Exclusionary Minimum Resale Price Maintenance*

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Abstract

An upstream manufacturer can use minimum resale price maintenance (RPM) to exclude potential competitors. RPM lets the incumbent manufacturer transfer profits to retailers. If entry is accommodated by retailers, upstream competition leads to fierce downstream competition and the breakdown of RPM. Thus, via RPM, retailers internalize the effect of accommodating entry on the incumbent's profits. Retailers may prefer not to accommodate entry; and, if entry requires downstream accommodation, entry can be deterred. We discuss empirical and policy implications, as well as the exclusionary potential of other methods of sharing profits between upstream and downstream firms.

JEL Codes: K21, L42, L12, D42

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Abstract

An upstream manufacturer can use minimum resale price maintenance (RPM) to exclude potential competitors. RPM lets the incumbent manufacturer transfer profits to retailers. If entry is accommodated, upstream competition leads to fierce downstream competition and the breakdown of RPM. Hence, via RPM, retailers internalize the effect of accommodating entry on the incumbent's profits. Retailers may prefer not to accommodate entry; and, if entry requires downstream accommodation, entry can be deterred. We also discuss empirical and policy implications, as well as the exclusionary potential of other methods of sharing profits between upstream and downstream firms, such as slotting fees and revenue sharing.

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1 Introduction

A manufacturer engages in resale price maintenance (RPM) when it sets the price at which its distributors must sell its product to consumers. Minimum RPM involves the manufacturer setting a price floor for its distributors, whereas maximum RPM involves the manufacturer setting a price ceiling. In the US, for almost one hundred years, following

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the Supreme Court's 1911 decision in *Dr. Miles*,[1] minimum RPM was a *per se* violation of Section 1 of the Sherman Act, though statutory exemptions have existed at times (see Overstreet (1983) for a useful history and for data on the use of RPM under these exemptions).[2] The most cited concern about minimum RPM—a concern that persists to this day—is that it constitutes a practice that facilitates retailer and manufacturer collusion, by coordinating pricing and making monitoring easier (see Yamey (1954) and Telser (1960) for early examples, and Shaffer (1991), Jullien and Rey (2007), and Rey and Vergé (2009) for formal treatments).[3]

Largely in response to the *per se* status of RPM, a number of papers were written in the latter part of the last century to explore pro-competitive justifications for RPM (prominent examples include Telser (1960), Marvel and McCafferty (1984), Klein and Murphy (1988), Deneckere, Marvel, and Peck (1996, 1997), and Marvel (1994)). These papers suggest that RPM can be in the interest of both manufacturers and consumers.

In 2007, the Supreme Court finally overturned the *per se* rule against minimum RPM in the U.S. in the *Leegin* case, which decided that cases involving minimum RPM should be decided on a "rule of reason" basis.[4] That is, courts are now required to balance the potential efficiency benefits of RPM against the potential anti-competitive harm. In reaching this decision, the court relied heavily on the pro-competitive theories of RPM that had been developed in the economics literature. In the wake of the *Leegin* decision, economists advising antitrust enforcers are now forced to provide explicit theories for competitive harm that arise from RPM and must be able to quantify the extent of this harm.

This paper develops a model of competitive harm that arises from the exclusion of a more efficient entrant by an incumbent manufacturer. In our framework, minimum RPM is necessary for this to occur. Our framework, therefore, builds a foundation for pursuing the third basis of antitrust harm raised in the *Leegin* decision (see *Leegin* at p.894)—the potential for RPM to be used to provide margins to distributors that will likely disappear

[1] *Dr. Miles Medical Co. v. John D. Park and Sons*, 220 U.S. 373 (1911)

[2] A *per se* violation means that the party bringing the case is not required to establish in evidence that harm to competition occurred. Instead, it is presumed by the mere existence of the conduct. Horizontal price-fixing agreements are another example of a *per se* violation. Posner (2001, p.176ff) describes the evolution of the Court's treatment of the *per se* rule for RPM.

[3] The extent to which RPM impacts consumer welfare varies over time and jurisdiction, often due to changes in laws. Gammelgaard (1958) reports that in the United Kingdom over 30% of consumer goods expenditure was affected by RPM between 1938 and 1950, and in Sweden in 1948 the same number was between 25 and 28%. These numbers cover periods in which RPM was legal in these jurisdictions.

[4] *Leegin Creative Leather Products, Inc. v. PSKS, Inc.*, 551 U.S. 877 (2007), all page references are to the judgement as it appears in this reporter.

if entry occurs, resulting in exclusion.[5] In the model, exclusion is naked in the sense that minimum RPM serves no purpose other than to provide distributors with incentives to exclude a potential entrant; that is, with no possibility of entry, there would be no reason to employ RPM. The primary contribution of this paper is its rigorous framework for exploring the idea of RPM as an exclusionary device. It also gives some preliminary guidance about screens for, and empirical measures of, exclusion, which can be constructed from data using econometric methods that are standard in empirical industrial organization.

At the heart of this paper is a familiar intuition: RPM limits downstream competition and, so, can allow downstream retailers to earn relatively high profits. Indeed, it is precisely these profits (and the threat of losing them) that have been used to provide a pro—competitive theory of RPM: Klein and Murphy (1988) argue that manufacturers can use these profits to entice retailers to provide the desired level of service. However, here, we highlight a more harmful implication of such profits.[6] If an entrant cannot establish itself without some retailer support, then retailers may be hesitant to accommodate an entrant since following manufacturer entry, retail competition will be more intense.[7] Even if the entrant manufacturer can offer RPM, retailers will shop among the manufacturers for better terms that allow them to compete more intensely with other retailers.[8] Seeking to prevent the industry from evolving in this direction, which reduces the profitability of the whole industry (and, in particular, their own profitability), retailers will not accommodate entry.

The incumbent manufacturer, by an appropriate choice of RPM, can ensure that the industry as a whole earns the profits that a monopolized industry would earn, and, through an appropriate choice of the wholesale price, divide these profits between itself and the retail sector. To exclude entry, the incumbent must ensure that every retailer earns more than a competing manufacturer entrant could offer the retailer to stock its product; however, this may still allow the incumbent positive profits. Therefore, according to this theory, *both* the retail sector *and* the incumbent manufacturer gain from RPM.[9] This is in contrast to

[5] The first two bases for harm are RPM as a practice facilitating upstream collusion and as a practice facilitating downstream collusion.

[6] Shaffer (1991) also does this, in the context of RPM (and slotting fees) facilitating collusive outcomes among retailers.

[7] Comanor and Rey (2001) make a related point in the context of exclusive dealing.

[8] A more efficient entrant cannot simply replicate the incumbent manufacturer, since he faces a competitor. Even though all retailers might prefer an RPM agreement with the entrant, there is no way that they could commit to stick to such an agreement, absent collusion.

[9] In line with this observation, Overstreet (1983, p.145ff) describes lobbying by both manufacturers and retailers for the 'Fair-Trade' statutes that created exemptions from liability for RPM. These statutes lasted from the 1930s through to the mid-1970s, depending on the state(s) involved.

much of the policy discussion that suggests that there is less reason for antitrust concern when a manufacturer instigates RPM.

First, we set out the theory and illustrate the central mechanism through a simple model with homogeneous retailers. In contrast to much of the RPM literature, and in order to highlight our mechanism, there is no possibility of pre- or post-sale service. Retailers simply distribute the goods that they receive from the upstream manufacturer. We analyze a single market. Entry, of course, may reflect a manufacturer expanding from an existing geographic location or adding a new product line that appeals to a new consumer segment.

In this environment there are always equilibria in which entry is accommodated since, if a retailer anticipates that some other retailer will accommodate the entrant, then it will be keen to accommodate the entrant as well, and, thus, such beliefs can be self-sustaining. We note, however, that in such equilibria, RPM agreements play no useful role and, hence, would not be used in practice. Our focus on equilibria where entry is excluded is, perhaps, further justified by the observation that if such an exclusionary equilibrium exists, then not only would it involve RPM, but also all retailers would prefer it to an accommodating equilibrium.[10]

We characterize the conditions under which an exclusionary equilibrium can be sustained in our baseline model and describe properties of such equilibria. In particular, we highlight the welfare loss associated with exclusionary equilibria, which may be of practical use to policy makers in quantifying harm. In addition, we discuss empirical screens useful for assessing whether such equilibria are feasible and, if so, for determining preliminary bounds on the scope of possible harm.[11]

Our baseline model allows for no coordination among firms in the event that an entrant succeeds in entering. However, the exclusionary equilibrium in the baseline model bears a resemblance to equilibria in models often used to model coordination in the form of collusion (e.g. Ch. 6 of Tirole; 1988). Allowing for coordination post-entry either by retailers, manufacturers, or the entrant and retailers, might require more coordination among market

[10] Inasmuch as both exclusionary and non-exclusionary equilibria exist, exclusion may require coordination (if only in beliefs over the equilibrium being chosen) among the downstream retailers. As we discuss below, sometimes this has been achieved through explicit downstream coordination via, for instance, trade associations.

[11] Empirical work on RPM is limited. All recent studies attempt to test theories of RPM different to ours. Ippolito and Overstreet (1996) and Ornstein and Hassens (1987) conduct industry case studies, Ippolito (1991) studies RPM litigation, while Gilligan (1986) and Hersch (1994) conduct stockmarket event studies. Earlier empirical work is extensively surveyed in Overstreet (1983). The evidence in support of collusive theories is mixed.

participants than can often be achieved, especially as explicit coordination may be illegal. However, these cases are clearly of interest, We, therefore, enrich the model to incorporate the possibility of these kinds of coordination. Broadly, we find that coordination post-entry makes it more difficult, or less likely, that the incumbent excludes the entrant. However, there are still cases where the incumbent prefers to and can successfully exclude the entrant. Further and perhaps surprisingly, while one might suppose that a retailer cartel should maximize retailers' profits and so lead to the entry of an efficient manufacturer, a retailer cartel is unable to commit not to restrict output (and set a higher retailer price). As a result an entrant may face relatively low sales and be unable to recoup entry costs in the presence of a retailer cartel, though it may be able to in its absence. Thus, retailer coordination, by itself, may lead to exclusion to the detriment of retailers (and to the benefit of the incumbent).

In addition to addressing post–entry collusion of various forms, we also consider extensions that allow for differentiation, either at the retail level or between the incumbent and entrant in the manufacturing segment. Beyond showing the robustness of the results, these extensions highlight that competition (as captured by the degree of differentiation between firms) in either the retail or the wholesale segment can exacerbate or alleviate exclusionary pressure, depending on the degree of differentiation.

Aside from the RPM literature already discussed, another related literature is that on naked exclusion arising from exclusive dealing arrangements (See Ch. 4 of Whinston (2006), Rey and Tirole (2007), and Rey and Vergé (2008) for useful overviews). In this literature, the closest papers to ours are Fumagalli and Motta (2006) and Simpson and Wickelgren (2007), which explicitly consider exclusive dealing arrangements between manufacturers and retailers. Earlier papers, by Rasmusen, Ramsayer and Wiley (1991), and Segal and Whinston (2000) are distinct in assuming that buyers (equivalently, retailers) act as local monopolists. Our setting differs from that presented in this line of research in that we build on a repeated game framework instead of exploiting contractual externalities arising from scale economies; although the coordination-style game that lies at the heart of this literature finds a close analog in our setting. Our model is most distinctive in the ease with which exclusion can occur in intensely competitive markets (i.e., Bertrand). In this setting, one way we depart from the well-known 'no-exclusion' result of Fumigalli and Motta (2006) is by resorting to a repeated–game environment. This gives a setting in which the impact of a single retailer's actions on industry profits can be imposed on that retailer. In this respect, a similar flavor is found in Simpson and Wickelgren's (2007) model, where exclusion in intensely competitive markets is established via contracts contingent on the actions of other retailers. As in Argenton (2010), which allows for vertical quality differentiation, and Abito and Wright (2008), which allows for downstream differentiation, in our environment, should the entrant succeed in entering, the incumbent remains present as a competitive pressure in the market rather than leaving the new entrant as an unfettered monopolist. In addition, the entrant poses no direct competitive pressure unless accommodated by a retailer. These are key assumptions for our analysis. We comment further on the relationship between our model and this literature in the conclusion. In particular, we suggest that the exclusionary effect of RPM we illustrate in this paper may complement the explicit contractual force of an exclusive dealing agreement.

In the remainder of this paper we first briefly review an older literature on RPM and exclusion, which includes discussion of some empirical examples. Then in Section 3, we carefully describe the model, which relies on a two-state infinitely repeated game (see Mailath and Samuelson (2006) for a comprehensive treatment of repeated games). In Section 4, we present properties of the equilibria of the model and highlight the possibility of equilibria in which the more efficient entrant is excluded. Sections 4.1 and 4.2 consider welfare implications of the model and derive a simple bound on the extent of harm, which we evaluate in a parameterized version of the model. In Section 5, we relax the Markov Perfect Nash Equilibrium concept used in the baseline model in three ways: first, we allow the entrant to attempt to exclude the incumbent post entry; second, we compare the incumbent's preference for exclusion over accommodating entry and colluding; and third we examine the effect of a retailer cartel. In Section 6, we extend the framework and, in particular, discuss differentiation among retailers and between the entrant and incumbent. In Section 7, we draw out policy implications of the analysis, including some implications for screens indicating the potential for exclusion. Finally, in the conclusion, we offer some remarks on how the framework we develop can be extended to understand the exclusionary potential of other forms of transfers between retailers and incumbent manufacturers, such as slotting fees and revenue sharing agreements. We also discuss the relationship between the exclusionary equilibria we investigate (which might be viewed as implicit exclusivity) and exclusion through explicit exclusive dealing contracts.

2 RPM and exclusion

The idea that RPM may have exclusionary effects has a long history in the economics literature. As early as 1939, Ralph Cassady, Jr. remarked on the potential for distributors to favor those products on which they were getting significant margins via RPM, noting that since "manufacturers are now in a real sense their allies, the distributors are willing (nay, anxious!) to place their sales promotional effort behind these products, many times to the absolute exclusion of non-nationally advertised competing products"(Cassady (1939, p. 460)). Cassady's remarks are interesting in that they suggest a complementarity between some of the pro-efficiency reasons for RPM and exclusion.[12]

Following Cassady's early remarks, the potential for RPM to be viewed as an exclusionary device did not surface again until the 1950s with the work of Ward Bowman in (1955) and Basil Yamey in (1954). Yamey describes a "reciprocating" role of price maintenance whereby, "(t)he bulk of the distributive trade is likely to be satisfied, and may try to avoid any course of action, such as supporting new competitors, which may disturb the main support of their security"(1954 p. 22). Yamey (1966) also raises the possibility of exclusion, suggesting that "Resale Price Maintenance can serve the purposes of a group of manufacturers acting together in restraint of competition by being part of a bargain with associations of established dealers to induce the latter not to handle the competing products of excluded manufacturers"(p. 10). The quote is particularly interesting in its suggestion of some complementarity between the possibility that RPM facilitates collusion, and the exclusionary effect. Gammelgaard (1958), Zerbe (1969), and Eichner (1969) make similar suggestions regarding the possibility of exclusion . More recently, following the *Leegin* decision, Elzinga and Mills (2008) and Brennan (2008) have discussed the exclusionary aspect of RPM that is mentioned in the majority judgement.[13]

Bowman (1955) describes several examples of RPM's use for exclusionary purposes involving wallpaper, enameled iron ware, whiskey, and watch cases. Many of these examples are drawn from early antitrust cases and involve a cartel, rather than a monopolist firm, as the upstream manufacturer instigating exclusion. Bowman also gives a few examples

[12]Indeed, as discussed above, Klein and Murphy (1988) highlight that a manufacturer's threat to withhold super-normal profits can be efficiency-enhancing by helping to ensure appropriate service at the retailer level. Instead, our paper argues that the possibility of losing these super-normal profits as a result of a changing market structure can lead to exclusion of an efficient manufacturer. To the extent that efficiency-enhancing rationales are more effectively implemented when more surplus is available, our framework would also suggest a complementarity between the "pro-efficiency" rationales and exclusion.

[13]None of the papers mentioned here develop a formal model.

of implicit upstream collusion rather than explicit cartelization and the use of RPM for exclusion; specifically, he highlights the cases of fashion patterns and spark plugs. Given that a cartel will wish to mimic the monopolist as much as possible, these examples are consistent with the setting considered in this model. They also underline the complementarities between the view that RPM facilitates collusion, and the exclusionary perspective articulated here.

These cases often involve contracts that include more-explicit exclusionary terms in conjunction with the use of RPM. For example, in 1892, the Distilling and Cattle Feeding Company, an Illinois corporation, controlled (through purchase or lease) 75-100 percent of the distilled spirits manufactured and sold in the U.S. It sold its products (through distributing agents) to dealers who were promised a five-cents-per-gallon rebate provided that the dealers sold at no lower than prescribed list prices and purchased all their distillery products from their (exclusive) distributing agents.[14]

Another well-documented example is that of the American Sugar Refining Company, discussed at some length by Zerbe (1969) (see, also, Marvel and McCafferty (1985)). The American Sugar Refining Company was a trust formed in 1887 that combined sugar-refining operations totaling, at the time of combination, approximately 80 percent of the industry's refining capacity. The principle purpose of the trust was to control the price and output of refined sugar in the U.S..[15] After a wave of entry and consolidation, by 1892, the trust controlled 95 percent of U.S. refining capacity. In 1895, the wholesale grocers who bought the trust's refined sugar proposed an RPM agreement. Zerbe reports that the proposal came in the form of "a threat and a bribe": The bribe was that, in return for the margins created by the RPM agreement, the grocers would not provide retail services to any refiner outside the trust. The threat was in the form of a boycott if the trust refused to enter into the RPM agreement. The exclusionary effect of the RPM agreement was only partial at best: In 1898, Arbuckle, a coffee manufacturer, successfully entered the sugar-refining business. In some regions, Arbuckle was unable to get access to wholesale grocers and had to deal directly with retailers. Thus, while not prohibiting entry, the RPM agreement may have raised the costs of this new competitor to the trust. Ironically, after several years of cutthroat competition, Arbuckle and the trust entered into a cartel agreement that persisted in one form or another until the beginning of the First World War.

[14] As recorded in *U.S. v. Greenhut et al.* 50 Fed., 469, and *U.S. v. Greenhut et al.* 51 Fed., 205.

[15] See Zerbe (1969, p. 349), reporting testimony given to the House Ways and Means Committee by Havermeyer, one of the trustees.

The sugar trust is informative in that it involves RPM's use in a setting in which the product is essentially homogeneous (see Marvel and McCafferty (1985) for a chemical analysis supporting this claim) and the manufacturer has close to complete control of existing output. The lack of product differentiation makes theories of RPM enhancing service or other non-price aspects of inter-brand competition difficult to reconcile with the facts. Clearly, there was no reason to use RPM to facilitate collusion on the part of refiners, since the trust already had achieved that end. The grocers may well have wanted to facilitate collusion at their end, but the openness with which they negotiated with the trust suggests that it was more in the spirit of good-natured extortion: a margin in exchange for blocking entry.

The sugar example fits the setting considered in our model, in which an incumbent monopolist faces entry by a lower-cost entrant. All products are homogeneous, and there is no differentiation between retailers. This gives the model the flavor of cutthroat competition familiar from standard Bertrand price competition models. In particular, there is no scope for service on the part of retailers, and the manufacturer easily solves the classical double-marginalization problems by simply using more than one retailer. If the entrant enters, then retailers and the incumbent see profits decrease (to zero), and the entrant captures market demand at a price equal to the incumbent's marginal cost. To deter this entry, the incumbent offers an RPM agreement which, over time, more than compensates the retailers for any one-off access payment that the entrant may be able to afford. At its heart, the RPM agreement is successful in that it forces individual retailers to internalize the impact of competition on the profitability of the incumbent's product and on the margins of all retailers. A feature of the model, which sits well with the sugar example, is that both the incumbent and the retailers benefit from the RPM-induced exclusion. In this sense, the fact that the grocers suggested the RPM agreement in the sugar example—in contrast to the distilled spirits example in which the upstream firm initiated the agreement—is entirely consistent with the exclusionary effect explored here.

3 The baseline model

There are two manufacturers who produce identical goods. Total market demand in each period in this market is given by $q(p)$. All firms discount future profits with discount factor δ.

One manufacturer is already active in the market (the incumbent) and another is a potential entrant (the entrant). The incumbent's constant marginal cost of manufacturing is given by c_i and the entrant's by c_e, where $c_i \geq c_e \geq 0$. We assume that $c_i < p_e^m$, where p_e^m is the price that would be charged by a monopoly with cost c_e. In order to enter the market, the entrant has to sink a fixed cost of entry $F_e \in [0, 1/(1-\delta)(c_i - c_e)\, q(c_i)]$. The upper bound on this fixed cost will ensure that an entrant, faced with a market with competition (no exclusionary RPM) will want to enter this market. In practice, this fixed cost may be difficult for an antitrust authority to evaluate and turns out to play a somewhat limited role in our baseline analysis; consequently, in the analysis, we often focus on the limiting case where $F_e = 0$. It is important, however, that the entrant is considered to be present in the market *only if* a retailer accommodates entry—i.e., an entrant is not perceived to have entered until its products are available to final consumers.[16]

There are $n \geq 2$ retailers in this market. Retailers are perfect substitutes for each other, and their only marginal costs are the wholesale prices that they pay to the manufacturers.

Contracting between manufacturers and retailers occurs on two fronts: first, when the entrant seeks to obtain a retail presence; and, second, when a manufacturer sells its product to a retailer (that is, when exchange occurs). Each setting is dealt with in more detail in the next two paragraphs.

As described above, for the entrant to gain a retail presence at least one retailer must agree to stock the product. This means that the retailer must be better off stocking the product than not. To this end, the entrant can offer any form of payment (lump sum or otherwise) to induce a retailer to carry its product.[17] Once a retailer has agreed to stock a product, it is always stocked. If the entrant's product is stocked by a retailer, the entrant joins the incumbent in the set of (perpetually) active firms.[18]

Conditional on being present in the market, a manufacturer sells to retailers via a per-unit wholesale price, w_i or w_e, depending on whether the price is set by the incumbent or the entrant. Manufacturers are not permitted to price discriminate across retailers or over the quantity sold.[19] Each manufacturer also has the option of setting a per-unit

[16] We assume that vertical integration is prohibitively costly. We also assume that a merger or acquisition of the incumbent by the entrant is not feasible.

[17] The contract space is left unrestricted here, as no further structure is required. If the entrant were limited to only offering transfers indirectly (for example, through a relatively low wholesale price), this would only make it more difficult for the entrant to transfer surplus and compensate the retailer for accommodating its entry. Thus, in making this assumption, we analyze the extreme case that makes it as difficult as possible for the incumbent to foreclose entry.

[18] That is, a firm has to sink the fixed cost of entry only once.

[19] In the model, there is no incentive to discriminate across retailers, so this assumption is not restrictive.

retail price (either p_i or p_e).[20,21] We say that a manufacturer imposes RPM if this price is different from the one that any retailer would choose. The rationale for this definition is that if an unfettered retailer would, independently, charge the price that a manufacturer preferred, with no need for any (potentially costly) monitoring or enforcement, then RPM plays no role. Although this paper is focused on minimum RPM, this formulation of an RPM contract involves a manufacturer directly setting a retailer price. We do this for expositional ease. As we will point out, to implement the exclusion the model illustrates, the incumbent only needs to use minimum RPM.

3.1 Timing

The model is an infinitely repeated game.[22] Figure 1 shows the structure of moves within a period, assuming only two retailers;[23] transitions between periods are indicated by a dotted line and the updating of the period counter, $t = t + 1$. There are two possible types of period, corresponding to different states of the manufacturer market, which we label M (incumbent monopolist), and C (competition).

The game begins in state M at $t = 1$. In this period the incumbent is active, but the potential entrant has yet to decide whether or not to enter. The order of moves within a period in state M is as follows:

1. the incumbent sets a retail price and a corresponding wholesale price (p_i, w_i) for all retailers (node $\mathbf{i_M}$); then,

2. the entrant attempts to enter by offering a transfer, $R \in [0, \infty)$, to a single retailer, payable if entry is accommodated, and also by committing to an associated retail

The restriction on discrimination on the basis of quantity sold may be more restrictive. For instance, Marx and Shaffer (2004) and Chen and Shaffer (2009) suggest that minimum share agreements may have an exclusionary effect.

[20] None of our arguments in the baseline model require the incumbent setting a maximum retail price limit. Minimum retail prices by the incumbent are necessary for exclusion in our framework and in formulating necessary and sufficient conditions for exclusion to be possible. We briefly consider a role for the incumbent's use of maximum retail prices in Sections 5.3 and 7, below.

[21] In this setting, the retailers will always be weakly better off accepting the RPM agreements that the manufacturers want to formulate; hence the retailer's acceptance of the RPM agreement is assumed. While a more complicated bargaining structure between the retailer and incumbent could be considered, for expositional ease, we have implicitly employed a structure where the incumbent makes a take-it-or-leave-it offer to all retailers simultaneously.

[22] Realistic values for δ depend, as in all repeated games, on the interpretation of a "period," which should be thought of as the length of time it takes for firms in a market to react to a change in circumstances.

[23] Figure 1 shows two retailers for expositional ease only. All arguments apply to the n-retailer case.

price and a corresponding wholesale price (p_e, w_e) (node $\mathbf{e_{M1}}$); then,

3. retailers ($\mathbf{r_1}$ and $\mathbf{r_2}$) simultaneously choose to accept (accommodate entry) or reject the entrant's offer (if more than one accepts, then the recipient of R is chosen at random) (nodes $\mathbf{r^1_M}$ and $\mathbf{r^2_M}$).[24]

4. if no retailer accommodates the entrant, then transactions occur, period profits are realized, and the period ends, with the state of the manufacturer market in the next period continuing to be M; otherwise,

5. if at least one retailer accommodates, then the entrant can choose either to pay the fixed cost, F_e, or not (node $\mathbf{e_{M2}}$). Following that decision, transactions occur, period profits are realized, and the next period begins. This next period, though, will be a competitive period, in which the state is C if the entrant incurs the fixed cost.

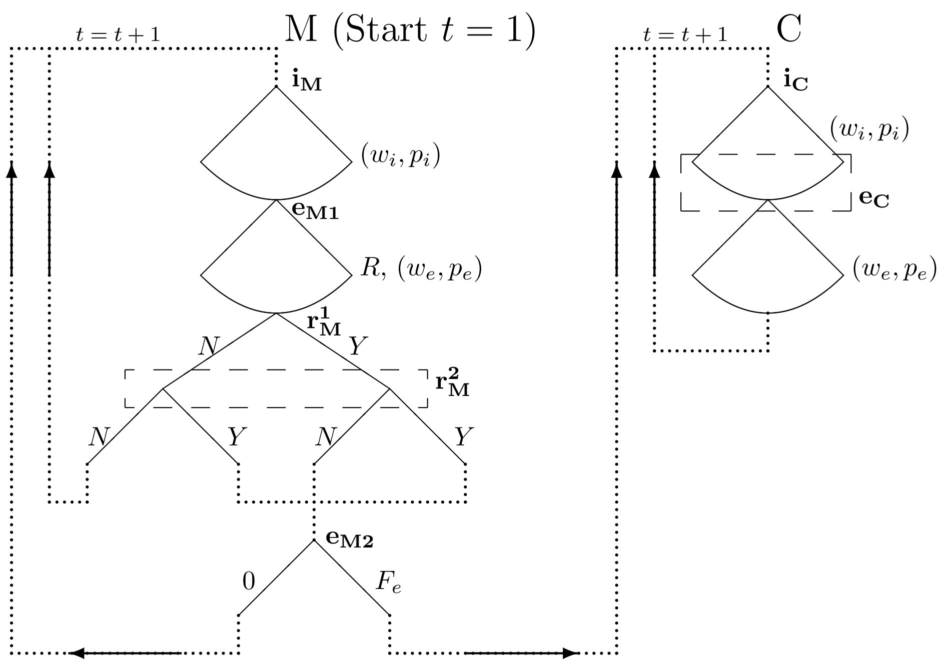


Figure 1: A schematic of the sequence of moves within periods and the transitions from one state to another, with two retailers.

[24]The dashed box in Figure 1 represents an information set.

A period in state C involves a simultaneous move game in which both the incumbent and entrant compete by setting a minimum retail price (should they wish) and a wholesale price.

Note that in this timing, we suppose that the fixed cost of entry is paid only if a retailer accommodates entry; this is a realistic assumption, for example, if the entrant needs access to final consumers for final product configuration or for the marketing of a new-product launch. Similar results apply if the fixed costs of entry are paid ex-ante as long as the entrant is not considered active until a retailer has accommodated the entrant.[25] We present the timing with fixed costs paid only after accommodation, first, since the analysis is a little simpler and, second, since this timing reinforces the importance and central role of retailer accommodation.[26]

The transfer, R, serves as an inducement to a retailer to carry the entrant's product. We restrict this transfer to be paid only to one retailer, but given that all retailers are perfect substitutes in the baseline model, this is not restrictive: our interest is in equilibria in which all retailers choose not to accommodate the entrant (exclusionary equilibria). For such an equilibrium to exist it must be the case that, if all other retailers are not accommodating, then any given single retailer also chooses not to accommodate. By considering an inducement R paid to a given single retailer, we maximize the chance that this retailer would want to deviate from the exclusionary equilibrium and, hence, study a case in which exclusion is, if anything, harder to attain.

What is crucial is the requirement that at least one retailer agree to carry the entrant's good for the entrant to become active. Hence, the transition from the state of the market M to state C requires a retailer to agree to stock the entrant's product. The effect of such an agreement, which is effectively an assurance of perpetual market access, is to guarantee competition between the two manufacturers in all periods post-entry; in particular, it is assumed that following entry, the incumbent remains present as a competitive threat that does not require retailer-accommodation.

[25] There would, therefore, be three states of the game. In addition to M (where the incumbent has not entered), and C (where there is competition between incumbent and monopolist), there could be periods where the entrant has sunk its fixed costs of entry, but no retailer has yet accommodated entry.

[26] The exclusive dealing literature has the retailers choosing to accommodate entry or not, prior to the entrant committing to any offer. If we adjusted our timing in this way, the inability of the entrant to commit to transfers post-accommodation can make exclusion easier than in the model we present here. We are grateful to a referee for pointing this out.

4 Analysis

Before analyzing the game outlined in Section 3, consider the behavior of an incumbent with no threat of entry. In the absence of RPM, Bertrand competition among retailers ensures that the retail price will simply be equal to the wholesale price that the incumbent manufacturer charged. The incumbent can, therefore, charge a wholesale price equal to its monopoly price, $p_i^m = \arg\max(p - c_i)q(p)$, and earn monopoly profits. It can do no better with RPM, and so without the threat of entry, in this model, RPM plays no role.[27]

We characterize the Markov Perfect Nash equilibria of this game, where the states are given by the type of the current market structure. That is, following the notation in Figure 1, the state space is the finite set $\{M, C\}$. We use Markov Perfection to remove the possibility of firms' colluding post-entry. However, note that since a "deviating" retailer who accommodates entry changes the state from M to C, the equilibrium play in state M resembles a collusive outcome among retailers—we highlight that this can be beneficial for the incumbent manufacturer in excluding a rival.[28] We first consider the absorbing state following entry (that is, the state C) and then turn to consider the entry decision (state M).

Suppose that the state is C, so that the period game has both the entrant and the incumbent active and simultaneously setting (w_i, p_i) and (w_e, p_e). Since the manufacturers' goods are identical and the retailers are perfect substitutes, the equilibrium resembles a standard Bertrand equilibrium. The equilibrium has the wholesale price set at the marginal cost of the less efficient incumbent (c_i) and all retailers purchasing at this price from the more efficient entrant—i.e., $w_e = w_i = c_i$.[29] The retail price (which, in the model, we assume is determined by manufacturers through RPM) will also be set at c_i, since at any higher price any manufacturer could attract all the retail customers by undercutting by an epsilon increment. The entrant has no incentive to force a lower price since it is assumed that $c_i < p_e^m$ where p_e^m is the price that would be charged by a monopoly with cost c_e. Note that Bertrand competition among retailers (since they are perfect substitutes) implies that RPM plays no role in this case and that competition among retailers is intense, in

[27]Indeed, this reasoning has led some commentators to suggest that a monopolist's use of RPM reflects that retail service is an important factor (see, for example, Winter 2009).

[28]The interaction between collusion and resale price maintenance is explored in Jullien and Rey (2007).

[29]Since the entrant's cost is lower than the incumbent's, there are actually a range of equilibria that involve the incumbent's pricing between c_e and c_i and the entrant just undercutting. As is standard, we ignore these equilibria since they involve weakly-dominated strategies that make little empirical sense and are not robust to trembling-hand style equilibrium refinements.

the sense that they earn no profits. The same outcome would arise—that is, retailers would set a retail price equal to $w_e (= c_i)$—whether or not the entrant used RPM, and so according to our definition, here there is no RPM. Since our equilibrium concept is Markov Perfection, there is no way to sustain pricing above c_i: The state-space does not admit the possibility of collusion and a punishment phase that could be used to deter undercutting. This reasoning yields the following result.[30]

Lemma 1 *Post-entry (that is, when the state is equal to C) per-period profits are:*

1. $\pi_i^{Entry} = 0$ *for the incumbent;*
2. $\pi_r^{Entry} = 0$ *for any retailer; and*
3. $\pi_e^{Entry} = (c_i - c_e)q(c_i)$ *for the entrant.*

Given this characterization for periods following entry, we can turn to characterize the full game. Our interest is in highlighting when exclusion via RPM is possible in equilibrium. However, there are always equilibria with no exclusion. We illustrate an example of such a no-exclusion equilibrium in Lemma 2 below.

Lemma 2 *There is always an equilibrium in which entry takes place in the first period (in state M) and the entrant offers $R = 0$ and $p_e = w_e = c_i$ in state M.*

Proof. Consider a period where the state of the market is M, and consider that part of the period in which retailers simultaneously choose whether to accept or reject the entrant's offer of $R = 0$. If one retailer accepts the entrant's offer, then the best response set of all other retailers will also include acceptance, as long as it is individually rational in the current period. This is because acceptance by one retailer ensures that entry occurs. If one retailer accommodates entry, then the entrant will get access to the market and be able to generate a retail price that undercuts all retailers that supply the incumbent's good. This steals the market from the incumbent and retailers who sell the incumbent's good. Given

[30] Shaffer (1991) considers a model that is analogous to our state C, but interprets RPM as incorporating a form of commitment that is more binding than merely setting a wholesale price, so that if one firm uses RPM and the other does not, a leader-follower pricing game emerges. This interpretation may change the equilibrium payoffs. We have not adopted this interpretation, and so our state C is always a simultaneous-move game. Adopting Shaffer's interpretation would not qualitatively change the analysis in the baseline model. In the extensions that consider differentiation, this alternate view would change the analysis somewhat but not the qualitative results.

this entry, retailers anticipate making no profit in the current or future periods (following Lemma 1), and so it is weakly optimal to accommodate (and would be strictly so if the entrant offers any $R > 0$).

It is easy to verify that the incumbent choosing $p_i = w_i = c_i$ is a best response to the entrant offering $R = 0$ and $p_e = w_e = c_i$ in state M when the incumbent expects that the entrant will be accommodated. Clearly, it is a best response for the entrant to choose $R = 0$ and $p_e = w_e = c_i$ in state M.

Note that here, there is no RPM (since if $w_e = c_i$, then Bertrand competition among retailers would lead to the same retail price). ∎

The equilibrium illustrated in Lemma 2 reflects a broader class of equilibria in which entry occurs. For instance, following the logic in the proof, if the entrant offers a payment of $R = \epsilon > 0$ to any accommodating retailer then an equilibrium would exist in which all retailers accommodate entry. That is, if all other retailers accommodate it would be strictly optimal for an entrant to also accommodate, since, at the very least, they get a payment R as opposed to not accommodating and getting a payment of zero. Clearly, any such payment $R = \epsilon > 0$ is unnecessary from the point of view of the entrant, since equilibrium only requires best responses to be weakly optimal. That is, the no exclusion equilibrium can involve no cost to the entrant as described in Lemma 2.

It is worth noting that, in setting up the model in Section 3.1, we assumed away the option of the entrant to offer a payment of $R = \epsilon > 0$ to all accommodating retailers, since our interest is in equilibria in which all retailers choose not to accommodate the entrant (exclusionary equilibria). As will become clear in the following analysis, for such an equilibrium to exist it must be the case that, if all other retailers are not accommodating, then any retailer also chooses not to accommodate. By considering an inducement R paid to a single retailer, we maximize the amount that the entrant would pay to any retailer and so also chance that this retailer would want to deviate from the exclusionary equilibrium; hence, we study a case in which exclusion is, if anything, harder to attain.

A comparison of the no-exclusion equilibrium illustrated in Lemma 2 (in which the accommodating retailers get zero rents) to the exclusionary equilibrium illustrated below, makes it clear that the retailers are better off in the exclusionary equilibrium. On this basis, one might think that the exclusionary equilibrium is more compelling as it is both individually and collectively better for the retailers. This argument is somewhat similar in spirit to the use of coalition-proof SPNE employed by Segal and Whinston (2000) in narrowing the set of potential equilibria in the context of exclusive dealing.[31]

We now turn to the necessary and sufficient conditions for an exclusionary equilibrium to exist. By exclusionary, we mean an equilibrium in which the retailers never accommodate entry. We show that the use of minimum RPM by the incumbent can generate this exclusion.

Entry depends on whether a retailer will agree to carry the entrant's products. Hence, the retailers' equilibrium strategies in state M are determinative. It is helpful to examine this part of the game more closely. This is done using Figure 2, which represents the retailers' payoffs, conditional on their action and that of the other retailers. These actions are either to accept the entrant's offer and accommodate it (Y) or to reject it (N). As in Figure 1, Figure 2 assumes only two retailers, but all arguments are valid for $n \geq 2$ retailers, and are, where useful, stated as such.

		Retailer 2	
		N	Y
Retailer 1	N	$\pi(N,N)$, $\pi(N,N)$	$\pi(N,Y)$, $\pi(Y,N)$
	Y	$\pi(Y,N)$, $\pi(N,Y)$	$\pi(Y,Y)$, $\pi(Y,Y)$

Figure 2: The retailers' payoff matrix.

Note that since retailers are symmetric, the payoff matrix in Figure 2 is symmetric. Payoffs are represented by, for example, $\pi(Y,N)$, where Y is the action of the retailer and N is the action of the other retailer. Note that if $\pi(N,Y) \leq \pi(Y,Y)$, then there is always an equilibrium where both retailers will choose Y—that is, where entry is accommodated. Lemma 2 points out that the game is structured so that this condition can always be

[31] We are grateful to a referee for pointing this out.

met (with $\pi(N,Y) = \pi(Y,Y) = 0$). The existence of this equilibrium, however, does not imply that this equilibrium is unique. Exclusion is also an equilibrium if there are optimal strategies by the manufacturers such that, for retailers, $\pi(N,N) \geq \pi(Y,N)$. An exclusionary equilibrium arises when the retailers coordinate on this (N,N). It can be supported in equilibrium whenever the cost to the entrant of raising $\pi(Y,N)$ above $\pi(N,N)$ is prohibitive, so that it prefers not to incur the fixed cost of entry.

Since exclusion results in a zero profit for the entrant, the entrant will always be happy to transfer as much surplus as is required to make sure that $\pi(Y,N) > \pi(N,N)$ if the alternative is exclusion, subject to meeting a non-negative discounted-profit-stream constraint.[32] The maximal surplus that the entrant could transfer to a retailer is given by first covering the fixed cost of entry and then transferring as much as possible of the maximal profit that can be earned in the current period, if entry occurs, plus the discounted value of all future profits in state C. The latter is easily determined given the characterization of per-period profits in Lemma 1. To compute the former, note that if the incumbent offers (w_i, p_i), then the entrant would maximize its surplus extraction in the current period by setting a retail price of $\hat{p}_e = \min\{p_i, p_e^m\}$.[33] Thus, the maximal value of $\pi(Y,N)$ that the entrant can generate is

$$\max \pi(Y,N) = (\hat{p}_e - c_e)\, q(\hat{p}_e) + \frac{\delta}{1-\delta}(c_i - c_e)\, q(c_i) - F_e. \tag{1}$$

This can be implemented through different combinations of R and (w_e, p_e); for example, by setting $w_e = c_e$ and $R = \frac{\delta}{1-\delta}(c_i - c_e)\, q(c_i) - F_e$.

We now turn to the incumbent's problem and, in particular, we consider the maximal value of $\pi(N,N) - \max \pi(Y,N)$, subject to the incumbent's making non-negative profits, to address the question of whether the incumbent *can* foreclose entry. In practice, the incumbent would wish that retailers earn only enough profits for them to prefer not to accommodate entry—that is, so that $\pi(N,N) = \max \pi(Y,N)$—and keep any additional profits; however, comparing $\max \pi(N,N) - \max \pi(Y,N)$ as defined in (1) determines whether exclusion is possible. That is, it provides necessary and sufficient conditions for the existence of an exclusionary equilibrium.

Note that $\pi(N,N)$ is simply determined as the discounted value of the stream of surplus

[32] Note that we assume away any frictions in capital markets.

[33] Note that the entrant's wholesale price is irrelevant in determining the maximum that the entrant can transfer to a retailer since any profits $(w_e - c_e)q(\widehat{p}_e)$ that the entrant earns can either be transferred as part of the lump sum R or through choosing $w_e = c_e$ instead.

that accrues to the retailers if all retailers deny access—that is, $\frac{1}{1-\delta}\frac{1}{n}(p_i - w_i)q(p_i)$, where the factor $\frac{1}{n}$ reflects the fact that the n retailers share the market evenly when charging the same retail price. Note that since p_i can affect $\hat{p}_e$ and, thereby, affect $\max \pi(Y, N)$, as defined in (1), the problem need not reduce to choosing p_i and w_i to maximize $(p_i - w_i)q(p_i)$; however, w_i does not affect the entrant's problem and so, clearly, the incumbent would choose $w_i = c_i$ to guarantee itself non-negative profits and guarantee retailers all the surplus generated. The incumbent's problem, therefore, is reduced to choosing p_i in order to maximize

$$\frac{1}{1-\delta}\frac{1}{n}(p_i - c_i)q(p_i) - \left((\hat{p}_e - c_e)\, q\,(\hat{p}_e) + \frac{\delta}{1-\delta}\,(c_i - c_e)\, q\,(c_i) - F_e \right). \tag{2}$$

First note that if $p_i \geq p_e^m$, then the problem is trivially solved by setting $p_i = p_i^m$. Consider, instead, the case $p_e^m > p_i$, and note that the above expression can be rewritten as

$$\max_{p_i < p_e^m} (\frac{1}{1-\delta}\frac{1}{n} - 1)(p_i - c_i)q(p_i) - (c_i - c_e)q(p_i) - \frac{\delta}{1-\delta}(c_i - c_e)q(c_i) + F_e. \tag{3}$$

If $\frac{1}{1-\delta}\frac{1}{n} > 1$, then, since $p_i < p_e^m \leq p_i^m$, the incumbent prefers to set p_i as high as possible, both to make the first term in the expression above larger, and to make the second term smaller. However, this corner solution takes us back to the previous case, where the incumbent would prefer to set $p_i = p_i^m$. Instead, if $\frac{1}{1-\delta}\frac{1}{n} < 1$, then regardless of the incumbent's choice

$$\max_{p_i < p_e^m} (\frac{1}{1-\delta}\frac{1}{n} - 1)(p_i - c_i)q(p_i) - (c_i - c_e)q(p_i) - \frac{\delta}{1-\delta}(c_i - c_e)q(c_i) < 0,$$

and so as long as F_e is small enough, the incumbent can never foreclose entry.[34]

This discussion establishes the following:

Proposition 1 *Suppose that $\frac{1}{1-\delta}\frac{1}{n} > 1$. Then, an exclusionary equilibrium (one in which the entrant does not enter) exists if and only if*

$$F_e + \frac{1}{1-\delta}\frac{1}{n}\,(p_i^m - c_i)\, q\,(p_i^m) \geq (p_e^m - c_e)\, q\,(p_e^m) + \frac{\delta}{1-\delta}\,(c_i - c_e)\, q\,(c_i)\,. \tag{4}$$

If $\frac{1}{1-\delta}\frac{1}{n} < 1$ and fixed costs, F_e, are sufficiently small, there is never an exclusionary equilibrium.

[34] Note that meaningful exclusion may still occur for sufficiently high values of F_e.

The following corollary is immediate.

Corollary 1 *An entrant with marginal cost* $c_e = c_i$ *can always be excluded if* $\frac{1}{1-\delta} \geq n$.

While Proposition 1 is derived assuming that RPM allows a manufacturer to set the retail price directly, all that is required for the incumbent to implement the exclusion illustrated here is minimum RPM. That is, what the manufacturer needs to do is ensure that sufficient rents are transferred to retailers in the M state (the state in which only the incumbent is active). To do this the incumbent must ensure that retailers enjoy a large enough margin. This is done by removing the ability of retailers to undercut each other below a price set by the incumbent—that is, precisely the point of minimum RPM. Hence, minimum RPM is all the incumbent need use to exclude the entrant.

4.1 The distortionary effect of exclusionary RPM

In this setting, the efficiency cost of an exclusionary minimum RPM agreement comes from two sources.

First, there is the productive efficiency loss from having a low-cost manufacturer excluded from the market. In the baseline model, above, the per-period loss in producer surplus from this exclusion is $(c_i - c_e)\, q\,(c_i)$.

The second source of inefficiency is due to a loss of consumer surplus. As argued in the paragraphs leading to Lemma 1, the retail price of the good, if entry occurs, is given by c_i. In examining the possibility of foreclosure, Proposition 1 determines when exclusion is feasible. However, as long as the condition in Proposition 1 is met, there could be many equilibria where entry is foreclosed. In all reasonable equilibria, however, the retail price for the good is given by p_i^m, with multiplicity arising from the differences in the division of producer surplus between manufacturer and retailers, via the choice of the wholesale price.[35] Thus, the second source of welfare loss is the difference in consumer surplus generated at $p = p_e^m$ and $p = c_i$ that is not captured by the incumbent as part of its monopoly rent.

[35] Formally, there may be other (unreasonable) equilibria that arise from the multiplicity and coordination among retailers discussed in Section 4. For example, all retailers may play the (perverse but) equilibrium strategy to deny entry only if the incumbent sets a retail price $(p_i^m - k)$ for some constant k low enough. Then, the incumbent would impose a price of $(p_i^m - k)$ using RPM. We argue that the sort of equilibrium selection process that is required by such an equilibrium is unconvincing. In any case, it does not undermine our main point: that RPM can support exclusionary equilibria.

Thus, the efficiency loss from exclusionary RPM, in the baseline model of Section 3, is given by

$$\text{RPM Welfare Cost} \;=\; \frac{1}{1-\delta}\left[\int_{c_i}^{p_i^m}\left[q\left(x\right)-q\left(p_i^m\right)\right]dx+\left(c_i-c_e\right)q\left(c_i\right)\right]-F_e>0. \tag{5}$$

4.2 The range of exclusion

Next, we turn our attention to the range of costs that can be excluded using minimum RPM in this manner. The upper bound on this range is given by Corollary 1 above. That is, if $\frac{1}{1-\delta}\geq n$, then the range of excluded costs is $[\underline{c}_e,\overline{c}_e]$, where $\overline{c}_e=c_i$. To articulate the lower bound, the value of F_e needs to be fixed. To examine the size of a 'smallest' range of exclusion, we set $F_e=0$.

Corollary 2 *Provided that* $\frac{1}{1-\delta}\geq n$*, the lowest marginal cost able to be excluded,* $\underline{c}_e$*, is implicitly defined by*

$$\frac{1}{1-\delta}\left(p_i^m-c_i\right)\frac{1}{n}q\left(p_i^m\right)=\left(p_e^m-c_e\right)q\left(p_e^m\right)+\frac{\delta}{1-\delta}\left(c_i-c_e\right)q\left(c_i\right). \tag{6}$$

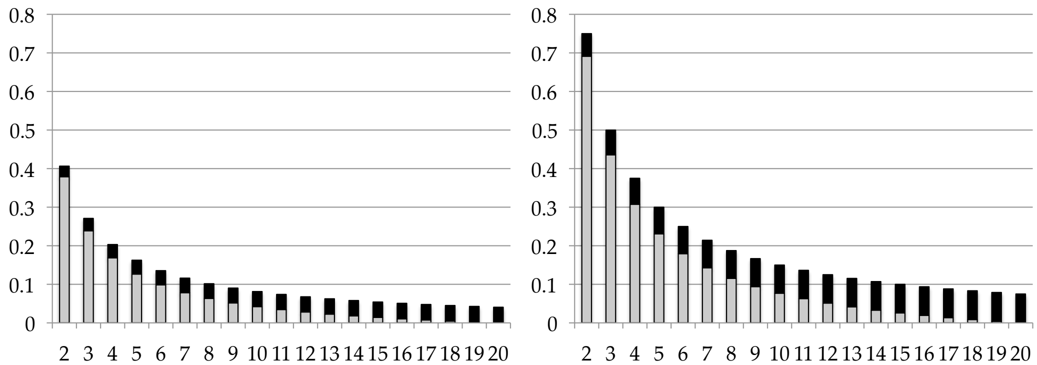
The expression in Corollary 2 is perhaps more useful via the derivation of a bound on $\underline{c}_e$. Note that

$$\begin{aligned}\frac{1}{1-\delta}\left(p_i^m-c_i\right)\frac{1}{n}q\left(p_i^m\right) &= \left(p_e^m\left(\underline{c}_e\right)-\underline{c}_e\right)q\left(p_e^m\left(\underline{c}_e\right)\right)+\frac{\delta}{1-\delta}\left(c_i-\underline{c}_e\right)q\left(c_i\right)\\ &\geq \left(p_i^m-c_i\right)q\left(p_i^m\right)+\frac{\delta}{1-\delta}\left(c_i-\underline{c}_e\right)q\left(c_i\right),\end{aligned}$$

which can be rearranged to yield

$$\left(c_i-\underline{c}_e\right)\leq\frac{\left(p_i^m-c_i\right)}{n}\frac{q\left(p_i^m\right)}{q\left(c_i\right)}. \tag{7}$$

The empirical utility of this bound lies in the fact that it uses only information about the incumbent firm. That is, it is based on information that is potentially estimable using observable price and quantity data.



Notes: The horizontal axis is the number of retailers in the market. The vertical axis is the difference between $c_i = 4$ and either the exact measure of $\underline{c}_e$ (the grey column; $c_i - \underline{c}_e$) or the upper bound computed using Equation (7) (grey and black columns combined). The left panel is constructed using the demand specification $\log(q) = 5.6391 - \frac{7}{3}\log(p)$, while the right panel is constructed using the demand specification $q = 10 - p$. The marginal cost of the incumbent is set equal to 4. The demand specifications generate the same monopoly price and quantity for the incumbent. We have set $\delta = 0.95$, which results in exclusion being impossible if the number of retailers is greater than 20 (see Corollary 1).

Figure 3: The interval of excluded costs, and the bound.

A sense of the extent to which exclusion is possible from RPM can be obtained from Figure 3, which compares the exact range of the excluded costs of the entrant for two parametrizations of the model, as the number of retailers changes. The panel on the left is computed using a constant elasticity demand curve, while the right uses a linear specification. The specifications are generated so that the incumbent's monopoly price in both settings is the same. The marginal cost of the incumbent is equal to four. The grey column shows the exact value of $c_i - \underline{c}_e$ given that $c_i = 4$, while the black interval shows the margin between the exact measure and the upper bound computed using equation (7).

The simulations suggest that the range of costs that can be excluded is sufficiently large as to be economically meaningful. In the specification on the left (which uses a constant elasticity demand specification), when there are two, five, and ten retailers, the range of excluded costs is 10.2, 4.1, and 2.0 percent of the incumbent's marginal cost, respectively. In the specification on the right (which uses a linear demand specification), the corresponding range of excluded costs is 18.8, 7.5, and 3.8 percent of the incumbent's marginal costs. Recall that these simulations assume that there are no fixed costs of entry and, so, these likely underrepresent the extent of possible exclusion.

Particularly in markets where there are relatively few retailers and, hence, where the exclusionary potential of a minimum RPM agreement is greatest, the bound appears to be useful. When there are only two retailers, the additional range indicated by the bound is seven and eight percent of the length of the true interval, for the constant elasticity and linear specifications, respectively.

5 Relaxing the Markov assumption

The structure of the baseline model sets a particular model of competition post entry: competition in the style of one-period Nash in the C state. Examination of Condition (4) in Proposition 1 makes it clear that the view the modeler takes of competition post-entry will have an impact on the range of exclusion that is possible. The Markov Perfect Nash Equilibrium assumption, given the structure of our state space, does the job of restricting us to this simple competitive equilibrium post entry.

Relaxing the MPNE assumption makes the equilibrium set, post-entry, become much bigger. In analyzing any potentially exclusionary scenario then, the analysis has to take a view as to what competition, post–entry looks like—that is, select a particular equilibrium from this set. Our baseline model adopts the post entry equilibrium that we view as the simplest, most widely appropriate, and most commonly applied notion of equilibrium (at least in empirical work): static Nash (for an overview see Ackerberg et al (2007)).[36]

However, in some settings there may be evidence to suggest that other forms of post entry equilibrium may be appropriate (for instance, drawing the analogy to merger analysis, if strong evidence supporting some sort of coordinated effects were present.) Different post-entry equilibria rely on the dynamic nature of the game and build on more involved dynamic strategies. While these are familiar to the industrial organization economist, in practice they may require greater co-ordination on the part of market participants in coalescing expectations around this equilibrium play, and it may be relatively difficult to establish such an equilibrium.[37] Indeed, our structure suggests that an incumbency advantage is

[36] Where empirical work in IO has explicitly taken into account dynamics, it has tended to be in a MPNE framework (Doraszelski and Pakes (2007) and Ackerberg et al (2007)). Even in these settings pricing is often assumed to be resolved according to static Nash, and dynamics enter through investment decisions (see for example, Collard-Wexler (2011)).

[37] We argue here intuitively, but one way to think about comparing different equilibria is by their com-

obtained from the notion that the exclusion equilibrium in the baseline model is relatively simple, insofar as equilibrium play depends only on the market structure.

In this section, we relax the MPNE assumption and allow for different possible equilibria in the post-entry game. First, the entrant and the retailers could try to exclude the incumbent in much the same way the incumbent excludes the entrant in the baseline model. Second, we might imagine that the incumbent accommodates entry and the manufacturers collude post-entry. Lastly, the retailers may collude. We consider each of these three cases in the following subsections, and show that, in each case, exclusion of the entrant by the incumbent, via RPM, may still occur.

5.1 Post–entry exclusion of the incumbent

In this section we consider the ability of an entrant to induce exclusion of the incumbent, should entry occur. To do this we have to both relax the MPNE assumption and also relax the assumption in the baseline model that, once entry occurs, a firm can always get retail access (that is, retailer accommodation also carries with it some form of longterm agreement to stock the product).[38]

The analysis proceeds in a series of steps. First, we derive the equilibrium play when both the entrant and the incumbent are active in the market (analogous to play in the state C). Then we examine how this post-entry play impacts the ability of the incumbent to exclude an entrant.

We consider play post-entry in which the entrant offers a contract $(\tilde{p}_e, \tilde{w}_e)$ to each retailer, if all retailers excluded the incumbent in the previous period (or if entry by the entrant occurred). If a retailer does not exclude the incumbent in the previous period, the game reverts to the equilibrium described in Lemma 1 (in which the retailers get zero rents).

For such a contract to induce exclusion of the incumbent, it must be the case that no individual retailer wishes to deviate. The benefit to deviating is that a retailer can expect to get a share in the profits earned by the incumbent in the deviation period. Since the incumbent gets zero profit if it is excluded, the incumbent is indifferent between being

plexity. For example, it may be possible to consider the minimal number of states required by a finite-state automaton used to replicate the equilibrium strategy, along the lines of Rubinstein (1986).

[38] We ignore the possibility of any liquidated damages that the incumbent may be able to recover from retailers who breach a wholesale agreement. We speculate that, following Aghion and Bolton (1987) or Simpson and Wickelgren (2007), that such an agreement could be to the ultimate advantage of the incumbent, by making it costly for the retailers (and hence entrant) to exclude.

excluded and giving a deviating retailer all the profits earned in the deviating period. Hence, the maximum a deviating retailer could expect to earn by deviating is determined by the profit earned on the incumbent's good in the period in which it gets access to the market. The gain to a retailer from not deviating is the net present value of the profits afforded to them by complying with the entrant's RPM-like strategy. This gives the following condition for exclusion of the incumbent by the entrant following entry, given a set of prices $(\tilde{p}_e, \tilde{w}_e)$:

$$\frac{1}{1-\delta}\frac{1}{n}\left(\tilde{p}_e - \tilde{w}_e\right) q\left(\tilde{p}_e\right) \geq (\tilde{p}_e - c_i) q(\tilde{p}_e) \tag{8}$$

It should be noted that the entrant may choose not to try to induce exclusion if the profit from doing so is less than the profit from just accommodating entry. That is, it is individually rational for the entrant to induce exclusion, given a set of prices $(\tilde{p}_e, \tilde{w}_e)$, if:

$$\left(\tilde{w}_e - c_e\right) q\left(\tilde{p}_e\right) \geq (c_i - c_e) q(c_i) \tag{9}$$

The optimal price for the entrant to choose is given by maximizing the entrant's profits with respect to $(\tilde{p}_e, \tilde{w}_e)$, subject to the above two constraints. That is,

$$\tilde{p}_e^* = \arg\max_{(\tilde{p}_e, \tilde{w}_e)} \left(\tilde{w}_e - c_e\right) q\left(\tilde{p}_e\right) \qquad \text{s.t. } (8) \text{ and } (9)$$

imposing equality on equation (8) and noting that equation (9) holds with equality when $\tilde{p}_e = c_i$, allows the program to be reduced to solving

$$\tilde{p}_e^* = \arg\max_{\tilde{p}_e \geq c_i} \left(\tilde{p}_e - c_e\right) q\left(\tilde{p}_e\right) - (1-\delta) n \left(\tilde{p}_e - c_i\right) q\left(\tilde{p}_e\right). \tag{10}$$

Note that the optimal $\tilde{p}_e$, denoted $\tilde{p}_e^*$, will be less than p_e^m, the entrant's monopoly price.[39]

This completes the characterization of play following entry when the entrant seeks to exclude the incumbent. In what follows we assume that this play occurs following entry and investigate whether there exists scope for the incumbent to still induce the exclusionary style equilibrium we discuss in the baseline model. Proposition 1 can be adjusted as follows to account for the different pattern of play post–entry.

[39] When the incumbent excludes the entrant in the baseline model, the incumbent's retail price is p_i^m. The different pricing behavior by the entrant in this analogous situation is a function of the concavity of the profit function coupled with the observation that $c_i > c_e$ implies $p_i^m > p_e^m$.

Proposition 2 *Suppose that* $\frac{1}{1-\delta}\frac{1}{n} > 1$*. Then an exclusionary equilibrium (one in which the entrant does not enter) exists if and only if*

$$F_e + \frac{1}{1-\delta}\frac{1}{n}(p_i^m - c_i)q(p_i^m) \geq (p_e^m - c_e)q(p_e^m) + \frac{\delta}{1-\delta}\left[(\tilde{p}_e^* - c_e)\, q\,(\tilde{p}_e^*) - (1-\delta)(n-1)\,(\tilde{p}_e^* - c_i)\, q\,(\tilde{p}_e^*)\right] \tag{11}$$

Note that the difference between the proposition above and Proposition 1 is that the continuation value post-entry is changed to take into account the possibility of exclusion of the incumbent by the entrant, and the profits to the entrant and retailers associated with doing that. The expression in square brackets captures the entrant's flow profit from exclusion, net of transfers to retailers needed to effect the exclusion, together with the individual retailer's flow profit in this regime.

In general, as one would anticipate, Condition (11) is a more stringent condition than the analogous Condition (4) in Proposition 1 where post-entry play is Nash. This follows since post-entry collusion between retailers and the entrant allow for greater industry profits that can be shared through an RPM scheme between the entrant and retailers. However, the constraints (8) and (9) on this collusion, together with potentially high fixed costs that the entrant must pay to enter, suggest that there is still room for the incumbent to exclude the entrant. It is easily verified by example. For instance, taking the parameter values in Figure 3, where demand is $q = 10 - p$, $\delta = 0.95$ and the marginal costs are $c_i = 4$ and $c_e = 1$, then, supposing that there are two retailers, the incumbent can use RPM to foreclose entry by an entrant for all values of $F_e \in [308.6, 360]$.[40]

5.2 Manufacturer collusion

We keep the retail sector as in the baseline model (i.e., competitive) and consider collusion among manufacturers post-entry. In doing so, we consider the scenario suggested by the cartel formed by Arbuckle and the American Sugar Company following Arbuckle's entry. The question we ask is: Under what conditions would an incumbent prefer to exclude an entrant when colluding post-entry is an option?

One form of manufacturer collusion would involve the entrant simply paying off the incumbent for not producing at all. This is essentially an acquisition. Since we have assumed, so far, that the entrant (for whatever reason) cannot buy out the incumbent, we consider a

[40]Note that the upper bound on the fixed cost here is the one assumed throughout. Beyond this level the entrant would not enter in a competitive market regardless of an incumbent's use of RPM.

different form of collusion. We consider collusion in which the manufacturers cannot make explicit lump-sum payments to each other (that is, no sidepayments). Given this restriction, and retaining the assumption that the retail sector plays single-stage Bertrand, this means that collusion is brought into effect by splitting the market in some way between the entrant and incumbent (Harrington (1991) investigates the same cartel problem).

Specifically, we assume that the entrant and incumbent collude on the price and the quantity that each provides to the market.[41] Hence, the collusive agreement is over $< q_e, q_i >$ where the total market quantity, q, is equal to $q_i + q_e$, and the market price is $p(q)$. Employing a grim-trigger-strategy equilibrium, a collusive market split following entry must satisfy the following condition for the entrant (with an analogous condition for the incumbent):[42]

Entrant's cooperation condition if $p(q) < p_e^m$:

$$q_e [p(q) - c_e] \geq (1 - \delta) q [p(q) - c_e] + \delta (c_i - c_e) q(c_i) \tag{12}$$

Entrant's cooperation condition if $p(q) \geq p_e^m$:

$$q_e [p(q) - c_e] \geq (1 - \delta) q (p_e^m) [p_e^m + c_e] + \delta (c_i - c_e) q(c_i) \tag{13}$$

The entrant's cooperation condition says that, if cooperation occurred in previous rounds, the entrant will continue to cooperate (in which case, the return in each period is their quantity allocation multiplied by the margin they earn) as long as the continuation value from deviating is less than the return from cooperating. The continuation value under a deviation is the one-period opportunity to just undercut the cartel price and meet total market demand at that price, followed by profits in the stage game (as per Lemma 1) thereafter.

Faced with these conditions, there is a range of $< q_e, q_i >$ combinations that the manufacturer cartel can support. Lemma 3 below states an upper bound on the profit the incumbent can earn in the incumbent-optimal cartel.

Lemma 3 *An upper bound on what an incumbent can earn per period from colluding with an entrant is:*

[41] For an empirical analog, consider the lysine cartel described in de Roos (2006).

[42] Here, consistent with our approach in Section 4, we restrict attention to strategies that are not weakly-dominated; that is, we suppose that the incumbent does not set a price below c_i. For an interesting analysis of collusion with asymmetric firms that does not impose such a constraint, see Miklos-Thal (2010).

$$\pi^{Collude} = \delta q\left(p_e^m\right)\left(p_i^m - c_i\right) - \delta\left(c_i - c_e\right) q\left(c_i\right) \frac{\left(p_i^m - c_i\right)}{\left(p_e^m - c_e\right)}$$

This bound is tight when $c_i = c_e$.

This bound is constructed by observing that the incumbent-optimal collusive agreement involves setting a price between p_e^m and p_i^m, with the incumbent's quantity set by making the entrant's cooperation condition bind. The bound is reached by setting the collusive price equal to p_i^m, but with the the quantity supplied by the industry as a whole consistent with a price of p_e^m (and noting that the incumbent's quantity is decreasing in the price in this range).

It follows from Proposition 1 that a tight upper bound on the profit that an incumbent can enjoy in excluding an entrant is

$$\pi^{Exclude} = \left(p_i^m - c_i\right) q\left(p_i^m\right) - n\left[\left(1-\delta\right)\left(p_e^m - c_e\right) q\left(p_e^m\right) + \delta\left(c_i - c_e\right) q\left(c_i\right)\right] + \left(1-\delta\right) nF_e.$$

On the assumption that the incumbent can get its optimal surplus under either scheme, we can understand when the incumbent might prefer to exclude, rather than accommodate and collude, by comparing $\pi^{Exclude}$ and $\pi^{Collude}$.[43]

Examination of these conditions suggests that exclusion is attractive when entrants have low marginal costs, but high fixed costs. To see this, consider two polar cases, first the case where $c_e = c_i$. In this instance, the (best-case) return from collusion is $\delta\left(p_i^m - c_i\right) q\left(p_i^m\right)$, while the (best-case) return from exclusion is $\left(n\delta - 1\right)\left(p_i^m - c_i\right) q\left(p_i^m\right)$, which is always strictly less than the return from collusion, except when $\delta = 1$ and $n = 2$.[44] Next, consider the case where c_e is so low that $p_e^m = c_i$, but the fixed cost is so high as to make entry marginal in a competitive environment (that is, $F_e = \frac{1}{1-\delta}\left(c_i - c_e\right) q\left(c_i\right)$). In this instance, the incumbent's collusive return is equal to zero, while the exclusionary return is equal to the incumbent's monopoly profit.

The underlying force at work is that the entrant can not credibly commit to give the incumbent a high collusive rent. Indeed, once entry has occurred and the fixed cost is sunk, a low-cost entrant requires a high proportion of market quantity to be induced to cooperate in a collusive agreement since the difference between the collusive payout and the competitive payout is comparatively small. Any commitment to give the incumbent a

[43] One reason to prefer one over the other is the relative ease of coordinating exclusion and collusion. In this subsection we ignore this consideration.

[44] Recall that fixed costs are assumed to be low enough to allow entry when the market is competitive, when $c_i = c_e$ that implies $F_e = 0$.

large share of any subsequent agreement would not be credible in the face of the temptation to deviate. However, prior to the fixed cost being sunk, it can be cheap for the incumbent to exclude the entrant since the fixed cost offsets much of the rent that the entrant might expect to earn post entry (and this reduces how much the entrant can afford to compensate retailers for accommodating).

Lastly, note that this argument was developed for the case where the incumbent faces a single potential entrant. If the incumbent were to face many entrants, then exclusion would continue to be equally effective, while accommodation and subsequent collusion would become a markedly less attractive option. Thus, relative to manufacturer collusion, exclusion becomes more likely as potential entrants become more numerous.

5.3 Retailer collusion

We now turn to the possibility of the retailers forming a cartel in the product market, while the manufacturers set the wholesale price competitively.[45] The retail cartel we have in mind is supported by standard grim-trigger strategies in a repeated game. Figure 4 depicts the market following entry, when the retailers collude in the product market. The retailers act like a monopolist, taking the wholesale price as given. Since the entrant has the lower marginal cost, the outcome of competition (as in Lemma 1) is that the entrant serves the wholesale market. However, the monopoly distortion coming from the retailers means that some quantity less than $q(c_i)$ gets demanded. That is, we observe standard double marginalization. The amount transacted will either be $q(p_i^m)$, if the entrant charges a wholesale price of c_i, or some quantity $\tilde{q}$, if it is profitable to drop the wholesale price to induce the retail cartel to sell more quantity.

Regardless of the actual wholesale price the entrant sets, the entrant's profit is less than that described in Lemma 1 when everyone competes. That is, if everyone competes, the entrant's post-entry, per-period, profit is represented by rectangle ABFE. However, if the entrant charges a wholesale price of c_i, profits are ABCD, and if the entrant charges a wholesale price of $\tilde{p} < c_i$, then profits are GBJH.

Hence, if the fixed costs of entry are sufficiently high, such that $(1-\delta)F_e$ is greater

[45] Another scenario might be that the retailers also use a repeated game mechanism to extract more-favorable terms from the manufacturers, wherein the threat to manufacturers might be to not stock the product. This could occur in combination with product-market collusion. Examining this case, which seems interesting and important, involves a substantial modeling exercise beyond the scope of this paper. We are unaware of any papers that consider a retail sector colluding to extract rents from upstream manufacturers and consumers simultaneously.

than the post-entry, per-period profit when the retail cartel operates, then the entrant will not enter. This, of course, is good news for the incumbent. Indeed, the presence of the retail cartel can ensure that the incumbent need not expend resources on exclusion, whether via RPM or otherwise. Instead, the only problem the incumbent faces is how to mitigate the damage caused by the double-margin distortion imposed on its profits by the retailer cartel. If maximum RPM is available, then this is an easy contractual solution (set $w_i = p_i = p_i^m$). In the absence of maximum RPM, the incumbent still enjoys profits, and possibly more than if it had to use RPM as an exclusionary device.

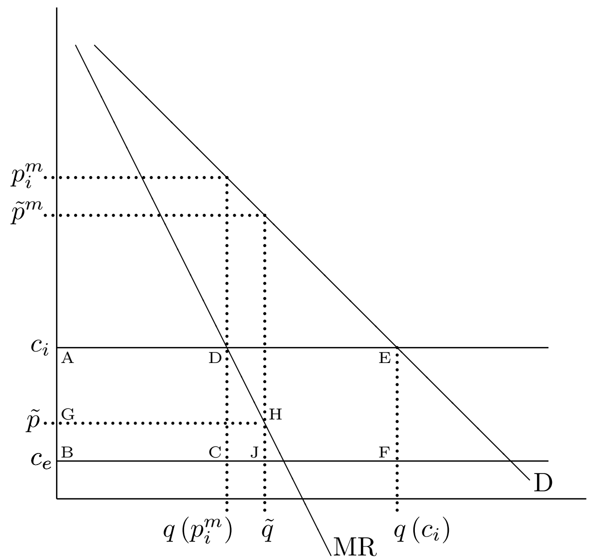


Figure 4: Pricing by a retailer cartel and the entrant's wholesale price response.

An important point is that the cartel suffers from not having the entrant in the market, since, with the entrant active, the wholesale price must decrease. This raises the question of why the retail cartel does not accommodate entry. The problem is that retailers are unable to commit to not colluding post-entry, and, hence, even if they are keen to accommodate the entrant, the entrant will stay away. Faced with this commitment problem, the retailers might be able to subsidize entry using a lump-sum transfer or increase their ability to commit to not colluding by using antitrust regulators and inviting regulatory scrutiny via, say, whistle-blowing behavior. Of course, either of these measures involves costs on the part of the retailers and, depending on the parameters, may not be worthwhile.

Hence, collusion by the retailers in the product market creates a series of problems that can work to the incumbent's advantage. Indeed, in the case illustrated here, it can remove the need for minimum RPM as an exclusionary device altogether. Instead, maximum RPM becomes useful for the incumbent to mitigate the distortion caused by the cartel, resulting in highly profitable exclusion.[46]

6 Differentiation

Our baseline model is deliberately stark and simple in order to aid the presentation; however, the intuitions and economic forces apply more generally. In particular, in this section, we extend it first by allowing for differentiation between the incumbent and entrant manufacturers in Section 6.1, and then by allowing for differentiation among the downstream retailers in Section 6.2. These extensions not only show the robustness of our central result—that RPM can be used for upstream exclusion—but also provide additional insight in highlighting that stiffer competition (through greater substitution at either the upstream or the downstream market) has subtle and non-monotonic effects.[47]

In order to provide analytic results, we consider firms that are differentiated along a Hotelling line with uniformly distributed consumers; however, first, we step back from the modeling details and highlight that, analogous to the baseline model, we can consider whether the incumbent can profitably exclude an entrant by breaking down the problem to characterizing the maximal static profits under the different possible market structures: (i) where the incumbent is a monopolist, (ii) in a period where a retailer accommodates the entrant, and (iii) in post-entry competition between the incumbent and entrant, where the entrant will be serving all retailers. We denote the per-period retailer profits under the most generous RPM arrangement that the incumbent can profitably offer by π_r^{RPM}; the payoffs to retailers and the entrant in a post-entry period by π_r^{post} and π_e^{post}, respectively; and the maximal combined payoffs for the entrant and accommodating retailer, in a period in which the entrant is accommodated by π_{ac}^m.[48]

[46] When two manufacturers are present, reasoning analogous to that used in Lemma 1 implies that maximum RPM ceases to be useful.

[47] Another extension would be to consider two differentiated incumbent manufacturers, and investigate their incentive to exclude. As should be clear, the basic mechanism will persist should the incumbents be sufficiently differentiated.

[48] Note that in the baseline model, $\pi_r^{post} = 0$ since in that model retailers are homogeneous and compete in prices. Instead, when we allow for differentiated retailers, below, $\pi_r^{post} > 0$.

Following the logic of the baseline model, there is an equilibrium where the incumbent can foreclose entry using RPM whenever every retailer prefers to continue with the most generous RPM arrangement rather than to accommodate the entrant even under the most generous terms that the entrant can offer (which involves transferring all of π_{ac}^m and the net present value of its post-entry profits net of fixed entry costs). It is convenient for presentation to assume that entry costs are equal to zero, in which case there is an equilibrium with entry foreclosure as long as $\frac{1}{1-\delta}\pi_r^{RPM} > \pi_{ac}^m + \frac{\delta}{1-\delta}\pi_e^{post} + \frac{\delta}{1-\delta}\pi_r^{post}$ or, equivalently,

$$\pi_r^{RPM} > (1-\delta)\pi_{ac}^m + \delta(\pi_e^{post} + \pi_r^{post}). \tag{14}$$

6.1 Upstream differentiation

In this section, we extend the baseline by allowing for differentiation between the incumbent and entrant manufacturers. We suppose that retailers are undifferentiated and allow retailers to stock both of the upstream products. Clearly, a little differentiation has little impact on the foreclosure condition in (14), as compared to the baseline model; however, in this section, we also highlight that as differentiation increases, Condition (14) changes in important ways, and it can become either more or less difficult to satisfy.

First note that, as in the baseline case, $\pi_r^{post} = 0$ since there is Bertrand competition among retailers. In the post-entry game (state C), all retailers can stock both types of product, and Bertrand competition leads all retailers to price each product at the wholesale price and so erode all their profits. Also, note that differentiation between the entrant and the incumbent has no impact on profitability if the entrant is absent from the market; that is, π_r^{RPM} is independent of the degree of differentiation.

It follows that differentiation affects the foreclosure condition (14) only through its effect on π_{ac}^m and π_e^{post}. It is sufficient to consider π_e^{post} (and δ close to 1) to gain intuition for why differentiation can have non-monotonic effects on Condition (14). More differentiation can either increase or decrease the entrant's post-entry profits: If the entrant is much more efficient than the incumbent, then it may prefer little differentiation, as this would allow it to poach the incumbent's customers cheaply; instead, if the entrant and incumbent are competing on relatively level terms, then differentiation will weaken price competition in the post-entry game, and so increase the entrant's profits. That is, depending on the differences in costs, the entrant may either prefer to grab the entire market for a low price, or some of the market for a relatively high price.

These intuitions can be analytically illustrated by formally modeling and parameterizing the extent of differentiation between the incumbent and entrant manufacturers. We do so by adopting a standard Hotelling framework, where final consumers have preferences that are uniformly distributed along a line of length 1. The incumbent is located at 0, and the entrant is located at $\alpha \in [0,1]$ along the line. Consumers face quadratic transport costs in consuming a product that is not at their ideal location; specifically, a consumer who is located at x gains net utility $A - x^2 - p_i$ from purchasing from the incumbent at price p_i and gains $A - (\alpha - x)^2 - p_e$ from purchasing from the entrant at price p_e. We suppose that A is sufficiently high that the market is always covered by a monopolist.

The available strategies and the timing of the game are identical to those considered in our baseline model, and the analysis proceeds in a similar fashion. The characterization of profits is a little more involved than in the baseline case, and we summarize the results in Lemma 4. Its proof is somewhat mechanical and appears in the Appendix. We assume throughout that the market is fully covered (which, here, requires that $A > 3 + c_i$).

Lemma 4 *Maximal profits under different market structures are given by* $\pi_r^{RPM} = \frac{A-1-c_i}{n}$, $\pi_{ac}^m = A - 1 - \alpha^2 - c_e$, $\pi_r^{post} = 0$ *and* $\pi_e^{post} = \left\{ \begin{array}{ll} \frac{1}{18}\frac{\left(4\alpha - c_e + c_i - \alpha^2\right)^2}{\alpha} & \textit{if } \alpha(2+\alpha) > c_i - c_e > \alpha(2-5\alpha) \\ c_i - c_e - \alpha^2 & \textit{otherwise} \end{array} \right\}$.

Lemma 4 allows us to populate Condition (14). In particular, it allows us to show that entry can be excluded when the upstream manufacturers are differentiated and that differentiation (greater α) can have a non-monotonic impact on the incumbent's ability to exclude the entrant. Confirming the general intuition discussed above that differentiation may either increase or decrease post-entry profits, depending on whether competition-softening or business-stealing dominate, it is immediate, following the characterization in Lemma 4, that if $c_i >> c_e$ then $\frac{d}{d\alpha}\pi_e^{post} = -2\alpha$; instead, consider the case $c_i = c_e$ and $\alpha > \frac{2}{5}$, then $\frac{d}{d\alpha}\pi_e^{post} = \frac{(4-3\alpha)(4-\alpha)}{18} > 0$.[49] Since $\frac{d}{d\alpha}\pi_r^{RPM} = 0$ and δ can be taken arbitrarily close to 1, α need not have a monotonic effect on the foreclosure condition (14).[50]

[49] Note that the incumbent and the entrant are asymmetric here, and the entrant, even if enjoying the same marginal cost, has an advantage in being more centrally located in terms of preferences. Thus, there is an effect here that the entrant prefers lower differentiation, as this reduces transport costs for the (uncontested) consumers to its right.

[50] For completeness, note that $\frac{d\pi_{ac}^m}{d\alpha} = -2\alpha < 0$. Since, in the period of entry, the incumbent enforces the high monopoly RPM price, and so the key effect is a business-stealing effect whereby the entrant seeks to undercut the incumbent and can do so more profitably the less differentiated are the products.

In other words, if firms value the future highly, and if cost differences are large enough to make the entrant want to claim the entire market post-entry (business stealing), then more differentiation leads to a lower price being needed to ensure full market capture. In this instance, differentiation makes exclusion easier because profits post-entry are reduced. However, if cost differences are small, leading to market segmentation, then differentiation makes exclusion harder, as competition in the post-entry subgame is softened (competition-softening). This increases post-entry profits, making exclusion harder to implement.

6.2 Downstream differentiation

In this section, we revert to our baseline case in assuming that the entrant and incumbent sell goods that are homogeneous from the consumers' perspective, but allow for differentiation among retailers, again employing the Hotelling framework.

Specifically, we now suppose that there are only two retailers located on a line of length 1. We maintain symmetry between the retailers and allow for greater or lesser substitution between them by supposing that the retailers are located at a distance β from the half-way point on the line; one retailer, L, lies to the left (at $\frac{1}{2} - \beta$) and the other, R, to the right (at $\frac{1}{2} + \beta$) where $0 \leq \beta \leq \frac{1}{2}$. Again, we suppose that transport costs are quadratic so that a consumer, located at x, gains net utility $A - (x - \frac{1}{2} + \beta)^2 - p_L$ from purchasing from the retailer on the left at price p_L and gains $A - (x - \frac{1}{2} - \beta)^2 - p_R$ from purchasing from the retailer on the right at price p_R. We suppose that A is sufficiently high that the market is always covered by a monopolist.

As in Section 6.1 and our baseline model, entry is deterred as long as the foreclosure condition (14) is satisfied. The analysis is slightly more involved in this case insofar as differentiation among the retailers implies that in the absence of RPM, and in any post-entry subgame, retailers would earn positive profits; that is, $\pi_r^{entry} \neq 0$.[51] We begin by characterizing properties of π_r^{entry} and other relevant profits and relegate the proofs to the Appendix.

Lemma 5 *In the downstream differentiation case when A is sufficiently high that the market is fully covered, then the entrant's post-entry profits are independent of the extent of*

[51] We suppose that once the entrant has been accommodated by a single retailer, then in the post-entry game (state C) both retailers use the entrants good. This follows, as once entry occurs the non-accommodating retailer is faced with procuring a homogenous good, and will take the best terms, which by construction are available from the entrant. See the proof for additional detail.

downstream differentiation ($\frac{d\pi_e^{post}}{d\beta} = 0$)*; retailers' post-entry profits are strictly increasing in the extent of differentiation* ($\frac{d\pi_r^{post}}{d\beta} = 1$)*; accommodating profits are decreasing in the extent of differentiation* ($\frac{d\pi_{ac}^m}{d\beta} < 0$)*; and the retailers' profits with only the incumbent and RPM can either be increasing or decreasing in the extent of differentiation* ($\frac{d\pi_r^{RPM}}{d\beta} = -\beta < 0$ *if* $\beta > \frac{1}{4}$ *and* $\frac{d\pi_r^{RPM}}{d\beta} = \frac{1-2\beta}{2} > 0$ *if* $\beta < \frac{1}{4}$).

The directions of these comparative statics are intuitive. First, notice that π_e^{post} is independent of β, as differentiation among retailers does not affect the nature of manufacturer competition (where products are undifferentiated). Post-entry profits for retailers increase if there is more differentiation ($\frac{d\pi_r^{post}}{d\beta} = 1 > 0$); this is for the standard reason that differentiation softens the intensity of price competition. In considering the profits under accommodation, loosely speaking, the non-accommodating retailer has a fixed price, and so differentiation does not soften price competition; instead, the entrant and accommodating retailer prefer little differentiation in the period of accommodation, as the primary effect is that it is less costly to undercut the other retailer. Finally, profits under RPM, with only the incumbent active, may be increasing or decreasing in the extent of differentiation—an integrated monopolist would prefer that $\beta = \frac{1}{4}$ in order to minimize consumer transport costs, and so either more or less differentiation than this would decrease π_r^{RPM}.

Overall, with several effects in play, cases can be found where retailer differentiation makes it easier or harder to exclude an entrant. For δ close to 1, the effect through π_{ac}^m in Condition (14) is negligible; then, since $\frac{d\pi_e^{post}}{d\beta} = 0$, the only effects are through π_r^{RPM} and π_r^{post}. It is easy to verify that the effect through π_r^{post} dominates, and so more retailer differentiation makes it harder to exclude an entrant. Instead, for lower values of δ, more differentiation can make it easier to exclude an entrant; for example, this will always be the case when $\beta < \frac{1}{4}$ and δ is small enough since $\frac{d\pi_{ac}^m}{d\beta} < 0$ and $\frac{d\pi_r^{RPM}}{d\beta} > 0$ for $\beta < \frac{1}{4}$.

Note that earlier studies have shown that product differentiation can have subtle and ambiguous effects on firms' ability to collude (see Deneckere (1983), Chang (1991), and Ross (1992)). We find similar results here where RPM allows duopolist retailers to split monopoly profits, but a retailer can "deviate" by accommodating an entrant, though such deviation leads to the static Nash outcome of the competitive game (albeit one where the retailers are supplied by the more efficient entrant rather than by the incumbent). In this context, our results here are perhaps not surprising but worth highlighting, particularly, as policy-makers have highlighted the extent of competition as an important factor for determining whether RPM is likely to be harmful.

7 Policy implications

Antitrust practitioners and academic economists have long debated RPM (the OECD (2008) roundtable provides a wide-ranging discussion; Matthewson and Winter (1998) and Winter (2009) provide useful overviews).[52] Recognizing that "respected economic analysts . . . conclude that vertical price constraints can have procompetitive effects" (p.1), the U.S. Supreme Court, in its 2007 *Leegin* ruling, overturned the 1911 *Dr. Miles* decision that viewed RPM as a *per se* antitrust violation. Similarly, in the E.U., the 2010 Guidelines on Vertical Restraints allow parties to plead an efficiency defense under Article 101(3) (see p.63, paragraph 223). These new antitrust regimes, therefore, require antitrust authorities and other interested parties to trade off the consumer and social benefits of RPM against the possible harm. To this end, clearly articulated theories of harm are necessary.

It is interesting to note that both *Leegin* and the E.U. Guidelines on Vertical Restraints explicitly highlight that "a manufacturer with market power . . . might use resale price maintenance to give retailers an incentive not to sell the products of smaller rivals or new entrants" (*Leegin* p.894) and that "resale price maintenance may be implemented by a manufacturer with market power to foreclose smaller rivals" (p.64, paragraph 224). In contrast, most of the economics literature, perhaps due to a reasonable desire to explain why rule of reason might be more appropriate than *per se* treatment of RPM, has not focused on this possible cause of harm (see the literature discussed in Section 2 of this paper for exceptions). Thus, the absence of a formally-articulated theory has, perhaps, led to less attention to this cause than is warranted among some policy makers.[53]

In addition to reinforcing the idea that RPM can be used as a means of upstream exclusion, in presenting this formally-articulated theory of harm, we provide a counter-

[52]Our analysis, in line with much of the literature and policy discussion, is focused on minimum resale price maintenance. Extending the model to allow for asymmetric downstream firms can allow a role for maximum resale price maintenance (or price ceilings) in tandem with minimum resale price maintenance (price floors). For example, consider a downstream segmented market, where in one segment a monopolist dealer operates and in the other segment dealers are competitive. A price ceiling can overcome the usual double mark-up problem in the monopolized downstream market creating greater overall industry profits, while the use of resale price maintenance and wholesale prices allows the incumbent dealer to pass on some of these profits to the retailers in the competitive segment. However, note that for this channel to operate, the model would also need to be further extended— for example, allowing for the incumbent to operate with decreasing returns to scale.

[53]For example, the OFT's submission to the OECD roundtable (2008) does not address this cause of harm in outlining economic theories (pp. 204-207) nor does the United States' submission in its review of theories of anti-competitive uses (pp.218-9), and, more generally, there is no mention of exclusion at all in this 300-page OECD report.

point to some of the screens that have been suggested for determining legitimate uses of RPM. Policy makers (such as in the OECD (2008) roundtable) and commentators have suggested that antitrust authorities should distinguish between manufacturer- and retailer-initiated RPM. For example, the *Leegin* ruling (p.898), citing Posner (2001) states:

> It makes all the difference whether minimum retail prices are imposed by the manufacturers in order to evoke point-of-sale services or by the dealers in order to obtain monopoly profits.

In this context, it is worth highlighting that in the exclusion theory articulated above, both the incumbent dealer and retailers stand to gain from RPM, and either side might initiate RPM for the purpose of exclusion.

Similarly, while the importance of competition (or lack of it) is often stressed, our analysis suggests a nuanced view insofar as imperfect competition through differentiation can have ambiguous consequences for the possibility of exclusion, though our analysis clearly relies on some upstream market power. In particular, if the strength of competition between manufacturers (or retailers) is measured using cross-price elasticities, then increased competition may strengthen (or weaken) the potential for exclusion. Where our theory is unambiguous is in saying that, all things being equal, adding an extra retailer makes exclusion harder.

Our analysis highlights a necessary condition for RPM to be used to exclude an entrant manufacturer: It is critical that the entrant requires an accommodating retailer to compete; if it easy for an entrant to vertically integrate or otherwise deal directly with final consumers, there is no possibility of exclusion in our model. Similarly, another critical assumption in the model is that an incumbent manufacturer does not simply disappear post-entry, leaving the entrant and retailers to share monopoly profits; instead, the industry earns only duopoly profits if entry occurs, so that overall industry profits may be lower following entry, providing the possibility that the incumbent can use RPM to share surplus with retailers and foreclose entry.

Lastly, we show that when a monopolist uses RPM, antitrust harm can still emerge. In particular, in markets where the good sold is undifferentiated (such as—recalling the American Sugar Refining Company—sugar) and a dominant firm exists, the use of RPM can be a cause for concern. Existing efficiency-based theories of added service or anti-competitive theories of collusion facilitation have trouble with this setting, as neither fits the institutional setting.

Unfortunately, the above discussion suggests that many existing screens for the existence of harm deserve cautious application. Should concerns regarding exclusion be raised, the bound suggested in Section 4.2 might provide a useful first indication of whether the scope of possible exclusion is large enough to be problematic. This bound can be estimated by using standard methods (see Ackerberg et al. (2007)). The use of this bound may be helpful in much the same way that a simple Lerner index is helpful in the evaluation of market power. If there is little indication that exclusion would be large enough to matter in an economic sense, then existing screens are likely reasonable. Otherwise, the use of RPM by a manufacturer with considerable market dominance may warrant further inspection, where, perhaps, under current screens it would not.

8 Conclusion

This paper presents a formal model in which an incumbent manufacturer is able to exclude a more efficient entrant, by using minimum RPM to increase the profits of retailers in the event that they refuse to accommodate entry. This makes it prohibitively expensive for the potential entrant to enter. We formalize notions of exclusion due to RPM that have repeatedly surfaced in the economic literature, at least since the 1930s. The recent decision of the U.S. Supreme Court in *Leegin*, together with recent policy developments in Europe, has generated an increased need for theoretical and empirical work on how RPM may harm competition. This paper explores exclusion as a theory of harm by grounding it in a theoretical framework. This provides a foundation for further research in the area, both theoretical and empirical.

It is worth noting that, in our model, we explicitly restrict the use of lump-sum transfers. Indeed, only the entrant, via R, is able to use lump-sum transfers. In the case of the entrant, we do this since leaving the contract space unrestricted makes entry easier—if the entrant were unable to make such payments, then the range of exclusion would be greater (i.e., $R = 0$ by assumption). This makes our finding somewhat more robust. As is the case in all vertical contracting models, the choice of contract space is a difficult one, more guided by the application that is being explored than by a deep theory of contracting frictions. Here, our contracting space has been guided by a wish to understand the possible effects of minimum RPM.

Nevertheless, little in the model would change if the incumbent made lump-sum transfers rather than shifting surplus via minimum RPM.[54] Indeed, the basic structure of the model suggests that exclusionary effects could be generated by any pricing structure that has the effect of transferring industry profits from the incumbent to the n retailers. To see this, simplify the environment so that the manufacturer and entrant have exactly the same marginal cost, c, and fixed costs of entry are zero. In every other respect, keep things as they are in the baseline model, so that products are homogenous and retailers are perfect substitutes and bear no cost other than the wholesale price. Say the incumbent sets prices at or below the monopoly level such that it generates π in profits each period. To get full access to the market, all the entrant needs is one retailer to accommodate. This means that the most that an entrant can pay an accommodating retailer is one period's worth of π (since products are homogenous, by undercutting the incumbent the entrant can get all the industry profits in the period that he enters, and, due to Bertrand competition, prices go to marginal cost thereafter and everyone gets zero profits in future periods). The most that an incumbent would ever be able to transfer to a retailer to ensure exclusion is π/n per period. Hence, for the exclusionary equilibrium illustrated in this paper to exist we would need, for each retailer, the net present value of payments from the incumbent to be equal to or to exceed the one-shot payoff that an entrant could give. That is, we need

$$\frac{1}{(1-\delta)}\frac{1}{n}\pi \geq \pi,$$

which is satisfied when $n(1-\delta) \leq 1$. So when $\delta = 0.95$, $n \leq 20$ is required for exclusion to be feasible. Note that the profits π can be transferred to the retailers in many ways. In this paper, we focused on how RPM can be used to generate the transfer. However, revenue sharing agreements, slotting allowances, lump-sum transfers and other payment structures that allow profits to be shared between retailers and incumbent manufacturers will have the same basic effect.[55]

This observation is also reminiscent of the exclusive dealing literature (see Simpson and Wickelgren (2007) and the papers cited therein), in that these papers consider exclusivity contracts that are induced via lump-sum payments. The framework here suggests that such

[54] The basic contract could be implemented by setting $p_i = w_i = p_i^m$ and using the lump-sum transfer to shift surplus.

[55] A minor point is that, in the event one retailer does accommodate entry, a lump-sum transfer to the retailers would still be paid by the incumbent in the entry period. This makes exclusion slightly harder and also makes entry expensive for the incumbent. RPM or revenue sharing agreements do not have this quality, since the retailer's surplus is intrinsically linked to sales. Shaffer (1991) also interprets slotting fees as a period-by-period lump-sum transfer.

agreements may be able to be synthesized implicitly, by utilizing the promise of future rent transfers if exclusivity continues.

While in this paper we focus on the extent to which RPM, on its own, can be used to generate exclusion (absent an explicit contractual exclusivity restriction), it is easy to see how exclusivity provisions in an agreement between retailers and a manufacturer can reinforce, or be reinforced by, the exclusionary effect of an RPM contract. In practice one might consider exclusivity as giving explicit form to the agreement and, possibly, helping coordinate the equilibrium, while RPM may well render implicit force, especially in the face of uncertain enforceability of an exclusivity provision. To this extent, one might view RPM and exclusive dealing in some instances as being complementary exclusionary devices.

A Omitted Proofs

Proof of Lemma 3

Proof. The profit an incumbent could obtain from the incumbent-optimal collusive scheme is given by the solution to

$$\max_{q,q_i} (p(q) - c_i) q_i, \tag{15}$$

subject to the cooperation constraints of the incumbent and the entrant. We proceed by relaxing the constraint set and considering only the entrant's cooperation constraint. First we show that the incumbent-optimal cartel allocation occurs when q lies below $q(p_e^m)$.

Toward a contradiction, we assume that incumbent-optimal cartel allocation occurs when $p(q) < p_e^m$. The cooperation constraint of the entrant when $p(q) < p_e^m$ implies

$$q_i \leq \delta q - \frac{\delta (c_i - c_e) q(c_i)}{p(q) - c_e}. \tag{16}$$

Allowing the relaxed version of the above maximization problem to be written as (once it is observed that the cooperation constraint of the entrant must bind in the incumbent-optimal agreement)

$$\max_q \quad \frac{p(q) - c_i}{p(q) - c_e} (\delta q (p(q) - c_e) - \delta (c_i - c_e) q(c_i)), \tag{17}$$

which can be further rewritten as

$$\max_q \quad \overline{\pi}(q) \quad \equiv \quad \max_q \quad \frac{\pi_i(q)}{\pi_e(q)} (\pi_e(q) - \pi_e^c), \tag{18}$$

where π_e^c is the competitive profit of the entrant (that is, $(c_i - c_e) q(c_i)$).

Taking the derivative with respect to q yields

$$\begin{aligned} \frac{\partial \overline{\pi}(q)}{\partial q} &= \frac{\pi_i'(q)}{\pi_e(q)} (\pi_e(q) - \pi_e^c) + \frac{\pi_i(q)}{\pi_e(q)} \pi_e'(q) - \frac{\pi_e'(q) \pi_i(q)}{(\pi_e(q))^2} (\pi_e(q) - \pi_e^c) && (19) \\ &= \frac{\pi_i'(q)}{\pi_e(q)} (\pi_e(q) - \pi_e^c) + \frac{\pi_i(q) \pi_e^c}{\pi_e(q)^2} \pi_e'(q) && (20) \end{aligned}$$

.

Evaluating this derivative at any point in the interval $[q(p_e^m), q(c_i)]$ yields

$$\left.\frac{\partial \overline{\pi}(q)}{\partial q}\right|_{q\in[q(c_i),q(p_e^m)]} < 0, \tag{21}$$

where we have used the fact that, in this interval, $\pi_i'(q) < 0$ and $\pi_e'(q) \leq 0$. Hence, the optimal level of q lies below $q(p_e^m)$, establishing the contradiction.

As a consequence, the correct constraint to work with is

$$q_i \leq q - \frac{(1-\delta)\, q(p_e^m)[p_e^m - c_e] + \delta(c_i - c_e)\, q(c_i)}{[p(q) - c_e]}. \tag{22}$$

Following the same procedure as above, the incumbent-optimal q is the solution to

$$\max_q \quad \tilde{\pi}(q) \quad \equiv \quad \max_q \quad \frac{\pi_i(q)}{\pi_e(q)}\left(\pi_e(q) - (1-\delta)\,\pi_e^m - \delta\pi_e^c\right) \tag{23}$$

and,

$$\frac{\partial \tilde{\pi}(q)}{\partial q} = \frac{\pi_i'(q)}{\pi_e(q)}\left(\pi_e(q) - (1-\delta)\,\pi_e^m - \delta\pi_e^c\right) + \frac{\pi_i(q)\left((1-\delta)\,\pi_e^m + \delta\pi_e^c\right)}{\pi_e(q)^2}\pi_e'(q); \tag{24}$$

further,

$$\left.\frac{\partial \tilde{\pi}(q)}{\partial q}\right|_{q=q(p_e^m)} < 0 \quad \text{and} \quad \left.\frac{\partial \tilde{\pi}(q)}{\partial q}\right|_{q\in\left[0,q\left(p_i^m\right)\right]} > 0, \tag{25}$$

noting that (22) implies $q_i = 0$ if $\pi_e(q) \leq (1-\delta)\,\pi_e^m + \delta\pi_e^c$.

Hence, the optimal level of q lies in the interval $[q(p_i^m), q(p_e^m)]$. This leads to the conjecture that the incumbent's profit is bounded by the profits that accrue from setting $p = p_i^m$ and q_i equal to that implied by (22) when the inequality binds and $q = q(p_e^m)$. To convert this conjecture to a proposition, it must be established that q_i is greatest when $q = q(p_e^m)$, as compared to any other point in the interval $[q(p_i^m), q(p_e^m)]$.

Setting (22) to bind and taking the derivative of q_i with respect to q yields

$$\frac{\partial q_i}{\partial q} = 1 + \frac{(1-\delta)\, q(p_e^m)[p_e^m - c_i] + \delta(c_i - c_e)\, q(c_i)}{[p(q) - c_e]^2}\frac{\partial p(q)}{\partial q}. \tag{26}$$

From the first-order condition of the entrant's monopoly pricing problem, it must be the case that in the interval $[q(p_i^m), q(p_e^m)]$,

$$\frac{\partial p}{\partial q} \geq -\frac{(p(q) - c_e)}{q}, \tag{27}$$

with equality when $q = q(p_e^m)$. Hence, substituting this in yields

$$\frac{\partial q_i}{\partial q} \geq 1 - \frac{(1-\delta) q(p_e^m)[p_e^m - c_i] + \delta (c_i - c_e) q(c_i)}{[p(q) - c_e] q}. \tag{28}$$

Hence, provided that the numerator is less than the denominator, $\frac{\partial q_i}{\partial q} > 0$, which is sufficient for $q = q(p_e^m)$ to be the largest q_i in the relevant range. Note that if the numerator is greater than the denominator, then, from (22), $q_i = 0$.

Hence, q_i is greatest when $q = q(p_e^m)$, as compared to any other point in the interval $[q(p_i^m), q(p_e^m)]$. This is sufficient to establish that the incumbent's profit is bounded from above by the profits that accrue from setting $p = p_i^m$ and q_i equal to that implied by (22) when the inequality binds and $q = q(p_e^m)$. This upper bound on profit is given by $\pi^{Collude} = \delta q(p_e^m)(p_i^m - c_i) - \delta (c_i - c_e) q(c_i) \frac{(p_i^m - c_i)}{(p_e^m - c_e)}$. ■

Proof of Lemma 4

Proof. First, consider maximal industry profits in the absence of the entrant. The assumption of full market coverage implies that $p_i^{RPM} = A - 1$ and that $\pi_r^{RPM} = \frac{A-1-c_i}{n}$.

Note that the optimal price in the absence of full market coverage would maximize $(p - c_i)\sqrt{A - p}$; the solution is $p = \frac{2A+c_i}{3}$, and so the full market coverage assumption is equivalent to $\frac{2A+c_i}{3} < A - 1$ or, equivalently, $A > 3 + c_i$.

Next, consider π_{ac}^m. Given that the rival retailers set their price at $A - 1$, the entrant and accommodating retailer would agree on a retail price of $A - 1 - \alpha^2$ and cover the market. Trivially, this is the optimal strategy since if the higher-cost (and less centrally located) incumbent would cover the market, it is more attractive only for the entrant to do so. Formally, if the entrant charged a price p and was not covering the market, then the consumer indifferent between the incumbent and entrant would be at distance x from the entrant where $A - (A-1) - (\alpha - x)^2 = A - p - x^2$; it follows that the entrant would choose a price to maximize $(p - c_e)(\frac{(A-1-p+\alpha^2)}{2\alpha} + 1 - \alpha)$, which yields a maximized value equal to $\frac{1}{8}\frac{(A+2\alpha-c_e-\alpha^2-1)^2}{\alpha}$, where this expression is valid as long as the consumer that is indifferent between the incumbent's and the entrant's goods is interior; this requires that $\frac{(A-1-\frac{1}{2}A+\alpha+\frac{1}{2}c_e-\frac{1}{2}\alpha^2-\frac{1}{2}+\alpha^2)}{2\alpha} < \alpha$ or $A < 3 - c_e - \alpha(2 - 3\alpha)$, but this is inconsistent with the earlier restriction that $A > 3 + c_i$. It follows that the entrant and accommodating retailer would charge a price $A - 1 - \alpha^2$ and cover the market and $\pi_{ac}^m = A - 1 - \alpha^2 - c_e$.

Finally, we turn to consider π_e^{post}. Note that Bertrand competition among retailers ensures a retail price of w_e for the entrant's product and w_i for the incumbent's product. We solve for the Nash equilibrium of the wholesale pricing game. Suppose that the incumbent chooses w_i and the entrant $w_e \leq w_i$.[56] Although we assume full market coverage, there remain two cases to consider:[57]

(i) The entrant serves the whole market. In this case, the incumbent would charge a price equal to c_i, and the entrant would charge $p_e = c_i - \alpha^2$ and earn profits of $\pi_e^{post} = c_i - c_e - \alpha^2$; or

(ii) both the entrant and the incumbent are active.

In this latter case, the incumbent charges w_i, and the entrant charges w_e, and here the indifferent consumer is x such that $A - w_i - x^2 = A - w_e - (\alpha - x)^2$, and so $x = \frac{(w_e - w_i + \alpha^2)}{2\alpha}$. It follows that the incumbent chooses w_i to maximize $(w_i - c_i)\frac{(w_e - w_i + \alpha^2)}{2\alpha}$. Since an incumbent monopolist would fully cover the market, it follows that the entrant, whose equilibrium price can later be easily verified to be below $A - 1$, will sell to all consumers that are located at any $y \geq \alpha$, and so the demand for the entrant is given by $(\frac{(w_i - w_e + \alpha^2)}{2\alpha} + 1 - \alpha)$. Therefore, the entrant chooses w_e to maximize $(w_e - c_e)(\frac{(w_i - w_e + \alpha^2)}{2\alpha} + 1 - \alpha)$.

The first-order conditions for the incumbent and entrant yield best-response functions $w_i^{BR}(w_e) = \frac{1}{2}w_e + \frac{1}{2}c_i + \frac{1}{2}\alpha^2$ and $w_e^{BR}(w_i) = \alpha + \frac{1}{2}c_e + \frac{1}{2}w_i - \frac{1}{2}\alpha^2$. We can solve for equilibrium by solving for the intersection of these best-response functions; this is at $w_e = \frac{4\alpha + 2c_e + c_i - \alpha^2}{3}$ and $w_i = \frac{2\alpha + c_e + 2c_i + \alpha^2}{3}$.

Note that this solution requires that $x \in (0, \alpha)$; that is, $\frac{\left(\frac{4\alpha + 2c_e + c_i - \alpha^2}{3} - \frac{2\alpha + c_e + 2c_i + \alpha^2}{3} + \alpha^2\right)}{2\alpha} = \frac{1}{6}\frac{2\alpha + c_e - c_i + \alpha^2}{\alpha} \in (0, \alpha)$ or equivalently $\alpha(2 + \alpha) > c_i - c_e > \alpha(2 - 5\alpha)$. Under this solution, $\pi_e^{post} = \frac{1}{18}\frac{(4\alpha - c_e + c_i - \alpha^2)^2}{\alpha}$ by substituting for w_e and w_i in the entrant's profits function. ■

Proof of Lemma 5 The proof of this Lemma requires the following lemma (Lemma 6); the rest of the proof is contained after the proof of Lemma 6.

[56] It is clear that this inequality will hold in equilibrium and can be easily verified after solving for equilibrium values.

[57] We continue to ignore equilibria in which the incumbent prices below cost, yet gets no demand.

Lemma 6 *In the downstream differentiation case when A is sufficiently high that the market is fully covered, then* $\pi_r^{RPM} = \left\{ \begin{array}{ll} \frac{1}{2}(A-\beta^2-c_i) & \text{if } \beta \geq \frac{1}{4} \\ \frac{1}{2}(A-(\frac{1}{2}-\beta)^2-c_i) & \text{if } \beta < \frac{1}{4} \end{array} \right\}$, $\pi_e^{post} = c_i - c_e$,

$$\pi_r^{post} = \beta, \text{ and } \pi_{ac}^m = \left\{ \begin{array}{ll} \frac{1}{16}\frac{(A+\beta(2-\beta)-c_e)^2}{\beta} & \text{if } \beta \geq \frac{1}{4} \text{ and } \beta^2+6\beta+c_e > A \\ A-\beta(2+\beta)-c_e & \text{if } \beta \geq \frac{1}{4} \text{ and } \beta^2+6\beta+c_e < A \\ \frac{1}{256}\frac{(4A+\beta(12-4\beta)-4c_e-1)^2}{\beta} & \text{if } \beta < \frac{1}{4} \text{ and } 1+\beta(20+4\beta)+4c_e > 4A \\ A-(\frac{1}{2}-\beta)^2-2\beta-c_e & \text{if } \beta < \frac{1}{4} \text{and } 1+\beta(20+4\beta)+4c_e < 4A \end{array} \right\}.$$

Proof. First, consider maximal industry profits in the absence of the entrant. Note that since retailers are located at $\frac{1}{2}-\beta$ and $\frac{1}{2}+\beta$ on the Hotelling line, a consumer need only travel a maximal distance of $\max\{\frac{1}{2}-\beta,\beta\}$; the assumption of full market coverage implies that $p_i^{RPM} = \left\{ \begin{array}{ll} A-\beta^2 & \text{if } \beta \geq \frac{1}{4} \\ A-(\frac{1}{2}-\beta)^2 & \text{if } \beta < \frac{1}{4} \end{array} \right\}$ and that $\pi_r^{RPM} = \left\{ \begin{array}{ll} \frac{1}{2}(A-\beta^2-c_i) & \text{if } \beta \geq \frac{1}{4} \\ \frac{1}{2}(A-(\frac{1}{2}-\beta)^2-c_i) & \text{if } \beta < \frac{1}{4} \end{array} \right\}$.

Next, turning to the post-entry game, Bertrand competition among manufacturers with c_e sufficiently close to c_i, such that the entrant's monopoly price is above c_i, results in $w_i = w_e = c_i$ and the entrant making all sales. The full market coverage assumption, therefore, yields $\pi_e^{post} = c_i - c_e$.

Let us now consider retailers' post-entry period profits: Retailers set prices p_L and p_R while incurring a wholesale cost of c_i for the good. Suppose, as can be verified is the case in equilibrium, that the indifferent consumer will be between the two retailers; then, the indifferent consumer will be at a distance x from the left retailer where $A - p_L - x^2 = A - p_R - (2\beta - x)^2$, so $x = \frac{p_R - p_L + 4\beta^2}{4\beta}$, the demand for the left retailers is simply $\frac{1}{2} - \beta + \frac{p_R - p_L + 4\beta^2}{4\beta}$, and the demand for the right retailer is given by $\frac{1}{2} - \beta + 2\beta - \frac{p_R - p_L + 4\beta^2}{4\beta}$.

The left retailer maximizes profits by choosing p_L to maximize $(p_L - c_i)(\frac{1}{2} - \beta + \frac{p_R - p_L + 4\beta^2}{4\beta})$. The first-order condition yields $p_L = \beta + \frac{1}{2}c_i + \frac{1}{2}p_R$; and since the problem of the right retailer is symmetric, in equilibrium, $p_L = p_R = c_i + 2\beta$ and $\pi_R^{post} = \frac{1}{2}(c_i + 2\beta - c_i) = \beta$.

It remains to characterize π_{ac}^m. Without loss of generality, suppose that it is the left retailer who accommodates the entrant. The right retailer, as above, has a price of $A - \beta^2$ if $\beta \geq \frac{1}{4}$ and a price of $A - (\frac{1}{2} - \beta)^2$ if $\beta < \frac{1}{4}$. In each case, there are two possibilities. Note that, as above, the consumer that is indifferent between the left and right retailer is at a distance $\frac{p_R - p_L + 4\beta^2}{4\beta}$ as long as this takes a value in the range $[0, \frac{1}{2} + \beta]$. In this case, therefore, $\pi_{ac}^m = \max_p (p - c_e)(\frac{1}{2} - \beta + \frac{p_R - p + 4\beta^2}{4\beta}) = \frac{1}{16}\frac{(2\beta - c_e + p_R)^2}{\beta}$ with associated price $\beta + \frac{c_e + p_R}{2}$ and, otherwise, the retailer sells to all the market and so will make the right-most consumer indifferent; i.e., he will set p such that $A-p-(\beta+\frac{1}{2})^2 = A-p_R-(\beta-\frac{1}{2})^2$ so that $p = p_R - 2\beta$.

Summarizing, in case $\beta \geq \frac{1}{4}$, when $\frac{A-\beta^2-(\beta+\frac{c_e+A-\beta^2}{2})+4\beta^2}{4\beta} < \frac{1}{2}+\beta$, $\pi_{ac}^m = \frac{1}{16}\frac{\left(2\beta-c_e+A-\beta^2\right)^2}{\beta}$ and if $\frac{A-\beta^2-(\beta+\frac{c_e+p_R}{2})+4\beta^2}{4\beta} > \frac{1}{2}+\beta$, then $\pi_{ac}^m = p_R - 2\beta - c_e$. In the alternative case where $\beta < \frac{1}{4}$, then when $\frac{A-(\frac{1}{2}-\beta)^2-(\beta+\frac{c_e+A-(\frac{1}{2}-\beta)^2}{2})+4\beta^2}{4\beta} < \frac{1}{2}+\beta$, $\pi_{ac}^m = \frac{1}{16}\frac{\left(2\beta-c_e+A-(\frac{1}{2}-\beta)^2\right)^2}{\beta}$ and if $\frac{A-(\frac{1}{2}-\beta)^2-(\beta+\frac{c_e+A-(\frac{1}{2}-\beta)^2}{2})+4\beta^2}{4\beta} > \frac{1}{2}+\beta$ then $\pi_{ac}^m = p_R - 2\beta - c_e$. Simplifying these expressions yields the expression for π_m^{aq} in the statement of the lemma. ■

Proof of Lemma 5

Proof. These results are immediate from Lemma 6, though it is perhaps worth noting that the comparative statics of $\frac{d\pi_{ac}^m}{d\beta}$ are given by $\frac{d\pi_{ac}^m}{d\beta} = -\frac{1}{16}\left(A-2\beta-c_e+3\beta^2\right)\frac{A+\beta(2-\beta)-c_e}{\beta^2} < 0$ if $\beta \geq \frac{1}{4}$ and $\beta^2+6\beta+c_e > A$, $\frac{d\pi_{ac}^m}{d\beta} = -2(1+\beta) < 0$ if $\beta \geq \frac{1}{4}$ and $\beta^2+6\beta+c_e < A$, $\frac{d\pi_{ac}^m}{d\beta} = -\frac{1}{256}\left(4A-12\beta-4c_e+12\beta^2-1\right)\frac{4A+12\beta-4c_e-4\beta^2-1}{\beta^2} < 0$ if $\beta < \frac{1}{4}$ and $1+\beta(20+4\beta)+4c_e > 4A$, and $\frac{d\pi_{ac}^m}{d\beta} = -1-2\beta < 0$ if $\beta < \frac{1}{4}$ and $1+\beta(20+4\beta)+4c_e < 4A$. The inequalities can be shown by recalling that the full market coverage assumption—$A > 3 + c_i$—is maintained throughout. ■

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