*_{B1} = b \).

\( R_2 \) then will serve all consumers that value \( A \) more than \( 3/4 \), whether those that value only \( A \) or those that value \( A \) and \( B \), for a total profit of \( \pi_{R2} = (3/4 - 1/2)(1 - 3/4) = 1/16 \). \( R_1 \) will

\(^{24}\)In Appendix H we explain under what conditions focusing on this type of bundling arrangements is without loss of generality, and discuss the implications of restricting attention to full-line forcing when such conditions are not met.

\(^{25}\)Note that this reaction remains if we move away slightly from Bertrand competition. From the same differentiation argument, the (small) profit that \( S \) could now potentially leave the retailers is still insufficient to persuade both retailers not to choose \( M \)'s full-line forcing offer in equilibrium (see the online Appendix).
attract all $1 - \mu$ consumers that value only $B$, and all of those $\mu$ consumers that value both goods, but $A$ in less than $3/4$, for a payoff of $\pi_{R1} = \epsilon(1 - \mu + 3\mu/4)$. As far as $\epsilon$ is positive, $S$ can induce $R1$ to sign with him (while $R2$ will inevitably go with $M$), resulting in retail revenues as close to $b(1 - \mu/4)$ as $\epsilon \to 0$. As the next lemma establishes, this is actually the most $S$ can hope for, even if he approaches $R1$ with a contract offer that would make that retailer more aggressive in the retail market.

**Lemma 2.** Suppose that $M$ approaches each retailer with the full-line forcing contract (2). The largest revenue $S$ can obtain from the retail market is $b(1 - \mu/4)$.

**Proof.** See Appendix [B](#).

The main implication of Lemma 2 is that whenever economies of scale are important, i.e., $F_S \geq b(1 - \mu/4)$, $S$’s best response to (2) is to approach no retailer and exit the market. Moreover, since (2) maximizes $M$’s profits in the absence of a competitive threat (see Lemma 1), then (2) is also best response to $S$’s reaction. Hence, when $b \geq F_M > F_S \geq b(1 - \mu/4)$, it is clearly an equilibrium for $M$ to offer the full-line forcing contracts in (2) and for $S$ to exit the market. That is, $M$ has fully monopolized the market.27

A notable feature of this foreclosure equilibrium is that linear prices arise endogenously — both in the stand-alone offers and the full-line forcing offers — resulting in no compensation to retailers whatsoever. This is in marked contrast to many foreclosure mechanisms that require retailers to be compensated with lump-sum transfers, and helps explain why, in a bundling context, we may see a distributor initiating (or taking part of) an antitrust complaint, as in *Cablevision v. Viacom*.

Before we provide further intuition, it is important to establish, as the next proposition does, that wholesale bundling is a prerequisite for the result above. That is, under separate pricing, the full-monopolization outcome is not an equilibrium of the game:

**Proposition 1.** Suppose $M$ and $S$ supply final consumers through two Bertrand retailers. Then, if $F_S \geq b(1 - \mu/4)$, there exists an equilibrium in which $M$ fully monopolizes the market with the use of wholesale bundling contracts. This anticompetitive outcome, moreover, cannot be implemented as an equilibrium outcome when $M$ is restricted to stand-alone pricing contracts.

**Proof.** The proof of the first part of the proposition is immediate from Lemma 2. For the second part, see Proposition 3a in Section 4.

To understand why full-monopolization is impossible when wholesale bundling is not available, suppose that $M$ offers each retailer the stand-alone version of the full-monopolization

26This holds more generally for $N \geq 2$ retailers.

27 Note that this result does not qualitatively change if we allow manufacturers to use negative fixed fees (see Appendix [C](#)).
contracts above:

\[ C^M_{A_i} = (w^M_{A_i} = 1/2, T^M_{A_i} = 0), \quad C^M_{B_i} = (w^M_{B_i} = b, T^M_{B_i} = 0) \quad \text{for } i = 1, 2 \]

The difference, however, is that now a retailer not purchasing \( B \) from \( M \) is not forced to forgo \( A \). Thus, competition for the retailers’ preferences is effectively for each product line individually. It is then easy to see that \( S \) can operate profitably in the market by offering each retailer a slightly better deal for \( B \); namely, \( C^S_{B_1} = C^S_{B_2} = (w^S_B = b - \epsilon, T^S_B = 0) \) with \( \epsilon \to 0 \), which will be accepted by both retailers together with \( C^M_{A_i} \). This logic extends more generally. In fact, in the next section we show that no foreclosure equilibrium can exist when \( M \) is forced to condition the terms of trade on each product line individually. This holds true even when \( M \) offers discriminatory contracts that give him the option to cross-subsidize product lines.\(^{28}\)

What does it make wholesale bundling such an effective anticompetitive tool? The key is that it allows \( M \) to create a credible market segmentation threat against any retailer that deviates to purchase \( B \) from \( S \). Indeed, with the use of wholesale bundling, \( M \) can essentially force retailers to give up on good \( A \) if they decide to purchase \( B \) elsewhere. Consequently, even if \( S \) is offering substantially better terms for \( B \), a retailer accepting such an offer, say \( R_1 \), not only forgoes consumers who value only \( A \), but also ends up in a weaker position to compete for those one-stop shoppers who value both goods and have a high valuation for \( A \). At the same time, this reinforces \( R_2 \)’s incentives to accept \( M \)’s full-line forcing offer, since the broader portfolio of products gives her a competitive edge in terms of attracting those latter consumers.\(^{29}\)

Hence, by opting for \( S \), \( R_1 \) ends up with a much smaller set of potential consumers, namely, those who value only \( B \) and those who value both goods, but \( A \) not as much. \( R_1 \)’s equilibrium profit may not then be suffice to pay for any fixed fee that \( S \) would need to include in the contract to cover his fixed cost \( F_S \).

Essential for the previous argument to hold is the simultaneous presence of four key elements. First, there must exist a large fraction of consumers who value both goods (i.e., a large \( \mu \)); otherwise, when \( R_1 \) accepts \( S \)’s more advantageous terms for \( B \), she will be able to attract (almost) all consumers who value \( B \), which, by assumption, is sufficient to cover \( S \)’s fixed costs.

The second element is the presence of one-stop shopping. Indeed, if consumers can inexpensively visit multiple stores, then a broader portfolio of products does not give a retailer any

\(^{28}\)A manufacturer is said to be making discriminatory offers when he makes different offers to different retailers.

\(^{29}\)Notice that, for this to work, a critical assumption (one which we did not highlight in the presentation of the model because it is quite standard) is heterogeneity in consumers’ valuation for product \( A \). It is the fact that high valuation consumers are obtaining a strictly positive surplus in consumer markets what allows product portfolio decisions to create vertical differentiation among retailers. While vertical differentiation is often welcomed by retailers as a way to soften competition (e.g., Champsour and Rochet 1989), here it works to \( M \)’s advantage by credibly threatening to transform a fractious retailer into a “low quality” one in the eyes of those consumers interested in both goods.
competitive advantage in attracting consumers that value both goods. The market segmentation threat then fails. It should be noted, however, that the presence of “exogenous” one-stop shopping is not as crucial as it originally appears. In Section 5 we study the implications of relaxing this assumption, and show that $M$ can restore the anticompetitive mechanism at hand with the use of a different type of wholesale bundling arrangement, one which we have seen in some antitrust complaints.

The third element is the presence of important scale economies in production. It turns out, however, that scale economies are only essential to achieve a full-monopolization outcome. Indeed, in the next section we show that a foreclosure equilibrium can exist even if $F_S = 0$. Thus, while helpful, scale economies are not as crucial as they originally appear.

Finally, the fourth element, which has been implicit in all our discussion, is the presence of intense retail competition. Without it, the threat of taking away market share by segmenting the market vanishes. To see this, suppose for a moment that $M$ and $S$ no longer sell their products through two Bertrand retailers but rather through local monopolies. Implementing the full-monopolization outcome with monopoly retailers requires each retailer $i = 1, 2$ to sign for the offer $\{(w_{M Ai} = 0, T_{M Ai} = 1/8), (w_{M Bi} = 0, T_{M Bi} = b)\}$. The problem for $M$ is that, regardless of whether this offer comes from a pair of stand-alone contracts $C_{M Ai}$ and $C_{M Bi}$ or a full-line forcing contract $(\hat{C}_{M Ai}, \hat{C}_{M Bi})$, $S$ can always respond with a slightly better deal for product $B$, $C_{S Bi} = (w_{S Bi} = 0, T_{S Bi} = b - \epsilon)$ with $\epsilon \to 0$, that will surely be accepted by both retailers.

4 A Closer Look at Wholesale Bundling

We have identified key elements for the full-monopolization outcome to be implemented in equilibrium, namely, the existence of shopping costs, intense downstream competition, economies of scale, and a large fraction of consumers interested in both goods. While the focus on full-monopolization was helpful for illustrating the mechanism at hand, a more comprehensive analysis is certainly in order. Providing such analysis is the aim of this section.

We begin by looking for conditions necessary for exclusion to exist. We then move onto characterizing the foreclosure equilibrium when these necessary conditions, while still present, are not sufficient for $M$ to implement the full-monopolization outcome.

4.1 Necessary Conditions for Exclusion

We start the analysis by relaxing retail competition to simplify the discussion that follows regarding the other key elements.

\[30\]Note that any offer with $w_{M Bi}^M \in (0, b]$ and $T_{M Bi}^M = b - w_{M Bi}^M$ would also work.
Proposition 2a. There does not exist an equilibrium in which $S$ is excluded from the market if retailers are local monopolies, no matter the size of the scale economies, and/or the fraction of consumers who value both goods.

Proof. See Appendix D

To get intuition, consider the case in which $R_1$ and $R_2$ are horizontally integrated into a single retailer. From insights developed in the common agency literature (O’Brien and Shaffer 1997; Bernheim and Whinston 1998), it is easy to see why foreclosure fails (details on the connection of Proposition 2a to the common agency literature are provided in the online Appendix). Indeed, when manufacturers deal with a single retailer under nonlinear pricing schedules, manufacturers internalize the effect of their contracts in the retailer’s profit. Thus, the equilibrium necessarily involves the maximization of industry profits. But then foreclosure of a more efficient rival cannot emerge in equilibrium, as it entails destruction of industry profits.31

Restricting attention to a single retailer is insufficient, however, since with two or more retailers there might be scope for foreclosure due to the presence of scale economies and contracting externalities. In particular, if $F_S > b/2$, $S$ needs to trade with both retailers to operate in the market, a fact that $M$ might try to exploit by offering particularly attractive terms to one retailer at the expense of the other (Rasmusen, Ramseyer, and Wiley 1991; Segal and Whinston 2000). However, following the insights of Ide, Montero, and Figueroa (2016) for a single-product environment, such a divide-and-conquer strategy also fails in this setting given that manufacturers deal with both retailers simultaneously: $S$ can always distribute surplus among retailers so he is never excluded from the market.32 The resulting situation becomes analogous to that of a single retailer in the market.

Another way to understand Proposition 2a is by noticing that competition among retailers affects the mode of competition upstream. Under monopoly retailing, $M$ and $S$ are forced to compete in utility space, so a retailer must be fully compensated for any surplus loss from not carrying a rival’s product.33 Under this mode of competition, a more efficient rival manufacturer always has more surplus to offer a retailer. This situation changes radically, of course, when downstream competition is intense. A retailer’s outside option not only depends now on the terms offered by $S$, but also on what $M$ offers the other retailer. Consequently, $M$ can use

31 If, for some reason, manufacturers are restricted to anything but linear prices in their stand-alone offers, but nevertheless can offer bundle discounts, then foreclosure may arise in a monopoly setting in response to a double-marginalization motive (i.e., using good $B$ to minimize double marginalization in good $A$ due to the pricing constraint). For more, see Mathewson and Winter (1987) and Greenlee, Reitman, and Sibley (2008).

32 For instance, if $M$ offers attractive terms to $R_1$ in an effort to exploit $R_2$, $S$ uses the surplus that $M$ is expecting to extract from $R_2$ minus an epsilon, to offer even more attractive terms to $R_1$ (something that $S$ can always afford, as he is more efficient).

33 In the online Appendix we extend our model to show that this also holds when retailers are “almost” local monopolies.
wholesale bundling arrangements to make $S$’s offers particularly unattractive under the threat of keeping an important mass of consumers (those interested in $A$ and $B$ and those that highly value $A$) out of the retailer’s reach. Such strategy requires, however, the simultaneous presence of consumers who value both goods.

**Proposition 2b.** There does not exist an equilibrium in which $S$ is excluded from the market if all consumers have preferences for one of the two goods (i.e., $\mu = 0$).

**Proof.** See Appendix D.

### 4.2 Foreclosure beyond Full-Monopolization

We learned from Proposition 1 that implementing the full-monopolization outcome requires the concurrence of several conditions, including the use of wholesale bundling. What are the implications of moving away from those conditions? Is wholesale bundling always essential for foreclosure to exist, even when it is not as profitable as in Proposition 1? If we restrict manufacturers to separate pricing, are there conditions under which foreclosure can still arise? Or is it always the case that under separate pricing, $M$ has no choice but to accommodate to $S$’s presence? If the latter, how does the separate-pricing (accommodating) equilibrium compare to the foreclosure (bundling) equilibrium? Is it always better for consumers? How much beyond the full-monopolization conditions can a foreclosure equilibrium exist? Does it always require important scale economies (i.e., large $F_S$)?

In this section, we tackle all these questions. Since we have already established the impossibility of foreclosure under retail monopolies (Proposition 2a) and/or when final consumers value only one good (Proposition 2b), we can restrict attention to Bertrand retailers and $\mu > 0$ in what follows. Our first result is that wholesale bundling remains essential not only for full-monopolization, but for any foreclosure equilibrium to exist.

**Proposition 3a.** There exists no foreclosure equilibrium when manufacturers are restricted to separate pricing.

**Proof.** See Appendix E.

At first, Proposition 3a may come as no surprise. The initial reaction is that under separate pricing, manufacturers are forced to compete for each product line individually, so $S$ can always outbid $M$ for product $B$, irrespective of the offers on $A$. This is only partially correct, however, holding only when $M$ is not allowed to discriminate across retailers.

To see this, suppose $M$ approaches both retailers with the same wholesale prices for product $A$ (i.e., $w^M_{A1} = w^M_{A2} = w^M_A$), but one of them, say $R1$, with strictly better terms on product $B$ (i.e., $w^M_{B1} < w^M_{B2}$). According to Lemma A.2 in Appendix A, if retailers were to accept those
offers, their profits before fixed fees would be $\bar{\pi}_{R1} = w^M_{B2} - w^M_{B1}$ and $\bar{\pi}_{R2} = 0$.\footnote{We denote by $\bar{\pi}_{Ri}$ and $\pi_{Ri}$ $Ri$’s profits before and after fixed fees, respectively. Similarly, we denote by $\bar{\pi}_h$ manufacturer $h$’s profits before fixed costs.} Therefore, it appears that the marginal contribution of product $A$ to the retailers’ profit is zero, necessarily implying that $T^M_{A1} = T^M_{A2} = 0$.

This, however, is incorrect. Note that if $R1$ decides to drop product $A$, Lemma A.3 states that her profits would no longer be $w^M_{B2} - w^M_{B1}$, but rather $w^M_{B2} - w^M_{B1} - \mu (w^M_{B2} - w^M_{B1})(1 - w^M_A)/2$. Thus, $T^M_{A1}$ can be set as high as $\mu (w^M_{B2} - w^M_{B1})(1 - w^M_A)/2 > 0$. Intuitively, although $R1$ is making no profits on $A$, given that her margin for $B$ is strictly positive, not carrying $A$ generates a loss due to all those consumers who value both goods, and $A$ highly, who end up switching to $R2$. Thus, with discriminatory offers, $M$ has the option to create cross-subsidization among product lines: instead of trying to extract rents from $B$ only through $T^M_{B1}$, he can use a combination of $T^M_{A1}$ and $T^M_{B1}$.

This cross-subsidization strategy may open the possibility of exclusion with separate pricing, as $M$ can make very aggressive offers for $B$ (i.e., involving low fixed fees) without sacrificing any profits (which are being extracted with high fixed fees for $A$). The proof of Proposition 3a handles such cases (see Lemma E.3 in Appendix E) as follows: Suppose such a foreclosure equilibrium exists; then there is always a profitable deviation for $S$, whereby he persuades not only both retailers to favor his product, but also $R1$ to disregard $M$’s offer for $A$ altogether. This latter is done by making $R2$ slightly more efficient in $B$ than $R1$.\footnote{Because in any equilibrium retailers must be indifferent between carrying $A$ or not (otherwise, $M$ would deviate, extracting more profits in $A$), offering, say, $w^S_{B1} = w^M_{B1} - \epsilon$ and $w^S_{B2} = w^M_{B2} - 2\epsilon$ reduces $R1$’s profit margin for the bundle in $\epsilon$, which is sufficient to break the indifference and induce her to drop product $A$.}

The most important implication of Proposition 3a is to assert the multi-product nature of our foreclosure mechanism. In particular, since the ability to offer wholesale bundling arrangements is crucial for foreclosure, then a broader portfolio of products is a prerequisite for foreclosure, as well. Why are product portfolio effects so important in our setting, and not in single-product environments (e.g., Aghion and Bolton 1987; Rasmusen, Ramseyer, and Wiley 1991; Simpson and Wickelgren 2007b)? The key is that we have ruled out any first-mover advantage of the dominant firm. Indeed, as Ide, Montero, and Figueroa (2016) have shown, giving $M$ a first-mover advantage is necessary (though not sufficient) to generate foreclosure in almost all single-product models.

Despite its failure to generate foreclosure, it is nevertheless instructive to characterize the equilibrium when manufacturers compete with stand-alone contracts, so $M$ has no choice but to accommodate $S$’s presence. Computing this accommodating equilibrium serves not only to evaluate how much is potentially lost in terms of consumer surplus with the introduction of wholesale bundling, but also to rule out the possibility that this separate pricing equilibrium may coexist with a foreclosure (bundling) equilibrium.
Proposition 3b. If manufacturers are restricted to separate pricing, the equilibrium is essentially unique.\(^{36}\) In all equilibria, both retailers procure \(A\) from \(M\) and \(B\) from \(S\), \(\pi^*_M = 1/4\), \(\pi^*_S = F_M - F_S\), and \(p^*_{Ai} = 1/2\), \(p^*_{Bi} = F_M\), \(p^*_{ABi} \geq p^*_{Ai} + p^*_{Bi}\), \(\pi^*_R = 0\) for \(i = 1, 2\).

Proof. See Appendix E. \(\blacksquare\)

Interestingly, despite the simultaneous presence of (i) Bertrand competition downstream, (ii) perfect substitutability of the different varieties of \(B\) upstream, and (iii) (stand-alone) nonlinear pricing contracts, no multiplicity of equilibria arises in the game. This is in marked contrast to other models of wholesale markets that also exhibit these features, such as Nocke and White (2007), in which multiplicity is pervasive even after the usual equilibrium refinements are applied.\(^{37}\) It turns out that an \(\epsilon > 0\) fraction of one-stop shoppers suffices to completely refine the equilibrium.

We now introduce wholesale bundling. The following preliminary lemma will prove instructive in the developments that follow:

Lemma 3. Suppose \(S\) approaches retailers with the nondiscriminatory offers

\[
C^S_{Bi} = (w^S_{Bi} = \omega \leq b, T^S_{Bi} = 0)
\]

for \(i = 1, 2\). Then \(M\)’s optimal foreclosure strategy is given by

\[
\begin{align*}
C^M_{Ai} &= C^M_{Aj} = (w^M_{Ai} = 1, T^M_{Ai} = 0), \quad C^M_{Bi} = C^M_{Bj} = (w^M_{Bi} = b, T^M_{Bi} = 0) \\
\hat{C}^M_{Ai} &= (w^M_{Ai} = 1/2 + b - \omega, T^M_{Ai} = 0), \quad \hat{C}^M_{Bi} = (w^M_{Bi} = \omega - \epsilon, T^M_{Bi} = 0) \\
\hat{C}^M_{Aj} &= (w^M_{Aj} = 0, T^M_{Aj} = 1/4 - \epsilon), \quad \hat{C}^M_{Bj} = (w^M_{Bj} = b, T^M_{Bj} = 0)
\end{align*}
\]

with \(\epsilon \to 0\), for a total profit of

\[
\pi^f_M = \left(\frac{1}{4} + b - F_M\right) - \pi^0_{Ri}(\omega)
\]

where

\[
\pi^0_{Ri}(\omega) = \begin{cases} 
(b - \omega)[1 - \mu/2] & \text{if } \omega \geq b + 1/2 - 1/\mu \\
\mu[2 + \mu(b - \omega - 1)]^2/9 & \text{otherwise}
\end{cases}
\]

is \(R_i\)’s outside option.

Proof. See the online Appendix. \(\blacksquare\)

\(^{36}\)We rule out equilibria in which manufacturers offer below-cost contracts that are not accepted on the equilibrium path. This is the natural generalization to our setting of the standard below-cost refinement commonly found in asymmetric Bertrand games.

\(^{37}\)The model of Nocke and White (2007) satisfies (i) through (iii), though all manufacturers in their model produce a single homogeneous product.
Intuitively, Lemma 3 characterizes the solution to the following problem: Supposing $S$ offered nondiscriminatory contracts, what would $M$’s optimal contract be if he wishes to foreclose $S$ from the market, and wholesale bundling was available?

To understand (3), note that because $M$ can offer nonlinear schedules, the key tradeoff that arises is between maximizing industry revenues and reducing retailers’ outside options. Higher retail prices increase industry revenues (which can then be appropriated by $M$ with the use of fixed fees), but also make $S$’s offers more attractive from the retailers’ perspective (forcing $M$ to leave a greater share of the industry revenues in the hands of retailers).

As can be seen from Lemma 3, the solution to this problem exhibits two interesting features: (i) $M$ always keeps retail prices at the industry-maximizing levels, and (ii) only one retailer ends up with non-negligible profits. Indeed, it is possible to prove that after accepting offers (3), the equilibrium in the retail market involves $p_{Ai}^* = \hat{w}_{M}^{Ai} = 1/2 + b - \omega \geq 1/2$, $p_{Aj}^* = (1 + \hat{w}_{M}^{Aj})/2 = 1/2$, $p_{Bi}^* = p_{Bj}^* = \hat{w}_{M}^{Bj} = b$, so retailers’ profits are $\pi_{Rj} = \epsilon$ and $\pi_{Ri} = \pi_{Ri}^0 + o(\epsilon)$, where $o(\epsilon) \in (0, \epsilon)$.

Then, with the help of Lemma A.3 in Appendix A one can conclude that in equilibrium both retailers sign with $M$. On the one hand, it is a dominant strategy for $Rj$ to accept $M$’s offer, for whatever $Ri$ does, $Rj$ obtains $\epsilon$ as opposed to zero. On the other hand, and anticipating $Rj$’s decision, $Ri$ anticipates that she will get $\pi_{Ri}^0 + o(\epsilon)$ if she signs exclusively with $M$, and $\pi_{Ri}^0$ otherwise.

The intuition for these two striking features is the following: First, $M$ can always set one of the retailer’s outside options, say $Rj$’s, to approximately zero and at no cost by offering her rival, $Ri$, product $B$ at the same wholesale price at which $Rj$ can procure it from $S$. Thus, $\hat{w}_{Bj}^M = \hat{w}_{Bj}^S - \epsilon = \omega - \epsilon$. Second, since any increase in $\hat{w}_{Bj}^M$ —the wholesale price that sets the retail price for $B$— increases $Ri$’s outside option, all else being equal, the best way to reduce this outside option is by making $Rj$ a strong competitor in product $A$, i.e., by setting $\hat{w}_{Aj}^M$ as low as possible. Since $\hat{T}_{Aj}^M$ can be used to extract whatever $Rj$ makes in product $A$ (as her outside option is zero), it is optimal for $M$ to set $\hat{w}_{Aj}^M = 0$. Finally, the reason $\hat{w}_{Bj}^M$ is increased all the way to $b$ is precisely because $Ri$ captures only a fraction of that increase:38 the rest goes to $M$’s pocket through the bundles sold by $Rj$ to consumers interested in both goods. This is precisely what makes $A$ a must-stock good: $M$’s ability to use it as leverage to contain retailers’ outside options.

With the help of the previous lemma, we now can analyze the implication of allowing $M$ to offer wholesale bundling arrangements. We begin by showing that the accommodating equilibrium of Proposition 3b does not survive the introduction of wholesale bundling.

**Proposition 4.** No equilibrium of the game in which manufacturers are restricted to separate pricing survives the introduction of wholesale bundling.

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38 Either $1 - \mu/2$ or $2\mu^2[2 + \mu(b - \omega - 1)]/9$, depending on whether $\omega$ is greater or lower than $b + 1/2 - 1/\mu$. 

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Proof. Suppose $S$ approaches retailers with the nondiscriminatory offers $C^S_{Bi} = (w^S_{Bi}, T^S_{Bi} = 0)$ for $i = 1, 2$. Because in all equilibria of Proposition 3b, $S$ is the sole provider of $B$ and $p^*_{B1} = p^*_{B2} = F_M$, it must hold that $w^S_B = F_M$. But evaluating (4) at $\omega = w^S_B = F_M$, it is easy to see that $b - F_M > \pi^0_{Ri}(F_M)$, whether $b - F_M$ is smaller or greater than $1/\mu - 1/2$, so that $\pi^M > 1/4 = \pi^*_M$; this latter being $M$’s equilibrium profit in Proposition 3b. The case in which $S$ approaches retailers with discriminatory offers is considered in the online Appendix.

According to Proposition 4, if $S$ approaches retailers with the contracts in Proposition 3b, $M$ strictly prefers to foreclose him using the full-line forcing contracts in Lemma 3 rather than accommodate him as prescribed in the proposition, once bundling becomes available. We now build on this result to characterize the foreclosure equilibrium outside the full-monopolization zone:

Proposition 5. Suppose $F_S < b(1 - \mu/4)$. If $M$ can offer full-line forcing arrangements and

$$\frac{1}{4} + b - \frac{\pi^0_{Ri}(k)}{2} - F_M \geq \frac{1}{4}$$

where $\pi^0_{Ri}(k)$ is $R_i$’s outside option (see Lemma 3) and $k$ is the smallest root satisfying

$$k \left[ 1 - \frac{\mu}{4} + \frac{\mu}{2} (b - k) \right] - F_S = 0$$

then there exists a foreclosure equilibrium with $S$ offering $C^S_{Bi} = C^S_{Bj} = (w^S_B = k, T^S_B = 0)$ and $M$ offering the full-line forcing contracts (3) with $\omega = k$.

Proof. See Appendix F. ■

The proof of Proposition 5 consists of three steps. The first is to show that retailers have incentives to sign exclusively with $M$. The second is to prove that $S$ has no profitable deviations, in particular, that any attempt to attract either retailer leaves $S$ with less than $F_S$ whenever $k$ solves (6). And the final step is to prove that $M$ is playing optimally, given $S$’s offering. From Lemma 3 evaluated at $\omega = k$, $M$ clearly is playing his optimal foreclosure strategy, which we know from (3) gives him at least 1/4; the payoff of accommodating $S$’s entry.

In the foreclosure equilibrium, the continuation play leads to retail prices $p^*_{Ai} \geq 1/2 + b - k > p^*_{Aj} = 1/2$, $p^*_{Bi} = p^*_{Bj} = b$, and $p^*_{ABi} = p^*_{ABj} = 1/2 + b$, and payoffs $\pi^*_R = \pi^0_{Ri}(k)$, $\pi^*_R = 0$, $\pi^*_S = 0$, and $\pi^*_M = 1/4 + b - \pi^0_{Ri}(k) - F_M$. It is then not difficult to prove that when $F_S$ converges from below to $b(1 - \mu/4)$, then $\pi^0_{Ri}(k) \to 0$, and therefore $\pi^*_M \to \Pi^*_M$, $M$’s profit in the full-monopolization outcome.

In contrast to existing mechanisms in which scale economies are essential to achieve foreclosure (e.g., Whinston 1990; Rasmusen, Ramseyer, and Wiley 1991; Nalebuff 2004), Proposition

\[39\] Note that $1/2 < b - \omega < 1$ whenever $\omega < b + 1/2 - 1/\mu$. 

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indicates that foreclosure in this setting is possible even when \( F_S = 0 \) and \( S \) offers good \( B \) for free \((k = 0)\). The condition for this to happen is \( F_M \leq \mu b/2 \) if \( 0 \geq b + 1/2 - 1/\mu \) or \( F_M \leq b - \mu (2 + \mu b - \mu)^2/9 > 0 \) otherwise (note this latter is never valid for \( b < 1/2 \)). The reason is simple. Given that retailers’ outside options have been reduced with the help of the market segmentation threat, when \( F_M \) is not that large, \( M \) has enough surplus to pay for them. This result is important because in some cases, \( F_S \) may be sunk already at the time of contracting with distributors. When \( F_M \) is not that small and \( F_S < b(1 - \mu/4) \), however, what matters for foreclosure is the relative cost advantage of \( S \), as captured by \( (5) \), i.e., as given by \( F_M \leq b - \pi_0 Ri(k(F_S)) \).

Of the many questions posited at the beginning of this section, we are left with the welfare implications of allowing \( M \) to sign full-line forcing contracts. Contrasting Propositions 3b and 5, the loss in consumer surplus can be substantial. Bundling has allowed \( M \) to use product \( A \) as leverage to monopolize both markets while leaving retailers with as little as possible: just enough to keep them from signing with \( S \).

When considering how foreclosure is implemented in Proposition 5, one cannot help but draw a connection with existing foreclosure mechanisms in single-product environments. The use of discriminatory offers evokes the divide-and-conquer strategies of Rasmusen, Ramseyer, and Wiley (1991) and Segal and Whinston (2000), whereby some retailers (here, \( Rj \)) are exploited at the expense of others. Similarly, the idea of softening competition in the downstream market and “sharing” with retailers (\( Ri \) in particular) some of the surplus extracted from final consumers is reminiscent of the loyalty rebates in Asker and Bar-Isaac (2014).

A closer examination of how these mechanisms actually operate, however, show hardly any connection. Specifically, in contrast to the aforementioned models, neither discriminatory offers nor compensations for exclusivity are necessary for our foreclosure mechanism to operate. This is immediately apparent in the full-monopolization zone (Proposition 1), where no compensation to retailers was needed and foreclosure was implemented with nondiscriminatory offers. In Appendix F we show, in addition, that outside the full-monopolization zone, foreclosure still arises in equilibrium if \( M \) is restricted, possibly because of antitrust considerations, to making nondiscriminatory offers. This exercise is helpful not only for setting our mechanism apart from the existing literature, but also for its policy implications: the use of discriminatory offers, while useful, does not constitute a necessary condition for foreclosure to emerge in our model.

What explains that neither discriminatory offers nor lump-sum transfers are necessary for foreclosure to emerge in our model? It is \( M \)’s ability to generate and exploit an externality across retailers: the fact that a retailer’s decision to sign with \( M \) reduces the value of the relationship

\[ \text{Note that even in this case, the foreclosure region can be significant. For instance, if } F_M = b/2, \mu = 1/2, \text{ and } b = 1/4, \text{ foreclosure emerges even if } S \text{ is } 40\% \text{ more efficient than } M \text{ in the production of } B, \text{ i.e., even if } F_S/F_M \text{ is as low as } 11/18. \]
between $S$ and the rival retailer.\textsuperscript{41} This externality is endogenously generated by the use of wholesale bundling when the market in question simultaneously exhibits intense downstream competition, and is populated by consumers interested in both products (i.e. $\mu > 0$) that one-stop shop. Interestingly, and in contrast to existing post-Chicago models, $M$ does not need to rely on a first-mover advantage/commitment to exploit this externality, thus, overcoming the generalized Chicago critique (Ide, Montero, and Figueroa 2016).\textsuperscript{42} The reason is that even though $S$ is present and ready to counteroffer any foreclosure attempt, he cannot subdue the market-segmentation externality because of his limited portfolio of products.

5 Relaxing One-Stop Shopping

So far, we have assumed that all consumers are one-stop shoppers. While some retail markets fit this description well, clearly not all do. In this section, we relax this assumption by letting $z \in [0, 1]$ be the probability that any given consumer is a one-stop shopper. While this change has no effect on consumers who value only one good, it does introduce an important distinction among consumers who value both. A fraction $\mu(1 - z)$ of these consumers are now free to shop at different retailers, while the remaining fraction $\mu z$ must continue visiting a single store.

This modification clearly makes no difference when retailers are local monopolists since, by construction, all consumers are one-stop shoppers. With competing retailers, however, the argument is not as straightforward. Downstream competition might allow retailers carrying a different set of products to discriminate between one- and two-stop shoppers (Chen and Rey 2012). It turns out, fortunately, that such forces are not present in our baseline model, so nothing fundamental changes in our previous analysis other than $\mu$ being replaced by $\mu z$.

The best way to appreciate this is by replicating the full-monopolization problem for the case of competing retailers. Let $p_{Ai} \leq 1, p_{Bi} \leq b$, and $p_{ABi} \leq p_{Ai} + p_{Bi}$ be the prices charged by retailer $i = 1, 2$. Recall that $p_k = \min\{p_{k1}, p_{k2}\}$, where $k = A, B, AB$, and in addition define $\bar{p}_{AB} = \min\{p_A + p_B, p_{AB}\}$, the price paid by multi-stop shoppers if they purchase both goods.

Following the derivation of (1), industry profits are now given by

$$\Pi_M = (1 - \mu)p_A(1 - p_A) + (1 - \mu)p_B +$$
$$\mu z (1 - \bar{p}_{AB}) + \mu(1 - z)\mu(1 - \bar{p}_{AB}) + \mu(1 - z)\mu z (\bar{p}_{AB} - p_B) - F_M$$

\textsuperscript{41}Retailer-externalities are not present in Asker and Bar-Isaac (2014), which explains why in their model retailers must be directly compensated with lump-sum transfers.

\textsuperscript{42}The generalized Chicago critique, developed for single-product environments, states that, irrespective of the size of the contestable demand, exclusion of a more efficient rival cannot arise if all relevant parties participate simultaneously in the bargaining process and are able to write contracts that are sufficiently complete (e.g., nonlinear prices).
where the first line shows the contribution from the two groups of consumers who value only one good, while the next two lines show the contributions from the two groups who value both goods: the one-stop shoppers (line 2) and the multi-stop shoppers (line 3).

While it is true that \( M, R_1, \) and \( R_2 \) have an additional instrument at their disposal, \( \tilde{p}_{AB} \), to try to extract more from consumers than in (1), such a possibility turns out to be irrelevant. If \( \tilde{p}_{AB} \) is set at \( p_{AB} \), then (7) reduces to exactly (1). If, on the other hand, \( \tilde{p}_{AB} \) is set at \( p_A + p_B \), then (7) departs from (1) only in that \( \mu z \) appears instead of \( \mu \). In either case, the optimal solution remains unchanged: \( p^*_A = 1/2, p^*_B = b \) and \( p^*_{AB} = 1/2 + b \), resulting in a total industry payoff of \( \Pi^*_M = 1/4 + b - F_M \).

Shopping costs do not impact the full-monopolization outcome because there is no reason to price-discriminate across groups of consumers in the first place. Even if third-degree price discrimination (i.e., discrimination across groups) were allowed/feasible, it would still be optimal from an industry perspective to charge \( p^*_A = 1/2 \) and \( p^*_B = b \) for the two products.\(^{43}\)

Shopping costs do have an impact, however, on how likely is for \( M \) to foreclose \( S \) from the market. For instance, following the proof of Lemma 2, it can be shown (see the online Appendix for more details) that if \( M \) offers each retailer the full-line forcing contract (2), the most \( S \) can obtain is \( b(1 - \mu z/4) > b(1 - \mu/4) \). Anticipating such offers, \( S \) will exit the market whenever \( F_S \geq b(1 - \mu z/4) \). Proposition 5 can also be similarly extended by replacing \( \mu \) by \( \mu z \).

It appears, then, that what matters for foreclosure is not \( \mu \) and \( z \) but the product of the two, that is, the fraction of one-stop shoppers who value both goods. Under this premise, a situation in which (i) all consumers value both goods but none is a one-stop shopper (\( \mu = 1, z = 0 \)), would be equivalent to one where (ii) all consumers are one-stop shoppers but none values both goods (\( \mu = 0, z = 1 \)). In either case \( \mu z = 0 \), so no foreclosure can be sustained in equilibrium. While this is true for the wholesale bundling arrangements we have considered so far, it is not necessarily so for alternative wholesale bundling arrangements in which the terms of trade are contingent on how retailers sell their products downstream.

Consider, for instance, the arrangement at the center of dispute in Cascade Solutions v. PeaceHealth. In the market for medical care, hospitals provide services to patients and sell services to insurers. The price negotiated between hospitals and insurance companies is known as the reimbursement rate: that fraction of a hospital’s regular price paid by an insurer when a patient/client demands a particular service. Such prices may vary within an insurance company depending on a patient’s plan. PeaceHealth and McKenzie (Cascade) were the only two healthcare providers in Oregon’s Lane County. While PeaceHealth provided primary, secondary, and tertiary care, McKenzie offered only primary and secondary care.\(^{44}\) McKenzie accused Peace-\(^{44}\)Chen and Rey (2012) is different because the exogenous presence of a more efficient (single-product) retail fringe introduces differences in a consumer’s outside options (i.e., valuations for the multi-product retailer’s products) in such a way that discrimination becomes profitable for the multi-product retailer.

\(^{44}\)Primary and secondary care include common medical services (e.g., setting a broken bone) and some ad-
Health of anticompetitive behavior when the latter started offering insurers discounts of up to 35-40% for tertiary care services on each plan that made PeaceHealth the sole preferred provider of all three services. The wholesale bundling arrangements of PeaceHealth were effectively instructing insurers how the different services should be bundled and sold downstream.45

If \( M \) can monitor and enforce how products are sold downstream, it matters a great deal whether the situation is (i) or (ii). As formally established in the next proposition, \( M \) can fully restore the exclusionary potential of bundling in (i) by requiring retailers to sell both products only in a bundle. Even if consumers can shop at no cost, retail bundling endogenously forces them to one-stop shop as if their shopping costs were high.

**Proposition 6.** Suppose \( M \) and \( S \) supply final consumers through two Bertrand retailers. All consumers value both products (\( \mu = 1 \)) and face no shopping costs (\( z = 0 \)). Then, if \( F_S \geq 3b/4 \), there exists an equilibrium in which \( M \) fully monopolizes the market with bundling arrangements à la Cascade v. PeaceHealth.

**Proof.** Provided that \( M \) can monitor and enforce how products are sold downstream, a bundling arrangement à la Cascade v. PeaceHealth can be built upon the full-line forcing contract (2) as follows

\[
\begin{align*}
(w^M_{Ai} = 1, T^M_{Ai} = 0), \quad & (w^M_{Bi} = b, T^M_{Bi} = 0) \\
(\hat{w}^M_{Ai} + \hat{w}^M_{Bi} \equiv \hat{w}^M_{ABi} = 1/2 + b, T^M_{Ai} + T^M_{Bi} \equiv T^M_{ABi} = 0)
\end{align*}
\]

for \( i = 1, 2 \). The only difference from (2) is that now a retailer who buys exclusively from \( M \) pays \( \hat{w}^M_{ABi} \) for each bundle sold, not \( \hat{w}^M_{Ai} + \hat{w}^M_{Bi} \). If, on the one hand, \( S \) makes no offer, both retailers sign with \( M \) and Bertrand competition drives retail prices down to marginal costs. All consumers buy the bundle for \( 1/2 + b \) and \( M \) obtains \( \Pi^*_M \). On the other hand, and following the proof of Lemma 2, if \( S \) decides to respond to \( M \)’s offer (8), the best option for him is to approach one retailer, say \( R1 \), with the offer \( w^S_{B1} = b - \epsilon \), with \( \epsilon \to 0 \). Given these offers, \( R2 \) will sign with \( M \) and \( R1 \) with \( S \) and the retail market will clear at prices \( p_{A2} = 1 \), \( p_{B1} = p_{B2} = \hat{w}^M_{Bi} = b \), and \( p_{AB2} = (1 + \hat{w}^M_{ABi} + p_{B1})/2 = 3/4 + b \). As \( \epsilon \to 0 \), \( S \)’s profit approaches \( \pi_S = b(p_{AB2} - p_{B1}) - F_S = 3b/4 - F_S \), which completes the proof.

Proposition 6 makes clear that what is essential for foreclosure is not high shopping costs, but a large number of consumers interested in both goods. Furthermore, it introduces a new advanced clinical diagnostics. Tertiary care, by contrast, includes highly specialized services (e.g., invasive cardiovascular surgery and intensive neonatal care).

45The bundling deals in 3M v. LePage’s, by contrast, follow to a large extent the full-line forcing arrangements we previously considered. They impose no restrictions on how products are to be sold to final consumers, whether as separate items or as a bundle. It would be hard to imagine 3M instructing retailers to sell its different products only in a bundle, not only because some consumers may care for only a few of them (\( \mu < 1 \)), but also because of monitoring constraints.
dimension along which to judge the anticompetitive potential of a wholesale bundling arrangement.

6 Discussion

We developed a framework to analyze the anticompetitive potential of bundled discounts in the context of business-to-business relationships, the context of study relevant to many antitrust cases. We have identified the key set of conditions under which a multi-product manufacturer does have incentives to bundle a monopoly product ($A$) with a competitive one ($B$), in an effort to monopolize the market for the latter.

Indeed, if the market in question simultaneously exhibits (i) intense retail competition, (ii) a significant fraction of final consumers with strictly positive valuations for both products, and (iii) final consumers who incur steep shopping costs when visiting multiple retailers (or alternatively, contract provisions — provided they can be monitored and enforced — that generate similar one-stop shopping effects), then the multi-product manufacturer is able to foreclose a single-product rival. This is done by creating a credible market-segmentation threat against any retailer that deviates to procure the competitive good from an alternative source. Put differently, the simultaneous presence of these three conditions, plus the possibility of offering wholesale bundling arrangements, allows the multi-product manufacturer to transform the monopoly product $A$ into a must-stock item, an item that no retailer can afford not to carry.

As shown in the online Appendix, the mechanism through which these three market conditions interact to generate foreclosure extends well beyond the simple setting of our baseline model. The online Appendix contains a series of extensions to accommodate for additional features present in actual cases, namely: versions of the competitive product with horizontal differentiation; efficiency advantages of the single-product manufacturer, not in terms of lower fixed costs, but rather, lower variable costs and/or higher product quality; retail competition away from the polar structures of Bertrand competitors and local monopolies; and consumer valuations leading to retail price discrimination.

Our theory not only is based on a novel foreclosure mechanism, one that is multi-product by nature, but also offers important implications for competition policy. For instance, in the United States, some consensus appears to be building around the use of the so-called Discount Attribution Test. Although this test is still far from becoming the benchmark (Jaeckel 2010; FTC/DoJ 2014), the Ninth Circuit Court of Appeals endorsed it in 2009 when it reversed the district court decision in Cascade Solutions v. PeaceHealth. According to this standard, a necessary condition for a bundled discount to be deemed exclusionary is for the competitive product to be sold below its incremental cost once all discounts attributable to the entire bundle are subtracted from the product’s stand-alone price. This criterion, unfortunately, is
not supported by our theory.\footnote{To appreciate this more clearly, note that the bundling arrangement in the full-monopolization outcome (Proposition 1) would be considered lawful whenever $b - 1/2 > 0$ (= the incremental cost in our setting).}

On the other side of the Atlantic, the European Commission exogenously defines an item as \textit{must-stock} when either it is highly preferred by a large fraction of consumers or it can only be supplied in large quantities by the dominant manufacturer (EU Commission 2009). Compared to our equilibrium notion, such a definition seems too broad. As an example, consider a case in which retailers serve two distinct groups of consumers, one interested only in product $A$ and the other only in $B$. This fits well, for instance, \textit{SmithKline Corp. v. Eli Lilly & Co}. Product $A$ clearly satisfies the definition put forth by the Commission, as it is highly preferred by a large fraction of consumers (all those interested in it exclusively). However, it does not satisfy the requirements of our equilibrium notion, as final consumers do not exhibit strictly positive valuations for both products. In particular, foreclosure in this setting would be highly unlikely no matter how large the group with preferences for $A$ is, even without the need to consider further market conditions such as the intensity of retail competition or the prevalence of shopping costs.

Having explained the drawbacks of current approaches, we conclude by applying our framework to a market facing increasing antitrust scrutiny: the market for subscription-based television services (see, for instance, FCC 2016). In the early 1990’s, competition between service providers was weak. Most households in the U.S. accessed television services through monopoly cable providers operating in exclusive franchise areas. Since then, thanks to the emergence of satellite television providers like DirecTV and the entry of telecom companies like AT&T and Verizon, competition for distribution has intensified. According to Chipty (2016), 99% of households today can choose from at least three distributors and 35% can choose from at least four. It is also known that households tend to value, to some extent, channel variety\footnote{According to Nielsen, in 2013 the average number of channels tuned was 17 (compared to the 189 channels received, on average). It should be noted, however, that such a number probably hides significant consumer heterogeneity, especially regarding households’ preferences for different subsets of channels.} and that shopping costs are not trivial, as most, if not all, households purchase video programming services from a single distributor (Crawford and Yurukoglu 2012; Crawford et al. 2017). Hence, when evaluating a case such as \textit{Cablevision v. Viacom}, our theory indicates that current market conditions are suitable for the emergence of must-stock channels. Thus, the wholesale bundling arrangements documented recently in this industry have the potential of being exclusionary.
Appendix A  Retail Market with Bertrand Retailers

A.1 Demands

Given retail prices $p_{Ai}$, $p_{Bi}$, and $p_{ABi} \leq p_{Ai} + p_{Bi}$ charged by retailer $i = 1, 2$, demands from consumers with preferences for only one good $k = A, B$ are rather simple to obtain:

$$D_{Ai}^{(1-\mu)}(p_{Ai}, p_{Aj}) = [1 - \min\{p_{Ai}, p_{Aj}\}]\mathbb{T}_A(p_{Ai}, p_{Aj}, w_{Ai}, w_{Aj})$$

$$D_{Bi}^{(1-\mu)}(p_{Bi}, p_{Bj}) = \mathbb{I}\{\min\{p_{Bi}, p_{Bj}\} \leq b\}\mathbb{T}_B(p_{Bi}, p_{Bj}, w_{Bi}, w_{Bj})$$

where $\mathbb{T}_k(p_{ki}, p_{kj}, w_{ki}, w_{kj})$ is an indicator that can take three values (this also applies for $k = AB$): 1 if $[p_{ki} < p_{kj}] \cup [p_{ki} = p_{kj}] \cap [w_{ki} < w_{kj}]$, 1/2 if $[p_{ki} = p_{kj}] \cap [w_{ki} = w_{kj}]$, and 0 otherwise. Note that superscript “$(1-\mu)$” is used to denote demand from consumers who value only one good, either $A$ or $B$, and “$(\mu)$” will be used to denote demand from consumers who value both goods.

Obtaining demands from consumers interested in both products is more involved since their option set expands to $k = A, B, AB$. Let $u^*_i$ denote the maximum utility that a consumer from this group with valuations $v_A \in [0, 1]$ and $v_B = b$ obtains when shopping at $i = 1, 2$

$$u^*_i = \max\{v_A + b - p_{ABi}, v_A - p_{Ai}, b - p_{Bi}\}$$

There are four cases to consider. Case (i) is when $p_{ABi} \leq p_{Ai} + \min\{p_{Bi}, b\} \leq p_{Ai} + b$ for both $i = 1, 2$. Since $p_{ABi} \leq p_{Ai} + b \iff v_A + b - p_{ABi} \geq v_A - p_{Ai}$, $u^*_i$ reduces to

$$u^*_i = \max\{v_A + b - p_{ABi}, b - p_{Bi}\}$$ (9)

which implies, that in this case, both retailers are competing for consumers with high $v_A$ not just with product $A$, but with the bundle. Hence, $D_{Ai}^{(\mu)}(p_{Bi}, p_{Bj}, p_{ABi}, p_{ABj}) = 0$, $D_{Bi}^{(\mu)}(\cdot) = \min\{1, p_{AB} - p_{B}B, w_{Bi}\}$, and $D_{ABi}^{(\mu)}(\cdot) = \max\{0, 1 - p_{AB} + p_{B}, w_{Bi}\}$, for both $i = 1, 2$ and where $p_{AB} = \min\{p_{ABi}, p_{ABj}\}$, $p_{B} = \min\{p_{Bi}, p_{Bj}\}$ and $w_{ABi} = w_{Ai} + w_{Bi}$.

Case (ii) is when $p_{ABi} \leq p_{Ai} + \min\{p_{Bi}, b\} \leq p_{Ai} + b$ and $p_{ABj} > p_{Aj} + \min\{p_{Bj}, b\}$. Since $p_{ABj} \leq p_{Aj} + p_{Bj}$, the latter inequality leads to $p_{Bj} > b$, which reduces the maximum utilities $u^*_i$ and $u^*_j$ to 0 and $v_A - p_{Aj}$, respectively. In this case, $R_i$ looks to attract consumers with high $v_A$ with the bundle and $R_j$ just with product $A$, resulting in the following demands: $D_{Ai}^{(\mu)}(p_{ABi}, p_{Bi}, p_{Aj}) = 0$, $D_{Aj}^{(\mu)}(\cdot) = 0$ if $p_{ABi} \leq p_{Aj} + b$ and $\min\{0, 1 - p_{Aj} - b - p_{Bi}\}$ otherwise, $D_{Bi}^{(\mu)}(\cdot) = \mathbb{I}\{p_{Bi} \leq b\}\min\{1, \min\{p_{ABi}, p_{Aj} + b\} - p_{Bi}\}$, $D_{Bj}^{(\mu)}(\cdot) = 0$, $D_{ABi}^{(\mu)}(\cdot) = \max\{0, 1 - p_{ABi} + p_{Bi}\}$ if $p_{ABi} \leq p_{Aj} + b$ and 0 otherwise, and $D_{ABj}^{(\mu)}(\cdot) = 0$.

Case (iii) is when retailers’ identities in case (ii) are exchanged. Finally, case (iv) is when $p_{ABi} > p_{Ai} + \min\{p_{Bi}, b\}$ for both $i = 1, 2$. As in case (ii), in this case $p_{Bi} > b$, so $u^*_i = \max\{v_A - p_{Ai}, 0\}$ for both $i = 1, 2$, which indicates that now both retailers are competing for consumers with high $v_A$ with product $A$ only. Therefore, demands for $i = 1, 2$ are given by $D_{Ai}^{(\mu)}(p_{Ai}, p_{Aj}) = [1 - \min\{p_{Ai}, p_{Aj}\}]\mathbb{T}_A(\cdot)$, and $D_{Bi}^{(\mu)}(\cdot) = D_{ABi}^{(\mu)}(\cdot) = 0$.

Having obtained retailers’ demands for any possible retail price configuration, we next compute the (subgame) retail pricing equilibrium.
A.2 Pricing Equilibrium

We denote by $\pi_{R_i}$ $R_i$’s profits before fixed fees, if any, and by $\pi_{R_i}$ the profits after fixed fees. When necessary, we apply the usual refinement in Bertrand environments that rules out retailers pricing below cost any product they expect to sell nothing of it. We say that an equilibrium in the retail market is essentially unique if all equilibria give retailers the same profit and each of the different groups of consumers the same surplus.

In what follows, we restrict attention to pricing subgames that appear in the text, including proofs of propositions and lemmas. Due to space constraints, we present here only the equilibrium outcomes of those subgames, leaving their derivations as well as the characterization of any possible pricing subgame to the online Appendix.

**Lemma A.1.** If $w_{B1} = w_{B2} = w_B \leq b$ and $\min\{w_{A1}, w_{A2}\} = w_{A2} < 1$, there is an essentially unique pure-strategy equilibrium in the retail market. It is given by $p_{A1}' = w_{A1}$, $p_{A2}' = \min\{w_{A1}, (1 + w_{A2})/2\}$, and $p_{B1}' = w_B$, $p_{ABi}' \geq p_{Ai}' + p_{Bi}'$, for $i = 1, 2$. Thus, $\bar{\pi}_{R1}' = 0$, and

$$\bar{\pi}_{R2}' = \begin{cases} 
(1 - w_{A2})^2/4 & \text{if } (1 + w_{A2})/2 \leq w_{A1} \\
(w_{A1} - w_{A2})(1 - w_{A1}) & \text{otherwise}
\end{cases}$$

**Lemma A.2.** If $w_{A1} = w_{A2} = w_A < 1$ and $\max\{w_{B1}, w_{B2}\} \leq b$, there is an essentially unique pure-strategy equilibrium in the retail market. It is given by $p_{Ai}' = w_A$, $p_{Bi}' = \max\{w_{Bi}, w_{Bj}\}$, and $p_{ABi}' \geq p_{Ai}' + p_{Bi}'$. Thus, $\pi_{Ri}' = \max\{w_{Bi}, w_{Bj}\} - w_{Bi}$, for $i = 1, 2$

Briefly, the intuition is that when retailers acquire one of the two products at the same price, whether $B$ or $A$, they compete intensively for the other, as in any Bertrand game with asymmetric costs, eliminating any possibility of generating “vertical differentiation” among them. Put differently, the subgame equilibrium is “as if” $A$ and $B$ were completely unrelated.

**Lemma A.3.** Suppose $\min\{w_{A1}, w_{A2}\} < 1$ and let $w_{A1} \to +\infty$. Then, there is an essentially unique pure-strategy equilibrium in the retail market. It is given by $p_{A2}' = (1 + w_{A2})/2$, and

- If $w_B \leq w_{B1}$, then $p_{B1}' = p_{B2}' = \max\{w_{B1}, w_{B2}\}$, and $p_{AB2}' \geq p_{A2}' + p_{B2}'$. Thus,

  $$\bar{\pi}_{R1}' = (\max\{w_{B1}, w_{B2}\} - w_{B1})[1 - \mu(1 - w_{A2})/2]$$
  $$\bar{\pi}_{R2}' = (\max\{w_{B1}, w_{B2}\} - w_{B2}) + (1 - w_{A2})^2/4$$

- If $w_{B1} < w_B$, then $p_{B1}' = 2(w_B - w_{B1})/3$, $p_{B2}' = w_{B2}$, and $p_{AB2}' = p_{A2}' + w_{B2} - (w_B - w_{B1})/3$. Thus,

  $$\bar{\pi}_{R1}' = [(w_B - w_{B1}) - 2(w_B - w_{B1})/3][1 - \mu(1 - w_{A2})/2 + \mu(w_B - w_{B1})/3]$$
  $$\bar{\pi}_{R2}' = (1 - w_{A2})^2/4 - \mu(w_B - w_{B1})[1 - w_{A2} - (w_B - w_{B1})/3]/3$$

where

$$w_B \equiv \max\{0, w_{B2} - 1/\mu + (1 - w_{A2})/2\}$$

The intuition is the opposite of that in Lemmas A.1 and A.2 in that vertical differentiation and one-stop shopping play a role now. Take the case in which $R1$ has a lower cost for product $B$ (i.e., $w_{B1} < w_{B2}$). Since $R1$ is carrying only this product, she is able to appropriate only a fraction of the rent $w_{B2} - w_{B1}$. Some consumers who value both goods perceive $R1$ as being a “low quality” retailer, so they would rather shop at $R2$ for both goods.
Appendix B  Proof of Lemma 2

Suppose that R2 signs for the full-line forcing contract (2) and R1 for S’s offer \( (w_{B1}^S, T_{B1}^S) \). According to Lemma A.3, if \( w_{B1}^S \geq w_B^S = \max\{0, b - 1/\mu + 1/4\} \), then \( \bar{\pi}_{R1} = (b - w_{B1}^S)(1 - \mu/4) \), so the most that S can obtain after setting \( T_{B1}^S = \bar{\pi}_{R1} \) is \( \bar{\pi}_S = \bar{\pi}_{R2} + w_{B1}^S(1 - \mu/4) = b(1 - \mu/4) \). If, on the other hand, \( w_B > 0 \) and \( w_{B1}^S \leq w_B \), then \( \bar{\pi}_S = \bar{\pi}_{R1} + w_{B1}^S q_{R1}^S \), where \( q_{R1}^S = 1 - \mu/4 + \mu(w_B - w_{B1}^S)/3 \) and \( \bar{\pi}_{R1} = [b - w_{B1}^S - 2(w_B - w_{B1}^S)/3] q_{R1}^S \). Evaluating \( \partial \bar{\pi}_S/\partial w_{B1}^S \) at \( w_{B1}^S = w_B \) leads to \( 2(1 - \mu/4)/3 - b\mu/3 > 0 \). This shows that making R1 more aggressive (i.e., letting \( w_{B1}^S < w_B \)) can only destroy profits, so \( \bar{\pi}_S \) reaches its maximum, which is equal to \( b(1 - \mu/4) \) at any \( w_{B1}^S \in [w_B, b] \).

Appendix C  Full-monopolization with Negative Fixed Fees

We will show that, even when we allow manufacturers to include negative fixed fees, if \( F_S \geq \max\{b - 1/8, b(1 - \mu/4)\} \), it remains an equilibrium for M to offer (2) and S to exit the market. First of all, negative fees are redundant to M, since he is already capturing the full-monopolization payoff. Hence, in what follows we focus on S’s incentives.

As in the baseline model (see Lemma 2), if S approaches a single retailer the most he can get is \( b(1 - \mu/4) \). The difference, however, is that with negative fees at his disposal S can now persuade both retailers to carry his products and get a total revenue of \( b \). But for that to happen, he needs to pay each retailer at least \( 1/16 \); a retailer’s payoff when signing exclusively with M while her rival is signing with S. Hence, S will leave the market when the most profitable of these two options does not cover his fixed cost, that is, whenever \( F_S \geq \max\{b - 1/8, b(1 - \mu/4)\} \).

Appendix D  Proof of Propositions 2a and 2b

D.1  Proof of Proposition 2a

The proof proceeds in three steps. First, we show that no equilibrium can have both manufacturers producing strictly positive quantities of B. Second, we show that no equilibrium can have M as the only manufacturer producing strictly positive quantities of B. Hence, if an equilibrium exists, S must be the sole provider of B. Finally, in the third step, we verify that the equilibrium set is non-empty. We do this by explicitly providing an equilibrium.

Let \( W_i^M(q_i^M) \) be the equilibrium schedule offered by M to retailer Ri as a function of \( q_i^M \), the quantities of A and B purchased by Ri from M. \( W_i^M(\cdot) \) is flexible enough to accommodate any of the pricing schedules discussed in the text, including stand-alone pricing offers like those described in Lemma 1 and Proposition 3b full-line forcing offers as in Propositions 1 and 6 and wholesale bundling offers that impose restrictions on how A and B must be sold downstream, as in Proposition 6. Similarly, let \( (w_{B1}^S, T_{B1}^S) \) be the equilibrium contract offered by S to Ri.

Because retailers are local monopolies, contract acceptance decisions and equilibrium prices and quantities chosen by each retailer are independent of each other. Therefore, without loss of generality, we can collapse dates 2 (i.e., the contract acceptance stage) and 3 (i.e., the retail pricing stage) into a single date. Denoting by \( (q_i^M, q_{B1}^S) \) Ri’s purchases given those schedules, we let \( V_i(q_i^M, q_{B1}^S) \) be the corresponding retail revenue, and \( \pi_{Ri}^M = V_i(q_i^M, q_{B1}^S) - W_i^M(q_i^M) - w_{B1}^S q_{B1}^S - T_{B1}^S 1\{q_{B1}^S > 0\} \) be her
profit. Likewise, manufacturers’ equilibrium profits are denoted by \( \pi^*_M \) and \( \pi^*_S \).

As a general observation valid for both steps of the proof, note that because retailers are local monopolies and \( M \) is the sole producer of \( A \), any pair of schedules that induces \( q^M_{Ai} = 0 \) cannot be optimal for \( M \); therefore, in any equilibrium we must have \( q^M_{Ai} > 0 \) for both \( i = 1, 2 \).

Now for the first step of the proof, suppose there exists an equilibrium in which both manufacturers produce strictly positive quantities of \( B \). For \( S \) to operate in equilibrium, we must have \( \pi^*_S \geq F_S \). We then have two cases to consider: \( S \) sells through either (i) one retailer, say \( R_1 \), or (ii) both \( R_1 \) and \( R_2 \).

Take case (i). In equilibrium, we must have \( w^S_{B1}q^S_{Bi} + T^S_{B1} \geq F_S \). In addition, since by assumption, at least either \( q^M_{Bi} \) or \( q^M_{Bi}^2 \) is strictly positive, \( M \) must be earning \( F_M \). Therefore, \( \pi^*_M = W^M_1(q^M_{i}, q^M_{Bi}) + W^M_2(q^M_{Bi}) - F_M \). In equilibrium, it must also be true that \( V_1(q^M_{i}, q^S_{Bi}) - W^M_1(q^M_{i}) - w^S_{B1}q^S_{Bi} - T^S_{B1} \geq \max \{ b/2 - w^S_{B1}/2 - T^S_{B1}, 0 \} \); otherwise, \( R_1 \) would be strictly better off by selling 1/2 units of \( B \) at price \( b \) or not operating at all, contradicting that \( q^M_{Bi} > 0 \). This implies

\[
\pi^*_M \leq W^M_2(q^M_{Bi}) - F_M + V_1(q^M_{i}, q^S_{Bi}) - w^S_{B1}q^S_{Bi} - T^S_{B1} - \max \{ b/2 - w^S_{B1}/2 - T^S_{B1}, 0 \}
\] (10)

Consider, then, a deviation by \( M \) where \( W^M_1(\cdot) \) is replaced by the pair of independent two-part tariffs \((w^M_{A1} = 0, T^M_{A1} = 1/8)\) and \((w^M_{Bi} = w^S_{Bi}, T^M_{Bi} = T^S_{Bi} - \epsilon)\) for products \( A \) and \( B \), respectively, and \( \epsilon \to 0 \). Clearly, \( R_1 \) will accept this pair and reject \( S \)’s offer. \( M \) profits from this deviation would then be \( \pi^*_M = 1/8 + w^S_{B1}/2 + T^S_{B1} + W^M_2(q^M_{Bi}) - F_M - \epsilon \). But then,

\[
\pi^*_M - \pi^*_M \geq \left[ 1/8 - V_1(q^M_{i}, q^S_{Bi}) \right] + w^S_{B1}(q^S_{Bi} + 1/2) + 2T^S_{B1} + \max \{ b/2 - w^S_{B1}/2 - T^S_{B1}, 0 \} - \epsilon
\]

\[
\geq w^S_{B1}q^S_{Bi} + T^S_{B1} - \left[ b/2 - w^S_{B1}/2 - T^S_{B1} \right] + \max \{ b/2 - w^S_{B1}/2 - T^S_{B1}, 0 \} - \epsilon
\]

\[
\geq \left[ b/2 - w^S_{B1}/2 - T^S_{B1} \right] - \epsilon
\]

where the first inequality comes from (10) and the second from the fact that \( V_1(q^M_{i}, q^S_{Bi}) \leq 1/8 + b/2 \), the maximum industry revenues in retail market 1. Thus, we have \( \pi^*_M - \pi^*_M \geq \pi^*_M \geq w^S_{B1}q^S_{Bi} + T^S_{B1} - \epsilon \). But \( w^S_{B1}q^S_{Bi} + T^S_{B1} - \epsilon \geq F_S - \epsilon > 0 \); thus, \( \pi^*_M > \pi^*_M \), a contradiction. Case (ii) follows a similar logic. Hence, we conclude that there cannot be an equilibrium when both manufacturers produce strictly positive quantities of input \( B \).

For the second step of the proof, suppose that in equilibrium \( M \), is the only manufacturer selling strictly positive units of input \( B \), i.e.,

\[
(q^M_{i}, \theta_i) \in \arg \max_{q^M_{A}, q^M_{Bi} \theta_i} \left\{ V_i(q^M_{i}, q^S_{Bi}) - W^M_i(q^M_{i}) - w^S_{B1}q^S_{Bi} - \mathbb{1}(q^S_{Bi} > 0)T^S_{B1} \right\}
\]

for \( i = 1, 2 \). In equilibrium, it must be true that \( \pi^*_M = W^M_1(q^M_{i}) + W^M_2(q^M_{Bi}) - F_M \geq 1/4 \); otherwise \( M \) would deviate and offer each retailer \( \{(w^M_{A1} = 0, T^M_{A1} = 1/8), (w^M_{Bi}, T^M_{Bi} = \infty)\} \) to obtain 1/4. Consider now a deviation in which \( S \) offers \((w^S_{B1} = 0, T^S_{B1})\) to both \( i = 1, 2 \). Since \( S \) is not operating on the equilibrium path, it must be true that such deviation gives him non-positive profits. The highest fixed fee that \( S \) can charge \( R_i \) while still getting his contract accepted is given by

\[
T^S_{B1} = \max \left\{ V_i(q^M_{i}, q^S_{Bi}) - W^M_i(q^M_{i}), b/2 \right\} - V_i(q^M_{i}, 0) + W^M_i(q^M_{i})
\]

\[48\] Let \( p^*_i(q^M_{i}, q^S_{Bi}) \equiv (p^*_A, p^*_B, p^*_{ABi}) \), with \( p^*_A \leq p^*_A + p^*_B \), be \( R_i \)’s equilibrium prices, then

\[
V_i(q^M_{i}, q^S_{Bi}) \equiv [(1 - \mu)p^*_A(1 - p^*_A) + (1 - \mu)p^*_B + \mu p^*_{ABi}(1 - p^*_A + p^*_B) + \mu p^*_B(p^*_{ABi} - p^*_B)]/2
\]
where 
\[(q_i^{M'}, q_{Bi}^S) \in \arg\max_{q_i^M, q_{Bi}^M, q_{Bi}^S} \left\{ V_i(q_i^{M'}, q_{Bi}^S) - W_i^M(q_i^M) - 1(q_{Bi}^S > 0)T_{Bi}^S \right\} \]

To simplify notation, let \( V_i' = V_i(q_i^{M'}, q_{Bi}^S) \), \( W_i' = W_i^M(q_i^M) \), \( V_i^* = V_i(q_i^{M*}, 0) \), and \( W_i^* = W_i^M(q_i^{M*}) \). Hence, for this deviation to not be profitable for \( S \), we need

\[ T_{Bi}^S + T_{B2}^S = \max\{V_i' - W_i', b/2\} + \max\{V_i' - W_i', b/2\} + W_i^* + W_i^* - V_i^* - V_i^* \leq F_S \quad (11) \]

But this implies that

\[ \pi_M^* = W_i^* + W_i^* - F_M \leq (F_S - F_M) + V_i^* + V_i^* - \max\{V_i' - W_i', b/2\} - \max\{V_i' - W_i', b/2\} \leq (F_S - F_M) + 1/4 + \epsilon - \max\{V_i' - W_i, b/2\} - \max\{V_i' - W_i, b/2\} \leq (F_S - F_M) + 1/4 \]

where the first inequality comes from (11), and the second from the fact that \( V_i^* + V_i^* \leq 1/4 + b \), which is the maximum overall industry revenue. But this implies \( \pi_M^* \leq (F_S - F_M) + 1/4 < 1/4 \), a contradiction.

Thus, we have also ruled out the existence of equilibria when \( M \) is the only manufacturer selling strictly positive units of \( B \). Hence, if an equilibrium exists, \( S \) must be the sole provider of \( B \).

For the third and final step, we claim that the following is an equilibrium of the game:

\[ C_{Ai}^M = \tilde{C}_{Ai}^M = (w_A^M = 0, T_A^M = 1/8), \quad C_{Bi}^M = \tilde{C}_{Bi}^M = (w_B^M = 0, T_B^M = F_M/2) \]

\[ C_{Bi}^S = (w_B^S = 0, T_B^S = F_M/2 - \epsilon) \]

for \( i = 1, 2 \), and \( \epsilon \rightarrow 0 \). After such offers, retailers will procure \( A \) from \( M \) and \( B \) from \( S \), so that \( \pi_{R1} = \pi_{R2} = (b - F_M)/2 \), \( \pi_M^* = 1/4 \), and \( \pi_S^* = F_M - F_S \).

It is easy to see that \( S \) has no strictly profitable deviations, so it remains only to check \( M \)'s incentives to deviate. Let \( W_i^{M'}(q_{Ai}^M, q_{Bi}^M) \) be \( M \)'s deviation offer (possibly including bundling) to retailer \( Ri \). Notice, first, that if \( M \) puts forth a deviation in which he starts selling \( B \), he will always find it more profitable to completely exclude \( S \) from the market. Indeed, suppose that after a deviation, \( M \) starts producing \( B \), but a retailer is still accepting \( S \)'s offer for \( B \) (and therefore disbursing the fixed fee \( T_{Bi}^S = F_M/2 - \epsilon \)). \( M \) can then strictly increase his profits by offering that retailer slightly better terms, and obtain an increase in profits equal to \( T_{Bi}^S - \epsilon \), given that \( M \) is already disbursing \( F_M \).

With this in mind, notice that for \( Ri \) to take \( W_i^{M'}(q_{Ai}^M, q_{Bi}^M) \) and completely disregard \( S \)'s offer we need

\[ 1/8 + b/2 - W_i^{M'}(q_{Ai}^M, q_{Bi}^M) \geq \max \left\{ 1/8 + (b - F_M)/2 - W_i^{M'}(q_{Ai}^M, 0) + \epsilon, (b - F_M)/2 + \epsilon \right\} \]

for \( i = 1, 2 \), where \( q_{Ai}^M \) and \( q_{Bi}^M \) are \( Ri \)'s purchases when dealing exclusively with \( M \) and \( q_{Ai}^M \) when buying only \( A \) from \( M \). But then, \( W_i^{M'}(q_{Ai}^M, q_{Bi}^M) \leq 1/8 + F_M/2 - \epsilon \), and therefore \( \sum_i W_i^{M'}(q_{Ai}^M, q_{Bi}^M) \leq 1/4 + F_M - 2\epsilon \). Thus, the maximum deviation payoffs are bounded above by \( \sum_i W_i^{M'}(q_{Ai}^M, q_{Bi}^M) - F_M \leq 1/4 - 2\epsilon < 1/4 = \pi_M^* \).

### D.2 Proof of Proposition 2b

In the proof that follows we restrict attention to full-line forcing contracts, but the argument extends to more general schedules as we explain in Appendix H. Suppose the following pair of contracts constitute
a foreclosure equilibrium: \( \{(w^M_{A_i} = 1, T^M_{A_i} = 0), (w^M_{B_i} = b, T^M_{B_i} = 0)\} \) and \( \{(\hat{w}^M_{A_i}, \hat{T}^M_{A_i}), (\hat{w}^M_{B_i}, \hat{T}^M_{B_i})\} \) for \( i = 1, 2 \). Suppose further that wholesale prices are such that \( p^*_{A_i} = \max(\hat{w}^M_{A_i}, \hat{w}^M_{A_j}) \) and \( p^*_{B_i} = \max(\hat{w}^M_{B_i}, \hat{w}^M_{A_j}) \) (the logic of the proof prevails for other cases), so \( M \)'s equilibrium payoff can be written as

\[
\pi^*_M = \min(\hat{w}^M_{A_i}, \hat{w}^M_{A_j})(1 - \max(\hat{w}^M_{A_i}, \hat{w}^M_{A_j})) + \hat{T}^M_{A} + \hat{T}^M_{A_j} + \min(\hat{w}^M_{B_i}, \hat{w}^M_{B_j}) + \hat{T}^M_{B_i} + \hat{T}^M_{B_j} - F_M
\]  

which must be at least 1/4.

Without loss of generality let \( \hat{w}^M_{A_i} \leq \hat{w}^M_{A_j} \). Consider first the case in which equilibrium offers are such that \( \hat{w}^M_{B_i} \leq \hat{w}^M_{B_j} \), which implies (for \( \mu = 0 \)) that \( \hat{T}^M_{A} = \hat{T}^M_{B} = \pi^*_R = 0 \) and \( \pi^*_R = (\hat{w}^M_{A_j} - \hat{w}^M_{A_i})(1 - \hat{w}^M_{B_j}) - (\hat{w}^M_{B_j} - \hat{w}^M_{B_i}) - \hat{T}^M_{A_j} - \hat{T}^M_{B_j} \). Using (12) to obtain \( \hat{T}^M_{A} + \hat{T}^M_{B} \geq 1/4 + F_M - \hat{w}^M_{A_i}(1 - \hat{w}^M_{A_j}) - \hat{w}^M_{B_j} \) and the fact that \( \pi^*_R \geq 0 \) and \( \hat{w}^M_{A_j}(1 - \hat{w}^M_{A_j}) \leq 1/4 \), we arrive that in equilibrium \( \pi^*_R \leq \hat{w}^M_{B_i} - F_M \) and \( \hat{w}^M_{B_i} \geq F_M \). But if so, \( S \) would profitably deviate by approaching \( R_i \) with the offer \( (\hat{w}^S_{R_i} = F_M - \epsilon, T^S_{R_i} = 0) \) with \( \epsilon \to 0 \), which \( R_i \) would be ready to take since \( \hat{w}^M_{B_i} - F_M + \epsilon > \hat{w}^M_{B_i} - F_M \) (recall that \( p^*_{B_i} \) remains at \( \hat{w}^M_{B_i} \ )); a contradiction.

Consider now the case in which equilibrium offers are such that \( \hat{w}^M_{B_i} > \hat{w}^M_{B_j} \), which implies (for \( \mu = 0 \)) that \( \pi^*_R = (\hat{w}^M_{A_j} - \hat{w}^M_{A_i})(1 - \hat{w}^M_{B_j}) - \hat{T}^M_{A_j} - \hat{T}^M_{B_j} \) and \( \pi^*_R = (\hat{w}^M_{B_i} - \hat{w}^M_{B_j}) - \hat{T}^M_{A} - \hat{T}^M_{B_j} \). Again, using (12) to obtain \( \sum_{k_i \epsilon i} \hat{T}^M_{k_i} \geq 1/4 + F_M - \hat{w}^M_{A_i}(1 - \hat{w}^M_{A_j}) - \hat{w}^M_{B_j} \) and the fact that \( \pi^*_R \geq 0 \), \( \pi^*_R \geq 0 \) and \( \hat{w}^M_{A_j}(1 - \hat{w}^M_{A_j}) \leq 1/4 \), we arrive that in equilibrium \( \pi^*_R \leq \hat{w}^M_{B_i} - F_M \) and \( \hat{w}^M_{B_i} \geq F_M \). But if so, \( S \) would profitably deviate by approaching \( R_j \) with the offer \( (\hat{w}^S_{R_j} = F_M - \epsilon, T^S_{R_j} = 0) \) with \( \epsilon \to 0 \), which \( R_j \) would be ready to take; a contradiction.

**Appendix E  Proof of Propositions 3a and 3b**

Throughout the proof, let \( C^M_{A_i} = (w^M_{A_i}, T^M_{A_i}) \), \( C^M_{B_i} = (w^M_{B_i}, T^M_{B_i}) \), and \( C^S_{B_i} = (\hat{w}^S_{B_i}, T^S_{B_i}) \) for \( i = 1, 2 \) be equilibrium offers, and denote by \( (q_i, q_j) \), with \( q_i^* = (q^M_{A_i}, q^M_{B_i}, q^S_{B_i}) \), the equilibrium quantities sold downstream on the path of play. Furthermore, let \( \pi^*_M \) and \( \pi^*_S \) be manufacturers’ equilibrium payoffs. The following preliminary lemmas will prove useful in what follows:

**Lemma E.1.** Suppose manufacturers are restricted to separate pricing; then \( \pi^*_M \geq 1/4 \).

**Proof.** Since \( M \) can always offer

\[
C^M_{A_i} = C^M_{A_2} = (w^M_{A_i} = 1/2, T^M_{A} = 0) , \quad C^M_{B_i} = C^M_{B_2} = (w^M_{B_i}, T^M_{B_i}) \to (+\infty, +\infty)
\]

and secure profits equal to 1/4, irrespective of the offers made for product \( B \), it necessarily follows that \( \pi^*_M \geq 1/4 \). ■

**Lemma E.2.** Suppose manufacturers are restricted to separate pricing. There cannot exist an equilibrium in which both manufacturers sell strictly positive units of \( B \).

**Proof.** Suppose otherwise. Then both manufacturers must incur their respective fixed costs and \( \pi^*_S \geq F_S \). But if so, \( M \) could deviate and offer a slightly better deal to any retailer that is purchasing units of \( B \) from \( S \), while keeping the contracts for \( A \) constant, and increase his profits in at least \( F_S - \epsilon > 0 \), as he is already disbursing \( F_M \). ■

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Lemma E.3. Suppose manufacturers are restricted to separate pricing; then
\[
\pi_{A1}^M q_{A1}^M + \pi_{A2}^M q_{A2}^M + T_A^M + T_A^M \leq 1/4
\]

**Proof.** See the online Appendix. ■

Lemma E.3 is a strong result. It states that when manufacturers are restricted to separate pricing, there is no equilibrium in which \( M \) is using a cross-subsidization strategy, irrespective of which offers for product \( B \) retailers end up accepting.

### E.1 Proof of Proposition 3a

By Lemma E.2, we know that, in equilibrium, either \( S \) or \( M \) is the sole supplier of \( B \). So, suppose a foreclosure equilibrium exists in which \( M \) is that supplier, i.e., \( q_i^* = (q_{A1}^M, q_{A2}^M, 0) \) for both \( i = 1, 2 \) and \( \pi_S = 0 \). If \( S \) decides to simultaneously and slightly undercut \( C_{B1}^M \) and \( C_{B2}^M \), he would obtain \( \pi_S' = w_{B1}^M q_{B1}^M + w_{B2}^M q_{B2}^M + T_{B1}^M + T_{B2}^M - F_S - \epsilon \). But since \( \pi_S' \leq \pi_S = 0 \) by definition, we have that

\[
\pi_M = \pi_{A1}^M q_{A1}^M + \pi_{A2}^M q_{A2}^M + w_{B1}^M q_{B1}^M + w_{B2}^M q_{B2}^M + T_{A1}^M + T_{A2}^M + T_{B1}^M + T_{B2}^M - F_M
\]

\[
\leq (F_S - F_M) + w_{A1}^M q_{A1}^M + w_{A2}^M q_{A2}^M + T_{A1}^M + T_{A2}^M
\]

\[
\leq (F_S - F_M) + 1/4
\]

where the last inequality comes from Lemma E.3. But this implies \( \pi_M \leq 1/4 + (F_S - F_M) < 1/4 \), contradicting Lemma E.1.

### E.2 Proof of Proposition 3b

By Lemma E.2 and Proposition 3a, we know that if an equilibrium exists, then \( S \) must be the sole provider of \( B \). So, suppose such an equilibrium exists, that is, \( q_i^* = (q_{A1}^M, 0, q_{B1}^S) \), for both \( i = 1, 2 \). The proof, then, proceeds in several steps. We begin by showing that in any equilibrium \( \pi_M^* = 1/4 \) and \( p_{A1}^* = p_{A2}^* = 1/2 \), and that \( M \) is obtaining the entire industry revenue created in market \( A \). Then we use two additional lemmas to establish \( \pi_S^* = F_M - F_S, p_{B1}^* = p_{B2}^* = F_M \), and \( p_{AB1}^* \geq p_{A1}^* + p_{B1}^* \) for \( i = 1, 2 \). This implies that retailers make no profit on \( B \), either; hence, \( \pi_{B1}^* = \pi_{B2}^* = 0 \). Thus, if an equilibrium exists, it is essentially unique, satisfying all the conditions of the statement. The final step is to show that the equilibrium set is non-empty by explicitly providing offers that constitute an equilibrium.

For the first step, notice that by Lemma E.1, \( \pi_M^* \geq 1/4 \). However, since \( M \) is selling only \( A \), then \( \pi_M^* = w_{A1}^M q_{A1}^M + w_{A2}^M q_{A2}^M + T_{A1}^M + T_{A2}^M \). But according to Lemma E.3, this is less than or equal to \( 1/4 \). Thus, \( \pi_M^* = 1/4 \). This immediately implies that \( p_{A1}^* = p_{A2}^* = 1/2 \) and that \( M \) is obtaining the entire industry revenue created in market \( A \), as this is the only way for \( w_{A1}^M q_{A1}^M + w_{A2}^M q_{A2}^M + T_{A1}^M + T_{A2}^M \) to reach \( 1/4 \).

For the second step, notice that \( \pi_S^* > F_M - F_S \) cannot be; if it were the case, then \( M \) could simultaneously and slightly undercut the terms in \( C_{B1}^S \) and \( C_{B2}^S \), while keeping \( C_{A1}^M \) and \( C_{A2}^M \) constant, to obtain \( \pi_M' = 1/4 + \pi_S^* - F_M - \epsilon > 1/4 = \pi_M^* \). Thus, \( \pi_S^* \leq F_M - F_S \). In addition, we have we have

Lemma E.4. Suppose manufacturers are restricted to separate pricing. Assume, furthermore, that manufacturers cannot offer below-cost contracts when they anticipate that such contracts will not be accepted on the equilibrium path. Then \( \pi_S^* \geq F_M - F_S \).

**Proof.** See the online Appendix. ■
From this lemma and $\pi_S^* \leq F_M - F_S$, we obtain $\pi_S^* = F_M - F_S$, which in turn is used to establish

**Lemma E.5.** If $\pi_M^* = 1/4$ and $\pi_S^* = F_M - F_S$, then in any equilibrium, $p_{Bi}^* = F_M$ and $p_{ABi}^* \geq p_{Ai}^* + p_{Bi}^*$ for $i = 1, 2$.

**Proof.** See the online Appendix. ■

Hence, if an equilibrium exists, it is essentially unique, satisfying all the conditions of the statement. Finally, we verify that the equilibrium set is non-empty. Consider the following offers

$$C_{A1}^M = C_{A2}^M = (w_A^M = 1/2, T_A^M = 0), \quad C_{B1}^M = C_{B2}^M = (w_B^M = F_M, T_B^M = 0)$$

$$C_{B1}^S = C_{B2}^S = (w_B^S = F_M - \epsilon, T_B^S = 0)$$

with $\epsilon \to 0$. It is then clear that both retailers procure good $A$ from $M$, and $B$ from $S$. Moreover, using either Lemma A.1 or A.2, the continuation play involves $p_{Ai}^* = 1/2, p_{Bi}^* = F_M$, and $p_{ABi}^* \geq p_{Ai}^* + p_{Bi}^*$ for $i = 1, 2$, so $\pi_M^* = \pi_S^* = 1/4$, and $\pi_S^* = F_M - F_S$. It is then easy to verify that neither manufacturer has an incentive to deviate from those offers.

**Appendix F  Proof of Proposition 5**

The proof consists of three steps. We first show that retailers have incentives to sign exclusively with $M$. With the help of Lemma A.3 in Appendix A it can be shown that it is a dominant strategy for $Rj$ to accept $M$’s offer, for whatever $Ri$ does, $Rj$ obtains $\epsilon$ as opposed to zero. Anticipating $Rj$’s decision, the same also lemma indicates that $Ri$ expects to get $\pi_M^* R_i (k) + o(\epsilon)$, where $\pi_M^* R_i (k)$ is defined in Lemma 3 and $o(\epsilon) \in (0, \epsilon)$ with $\epsilon \to 0$, if she signs exclusively with $M$, and $\pi_M^* R_i (k)$ otherwise.

In the second step, we prove that $S$ has no profitable deviations. Following the argument presented in section 3.2, it is clear that $S$ can at most persuade one retailer, never both, to take his contract, given $M$’s full-line forcing offers. So consider first the case in which $S$ offers $C_{Bj}^S = (w_{Bj}^S, T_{Bj}^S)$ to $Rj$ and, without loss of generality, nothing to $Ri$. Clearly, it is required that $w_{Bj}^S < k$ for $Rj$ to take $S$’s offer since her outside option is $\epsilon$. Now, if $Rj$ accepts $C_{Bj}^S$ (and $Ri$ accepts $M$’s full-line forcing offer), the continuation play involves (see Lemma A.3) $p_{Ai}^* = 3/4 + (b - k)/2, p_{Bj}^* = p_{Bj}^* = k, p_{ABj}^* \geq p_{Ai}^* + p_{Bj}^*$, and $\pi_{Ri}^* = (k - w_{Bj}^S)[1 - \mu/4 + \mu(b - k)/2]$. Therefore, for $Rj$ to accept $C_{Bj}^S$ we need

$$(k - w_{Bj}^S) \left[ 1 - \frac{\mu}{4} + \frac{\mu}{2}(b - k) \right] - T_{Bj}^S \geq \epsilon$$

to hold, which implies that $S$’s deviation payoff can be at most $\pi_S^* = (1 - \mu)w_{Bj}^S + \mu w_{Bj}^S (p_{Ai}^* + p_{Bj}^* - p_{Bj}^*) + T_{Bj}^S - F_S = k[1 - \mu/4 + \mu(b - k)/2] - F_S - \epsilon$. But according to the definition of $k$ in the proposition, we obtain $\pi_S^* = -\epsilon < 0$.

Suppose, instead, that $S$ approaches only $Ri$ with the offer $C_{Bi}^S = (w_{Bi}^S, T_{Bi}^S)$. If $Ri$ accepts $C_{Bi}^S$ (and $Rj$ accepts $M$’s full-line forcing offer), the continuation play involves (see Lemma A.3) $p_{Aj}^* = 1/2, p_{Bj}^* = p_{Bj}^* = b, p_{ABj}^* \geq p_{Aj}^* + p_{Bj}^*$, and $\pi_{Ri}^* = (b - w_{Bj}^S)[1 - \mu/2]$. Therefore, for $Ri$ to accept $C_{Bi}^S$, we need $(b - w_{Bj}^S) [1 - \mu/2] - T_{Bi}^S \geq \pi_{Ri}^* (k) + o(\epsilon)$ to hold, which implies that $S$’s deviation payoff can be at most $\pi_S^* = w_{Bi}^S [1 - \mu/2] + T_{Bi}^S = b(1 - \mu/2) - \pi_{Ri}^* (k) - o(\epsilon) - F_S$. But again, using the definition of $k$ yields $\pi_S^* < 0$ (note that $\pi_{Ri}^* (k)$ is decreasing in $k$). Thus, through neither $Ri$ nor $Rj$ can $S$ profitably enter the market.

The last step of the proof, to show that $M$ has no profitable deviations either, is in the text. We conclude the proof with a note about the contracts that $S$ may sign in equilibrium. Since his contracts
are not accepted on path, he can offer any contract along a continuum of possibilities leading to the same equilibrium outcome. Consider, for instance, $C$ are not accepted on path, he can offer any contract along a continuum of possibilities leading to the same offer full-line forcing arrangements and $S$ is restricted, possibly because of antitrust considerations, to make nondiscriminatory offers.

**Appendix G Beyond Full-Monopolization: Nondiscriminatory Offers**

In this appendix we show that outside the full-monopolization zone foreclosure still arises in equilibrium if $M$ is restricted, possibly because of antitrust considerations, to make nondiscriminatory offers.

**Lemma G.1.** Suppose that $M$ is restricted to nondiscriminatory offers and $F_S < b(1 - \mu/4)$. If $M$ can offer full-line forcing arrangements and

$$(1 - \omega_A)\omega_A + \omega_B - \epsilon - F_M \geq \frac{1}{4},$$

with $\epsilon \to 0$, then there exists a foreclosure equilibrium with $S$ offering $C_{Bi}^S = C_{Bj}^S = (w^S_B = \omega_B, T^S_B = 0)$ and $M$ offering the nondiscriminatory full-line forcing contracts

$$C^M_{Ai} = C^M_{Aj} = (w^M_{Ai} = 1, T^M_{Ai} = 0), C^M_{Bj} = (w^M_B = \omega_B - \epsilon, T^M_B = 0)$$

and $M$ offering the nondiscriminatory full-line forcing contracts

$$\hat{C}^M_{Ai} = \hat{C}^M_{Aj} = (\hat{w}^M_{Ai} = \omega_A, \hat{T}^M_{Ai} = 0), \hat{C}^M_{Bj} = \hat{C}^M_{Bj} = (\hat{w}^M_B = \omega_B - \epsilon, \hat{T}^M_B = 0)$$

where $\omega_A = \max\{\omega'_A, \omega''_A\} < 1/2$ and $\omega_B = \min\{b, \omega''_B\}$, and where $\omega'_A$, $\omega''_A$, and $\omega''_B$ are obtained, respectively, from

$$b \left(1 - \frac{\mu}{2}(1 - \omega_A')\right) = F_S,$$

$$2(1 - 2\omega_A') \left(1 - \frac{\mu}{2}(1 - \omega''_A)\right)^2 = \mu F_S,$$

and

$$\omega''_B \left(1 - \frac{\mu}{2}(1 - \omega''_A)\right) = F_S$$

**Proof.** Since retailers are getting nothing on the equilibrium path, for the above contracts to constitute a foreclosure equilibrium, $S$ cannot profitably deviate by approaching either retailer with a slightly better deal on product $B$, say, with $w_{Bj}'' = \omega_B - 2\epsilon$. We know from Lemma A.3 that the condition for this to happen is either (15), when $\omega_B = b$ and $\omega_A$ is set at $\omega_A'$, or (17), when $\omega_B = \omega''_B < b$ and $\omega_A$ is set at $\omega''_A$. In addition, we need (14) to be $M$’s optimal (foreclosure) response to $S$’s offers. Since, in principle, $M$ can use both $w^M_{Ai}$ and $\hat{w}^M_{Bi}$ to maximize his profit while keeping $S$’s potential entry profit just below $F_S$, equation (16) is the implicit (interior) solution to the foreclosure problem

$$\max_{\omega_A, \omega_B} (1 - \omega_A)\omega_A + \omega_B$$

subject to $\omega_B (1 - \mu(1 - \omega_A)/2) = F_S$. Solution (16) is feasible if $\omega''_B = F_S/(1 - \mu(1 - \omega''_A)/2) \leq b$; otherwise, the most profitable foreclosure strategy is the “corner” $\omega_B = b$ and $\omega_A = \omega_A'$. In either case, $M$ must get at least his accommodating payoff in equilibrium; that is, $\omega_A$ and $\omega_B$ must be such that (13) holds.
Lemma G.1 differs from Proposition 5 in that now implementing foreclosure, provided it yields at least $1/4$, requires $M$ to destroy some industry surplus by lowering either both $\hat{w}_A^M$ and $\hat{w}_B^M$ below their monopoly levels or just $\hat{w}_A^M$. When $F_S$ is not too far below the full-monopolization threshold $b(1 - \mu/4)$, it is optimal for $M$ to only lower $\hat{w}_A^M$ just enough to prevent $S$’s entry, as required by the exclusion condition (15); otherwise, it is optimal to lower both $\hat{w}_A^M$ and $\hat{w}_B^M$, as indicated by the first-order condition (16) and the exclusion condition (17). Lemma G.1 also differs from Proposition 5 in that foreclosure requires some scale economies (i.e., $F_S > 0$), no matter how small $F_M$ might be.

Appendix H  Restricting attention to full-line forcing contracts

We discuss the implications of restricting attention to full-line forcing contracts in different propositions of the paper.

Proposition 1: Since $M$ is appropriating the full-monopolization payoff, it is clear that restricting attention to these contracts is without loss of generality when $F_S \geq b(1 - \mu/4)$.

Proposition 2a: In the proof of the proposition we do not impose any particular form to the wholesale bundling contracts that $M$ could offer; we work with general schedules $W_i^M(q_i^M)$, where $q_i^M \equiv (q_{Ai}^M, q_{Bi}^M)$ for $i = 1, 2$.

Proposition 2b: Suppose we extend $M$’s contract space to allow for contracts between $M$ and $R_i$ to be contingent on $R_j$’s acceptance/rejection decisions. It is now trivial for $M$ to approach retailers with foreclosure offers; for instance, with offers containing the threat that a retailer can obtain both products for free from $M$ if the rival happens to sign with $S$. However, this contract contains an empty threat in that $M$’s off-path (i.e. after $S$’s entry) payoff is $-F_M$. Once we refine the equilibrium to rule out such empty threats, it is not difficult to see that foreclosure cannot arise with these contingent contracts, and therefore, neither with contracts without such provisions (like the ones considered in the text).

Proposition 5: Despite full-line forcing contracts lead to substantial foreclosure, outside the region of full-monopolization we are not certain whether they remain optimal if more complex foreclosure contracts are allowed. Still, if that were the case, this would only make foreclosure more likely.

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For example, if $b = 1/2$, $\mu = 3/4$, $F_S = 1/3$, and $F_M \leq 0.42$, the foreclosure equilibrium is given by $\hat{w}_A^M = 0.396$ and $\hat{w}_B^M = \hat{w}_A^M + \epsilon = 0.431$. $M$’s payoff before fixed costs is $0.670 = (1 - \hat{w}_A^M)\hat{w}_A^M + \hat{w}_B^M$, which is only 2% less than the equivalent payoff of 0.682 that he would obtain in the (discriminatory) foreclosure equilibrium of Proposition 5.

This refinement would be equivalent to require contracts to be renegotiation proof (in the example above, $M$ and the retailer not taking $S$’s offer have incentives to renegotiate not to produce $B$ and, thus, save $F_M$). Note that all foreclosure equilibria characterized in the text are immune to these considerations.
References


