Market Share Exclusion*

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Abstract

A market share exclusion contract between a seller and a buyer prevents rival sellers from competing for a share of the buyer's purchases. For non-discriminatory contracting we show that, unlike exclusion through exclusive dealing, market share exclusion can be profitable even when buyers coordinate on the best equilibrium in the contract-acceptance subgame. The condition for the profitability of market share exclusion is characterized in terms of straightforward economic concepts. With discriminatory contracting market share exclusion contracts are generally less profitable than exclusive dealing contracts. The motive for employing market share exclusion contracts, which welfare impacts have not been well understood, instead of exclusive dealing contracts, which have been the focus of both theory and policy, may thus often be the avoidance of scrutiny by competition authorities rather than some more direct economic advantage of market share exclusion over exclusive dealing. However, we also show that market share exclusion decreases both buyer and total surplus. Hence, competition authorities should not view exclusion through exclusive dealing as a pre-requisite for the possibility of anti-competitive effects from exclusionary contracting.

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1 Introduction

Economic analyses of exclusionary contracting generally fall into one of two categories. In one category are analyses that examine how exclusionary contracts with buyout prices can be used to extract rent from a more efficient rival when the rival enters. In the other category are analyses that examine how externalities among buyers can render exclusionary contracting profitable even when no rent is extracted from any entrant. Both strands of analyses were initiated by Aghion and Bolton (1987). The key subsequent contributions to the second strand of analyses have been Rasmusen, Ramseyer, and Wiley (1991) and Segal and Whinston (2000a) (hereafter "RRW-SW"), which showed that exclusive dealing can be profitable both if buyers do not coordinate on their most preferred equilibrium and if the incumbent offers buyers discriminatory contracts.

A unifying feature for Aghion and Bolton (1987) and RRW-SW is the focus on exclusionary contracts which prevent a buyer under contract from purchasing *any* share of its purchases from an entrant. Exclusionary contracts observed in practice, however, often allow buyers under contract to still purchase some of their purchases from an entrant. The possible anti-competitive effects of such contracts have played a part in many recent antitrust cases. In *AMD v. Intel* (2005) and in *U.S. Federal Trade Commission v. Intel* (2009) the respective plaintiffs contended that the discounts offered by the defendant to buyers were contingent on the share of each buyer's purchases from the defendant and had an anti-competitive exclusionary effect.[1] The settlements in both cases prohibited the defendant from conditioning rebates or discounts on buyer purchases, but included an exception for the case when discounts were to be used for marketing the products. In *Masimo v. Tyco Health Care* (2004) the plaintiff argued that the defendant's pricing was contingent on the buyer's share of purchases from the defendant and that such pricing had an anti-competitive

[1] See the complaints and settlement agreements at http://www.intel.com/pressroom/legal/index.htm (last accessed 8/8/2011).

exclusionary effect.[2] In *Concord Boat v. Brunswick* (2000) the plaintiffs argued that market share and volume discounts offered to buyers by the defendant had had an anti-competitive exclusionary effect.[3] In *United States v. Microsoft* (1998) it was found that Microsoft's contracts with AOL and other internet access providers restricted each provider's distribution of Microsoft's competitors' browsers to less than fifteen percent of subscribers.[4]

In this paper we examine whether the conclusions in RRW-SW are robust to allowing the incumbent offer buyers also *market share exclusion* contracts, which only restrict the share of each buyer's purchases from an entrant, as opposed to allowing the incumbent offer buyers only exclusive dealing contracts, which prevent each buyer from purchasing any share of its purchases from an entrant. We focus on the case when buyers coordinate on the best equilibrium in the contract-acceptance subgame.

We first examine the case of non-discriminatory contracting, which was the original focus in Rasmusen, Ramseyer, and Wiley (1991). Analysis of non-discriminatory contracts is also important from a policy perspective given that in some contexts discriminatory contracting is already prohibited in the U.S. (see Burkart et al., 1998) and given that existing research has provided arguments in favor of a non-discrimination requirement (see Segal, 2003).

For this case we show that market share exclusion can be profitable unlike exclusive dealing. The profitability of market share exclusion arises because each acceptance of a market share exclusion contract decreases the rival's investments and thereby decreases every buyer's expected surplus from the buyer's unrestricted potential purchases, and because the excluding seller captures part of this decrease in the buyers' surplus. The reason for the unprofitability of exclusive dealing is familiar: with exclusive dealing contracts there can be no negative externalities among buyers in equilibrium because exclusionary contracts are either accepted by all buyers or rejected by all buyers and because an exclusive dealing contract

[2] See the Complaint at http://www.masimo.com/pdf/news/tyco.pdf (last accessed 8/30/2008).
[3] Concord Boat Corp. v. Brunswick Corp., 207 F.3d 1039, 1063 (8th Cir. 2000).
[4] See the Findings of Fact at http://usvms.gpo.gov/ms-findings2.html (last accessed 8/30/2008).

prevents a buyer from purchasing any share of its purchases from the entrant. Importantly, whether market share exclusion is profitable is characterized in terms of straightforward and empirically malleable economic concepts.

The contrast between our result that market share exclusion can be profitable and the result derived in RRW-SW that exclusive dealing is not profitable is striking because the demand structure and the entry technology in our model depart from RRW-SW in only two respects.

First, while RRW-SW assume that entry is dependent upon whether the rival can achieve a known minimum efficient scale upon entry, we assume that the threat of entry is increasing in the reward for entry. This assumption is both a more realistic description of the entry mechanism in innovative industries – such as those exemplified by the aforementioned cases of market share exclusion – and a necessary condition for each acceptance of a market share equilibrium contract to have a negative externality on all other buyers.

Second, we modify the demand structure of the RRW-SW model to include a "base good" and an "upgrade good". The base vs. upgrade good dichotomy is present in many industries (see e.g. Ellison, 2009). One example from an industry where also innovation is important is microprocessors where the product selection of each producer includes processors that vary greatly in terms of processor speed and graphics capabilities. The modification to the demand structure prevents the incumbent from using the market share exclusion contract to extract the monopoly profit also from each active buyer's non-restricted purchases. Without this modification buyers who accept a market share exclusion contract never benefit from entry and thus, from a buyer's perspective, market share exclusion contracts are equivalent to exclusive dealing contracts (and are thus not profitable). Our analysis can alternatively be interpreted as an analysis of exclusive dealing contracts that have a limited duration. If this interpretation is chosen, the modification of the demand structure is not necessary as entry then benefits all buyers after the limited duration exclusionary contracts expire.

We also show that with discriminatory contracting market share exclusion contracts are generally less profitable than exclusive dealing contracts. By itself this result implies that firms should always employ exclusive dealing contracts instead of market share exclusion contracts. This implication poses a question as to why then are market share exclusion contracts ever observed in practice. We offer two potential explanations for this.

One potential explanation is of course related to the possibility that the model applied here does not capture the relevant aspects of the strategic environment and thus yields inaccurate predictions of behavior. To this effect our analysis is a theoretical contribution demonstrating the limits of RRW-SW, which our analysis extends.

The other potential explanation is that firm behavior is endogenous to policy and policy is influenced by theory. Firms may employ market share exclusion contracts because such contracts may be less likely than exclusive dealing contracts to face scrutiny by competition authorities. For example, the Competition Bureau of Canada settled their challenge of exclusion by Canada Pipe with an arrangement that allows the firm to continue to offer buyers rebates and discounts as long as they are not conditioned on complete exclusivity.[5] Differential treatment of market share exclusion and exclusive dealing by competition authorities can be partly attributed to the fact that most prior formal analyses of exclusionary contracting have focused on exclusive dealing and thus the welfare impacts of exclusive dealing have been much better understood than the welfare impacts of market share exclusion. However, we also show that market share exclusion contracts too decrease buyer and total surplus. Competition authorities should thus give market share exclusion contracts the same level of scrutiny that exclusive dealing contracts have historically received.

The literature on exclusionary contracting traces back to the Chicago School exclusive dealing argument (see e.g. Director and Levi, 1958, Posner, 1976, and Bork, 1978). This

[5]See "Competition Bureau reaches agreement with Canada Pipe Company Ltd.," Competition Bureau Canada, 12/20/2007 at http://www.competitionbureau.gc.ca/epic/site/cb-bc.nsf/en/02548e.html (last accessed 8/30/2008).

argument states that exclusive dealing cannot reduce buyer welfare because buyers would not accept exclusive dealing contracts that would make them worse off.[6] In addition to Aghion and Bolton (1987) and RRW-SW, many existing analyses have challenged this conclusion.[7] Our analysis complements these contributions by further characterizing the set of conditions under which exclusionary contracting can be profitable and have anti-competitive effects.

Fumagalli and Motta (2005) extend RRW-SW to the case when buyers are downstream competitors and the deviation of one buyer triggers entry. Simpson and Wickelgren (2007) extend RRW-SW to the case when buyers can breach exclusive dealing contracts by paying expectation damages. Both analyses find that exclusion is not profitable.[8]

In Aghion and Bolton (1987) and RRW-SW only the incumbent offers buyers exclusionary contracts.[9] Mathewson and Winter (1987) show that when both the incumbent and the entrant can offer buyers exclusive dealing contracts and common representation contracts, exclusive dealing can be profitable and the effect on consumer welfare is ambiguous.[10] Bernheim and Whinston (1998) and O'Brien and Shaffer (1997) relax the linear pricing assumption in this analysis, and find that exclusion can occur only if it is efficient.

A central feature of our analysis is the focus on the effect of exclusionary contracting on the threat of entry on the margin. Segal and Whinston (2000b), Gilbert and Shapiro (1998), and Gilbert (2000) examine the effects of exclusive dealing on marginal investment

[6]See Rasmusen et al. (1991) for the formal triangle-loss argument. Posner (2001) notes that although the Chicago School argument was presented in Posner (1976) he did not conclude that exclusive dealing could never reduce consumer welfare, as many later contributions had asserted.

[7]In contrast with RRW-SW, in Aghion and Bolton (1987) contracts may specify prices and prices may be conditioned on other buyers' decisions.

[8]Simpson and Wickelgren (2005, 2007) also examine the case that buyers are downstream competitors and contracts can be breached by paying expectation damages. Contrary to Fumagalli and Motta (2005), they find that exclusive dealing can be profitable. Wright (2009), Abito and Wright (2008) and Kitamura (2010) further refine and extend these analyses of exclusion when buyers compete. See also Stefanadis (1998).

[9]The justifications for this assumption relate to entrants' financial constraints, lack of coordination among entrants, and the infeasibility of up-front payments (for example, in *United States v. Microsoft* (1994) it was alledged that Microsoft was able to offer low prices for the existing version of the OS in exchange for contracts that were effectively exclusionary beyond the expected lifetime of the OS (see Stefanadis, 1998)).

[10]A common representation contract rewards a buyer for rejecting all exclusionary contracts. The possibility that all firms can offer buyers exclusionary contracts was suggested by Marvel (1982). Spector (2004) combines the RRW-SW approach with this assumption, and finds that exclusion can be profitable.

incentives.[11] However, whereas contractual externalities between the buyers are central to our analysis, these related analyses do not consider the case of multiple buyers.[12]

We interpret market share discounts and volume discounts as an indirect and less transparent way to achieve market share exclusion.[13] In contrast, several recent papers explicitly examine the role of such discounts. Kolay et al. (2004) and Mills (2006) examine inducing buyer investments as a rationale for discounts. Marx and Shaffer (2004) characterize the ability to use market share discounts to shift rents from another seller. Ordover and Shaffer (2007) examine the incentives to use discounts to exclude a financially constrained competitor in the presence of switching costs. Erutku (2006) shows that rebates can be used to achieve the same exclusionary effect that can be achieved with liquidated damages.

2 The Model

2.1 The Model

The model has an incumbent, a rival, N ex-ante identical potential buyers, and two versions of a divisible good: a "base good" and an "upgrade good". Presence of the base good is the main departure from RRW-SW. The motives for this departure are discussed in Section 2.3.

As in RRW-SW (see footnote 7 in Segal and Whinston, 2000a), other aspects of the demand structure are built around two features which imply that the incumbent cannot extract all of the buyer surplus and that monopoly pricing involves a deadweight loss. The first assumption is that the precise nature of the goods is not known in the exclusionary contracting stage. The exclusionary contract thus cannot specify prices for the goods. The second assumption is that either the sellers are restricted to linear pricing or each buyer's

[11]Stefanadis (1997) examines the effect of exclusive dealing on innovation by upstream firms when buyers are downstream competitors. Elhauge (2003) discusses the impact of exclusion on innovation by rivals.

[12]Analyses of exclusionary contracting by Segal (1999, 2003) mention exclusive dealing as an application.

[13]Kaplow and Shapiro (2007) discuss *United States v. Dentsply* (2005) and the lack of distinction between contracts that are explicitly exclusionary and contracts that are exclusionary only in their effect. Brennan (2008) distinguishes *predatory rebates* to end-users and *exclusionary rebates* to complement providers.

ex-post valuation for the good is uncertain in the exclusionary contracting stage. We follow the latter approach but the results apply equally to the linear pricing approach.

All buyers have the same valuation mv for m units of the base good. Buyers differ only in terms of how much higher is each buyer's ex-post valuation for purchasing m units of the upgrade good instead of m units of the base good. For buyer i this marginal ex-post valuation for the upgrade good, which we interchangeably refer to as *upgrade utility*, is captured by $m\theta_i$, where θ_i is drawn from the uniform distribution on the interval $\left[0, \bar{\theta}\right]$.[14] Following Segal and Whinston (2000a), we denote by $q(p)$ the probability that $\theta_i \geq p$. Provided that the price of m units of the base good does not exceed mv, each buyer's ex-ante demand function for m units of the upgrade good is therefore $mq(p)$, where $q(p) = 1 - \frac{p}{\bar{\theta}}$ and p is the difference between the unit prices for the upgrade and base goods. After buyers learn their marginal ex-post valuations θ_i, these valuations become each buyer's private information.

Externalities among buyers are the driving force behind our results. The size of each individual buyer relative to the total potential market size is an important determinant of the magnitude of these externalities. Therefore, many of our results will be stated in terms of the number of buyers N. To isolate the effect of a change in the number of buyers, we keep the total potential market size independent of the number of buyers by assuming that $m \times N = 1$, so that $m \times N$ remains constant.

The incumbent can manufacture both versions of the good at marginal cost $\bar{c}$. If the rival enters, the rival can manufacture both versions of the good at marginal cost $\bar{c} - \Delta c$.[15] The rival's probability of entry is increasing in its expected reward for entry. Formally, $\mu = F(\Pi_R)$, where μ denotes the rival's probability of entry, Π_R denotes the rival's expected profit from all buyers in the event that it enters, and $F(\cdot)$ is a continuous and almost

[14] This distributional assumption restricts the number of cases in the analysis of the pricing equilibrium (see Section 3.1). A buyer's combined valuation for fm units of the base good and $(1-f)m$ units of the upgrade good is $fmv + (1-f)m(v+\theta_i)$, where $f \in [0,1]$.

[15] To limit the number of pricing equilibria Δc is assumed to be small enough for the rival to always set its unit price equal to the incumbent's marginal cost $\bar{c}$. This also sharpens the contrast with Aghion and Bolton (1987) as there is no equilibrium in which the incumbent extracts rents from the rival.

everywhere differentiable function with $F'(\Pi_R) > 0$ for all Π_R for which $F(\Pi_R) > 0$.

An exclusionary contract offered to buyer i specifies a payment t_i, which the buyer receives upon acceptance of the contract, and the share $s_i \in [0, 1]$ of the buyer's total actual purchases that the buyer must purchase from the incumbent if it accepts the contract. For market share exclusion contracts $s_i \in (0, 1)$, for exclusive dealing contracts $s_i = 1$, and for trivial exclusionary contracts $s_i = 0$. We follow the main analyses in RRW-SW and assume that the exclusionary contracts cannot be breached.

The timing of actions is as follows. In stage 1 the incumbent offers buyers exclusionary contracts, and buyers then accept or reject their offers. Buyers make acceptance decisions simultaneously and non-cooperatively. In stage 2 the rival makes its entry decision. Each buyer then learns its valuation for the upgrade good. In stage 3 there are two cases. If the rival does not enter, the incumbent sets prices. If the rival enters, the incumbent sets the prices for the buyers' restricted purchases and the incumbent and the rival compete on price for the buyers' unrestricted purchases. Buyers then make their purchase decisions.

We make two additional assumptions to limit the number of cases in the analysis of the pricing equilibrium (Section 3.1). First, the rival's cost of producing the upgrade good is always higher than a buyer's upgrade utility. Formally, $\bar{c} - \Delta c > \bar{\theta}$. Second, buyer surplus from consuming the base good is always higher than upgrade utility. Formally, $v - \bar{c} > \bar{\theta}$.[16]

2.2 Discussion of the Entry Technology

Our assumption that the rival's probability of entry is increasing in the reward for entry departs from the minimum efficient scale assumption in the RRW-SW model. This departure from the RRW-SW model is a more realistic description of the entry technology in innovative

[16]The first assumption implies that a buyer never first purchases more than ms units of the basic good from the incumbent to merely satisfy the contractual requirement and then purchases more than $m(1-s)$ units of the premium good from the rival for actual use (see Appendix 1). The second implies that the incumbent always sells both versions of the good in equilibrium (see Appendix 1). Both sets of assumptions are satisfied, for example, if $\bar{\theta} = 1$, $v = 4$, $\bar{c} = 2$, and $\Delta c = 0.5$.

industries and also necessary for our results as it implies that each acceptance of a market share exclusion contract has a negative externality on all other buyers.

The reduced-form entry technology can depict either of two cases. One interpretation is that entry requires successful R&D and the rival can increase its probability of success by increasing its R&D investment. The alternative interpretation is that entry involves an exogenous fixed cost and this cost is the rival's private information. Entry is again uncertain because the rival only enters when the cost of entry is lower than the reward for entry.

We express many of our results in terms of the responsiveness of the rival's probability of entry to changes in its potential market size. This is captured by the reward-elasticity of the rival's probability of entry, defined by $\varepsilon_\mu \equiv F'(\Pi_R) \times \frac{\Pi_R}{F(\Pi_R)}$. The advantage of stating the results in terms of the reward-elasticity of entry ε_μ is that it is a straightforward and empirically malleable economic concept (see Acemoglu and Linn, 2004, and Popp, 2002).

2.3 Discussion of the Demand Structure

The demand structure presented here is an analytically convenient representation of the type of vertical product differentiation that is prevalent in innovative industries such as the computer industry. That the sale of base and upgraded versions of a good is common in many industries has been noted and modelled by e. g. Ellison (2009). Our analysis in essence reveals a new rationale – commitment not to extract all buyer surplus – for such product differentiation. The chosen demand structure is also attractive from the point of view that all buyers who accept exclusionary contracts are active buyers in equilibrium. Simpson and Wickelgren (2007) have argued that the uncertain ex-post valuation interpretation of the RRW-SW model is unattractive because the incumbent then pays some buyers to accept an exclusionary contract even though those buyers ultimately do not purchase anything.

To see why we depart from the RRW-SW demand structure, which has only one good (corresponding to the "upgrade good" here), suppose for the moment that the RRW-SW demand structure is adopted instead. A buyer who has accepted a market share exclusion contract cannot buy from the entrant unless the buyer also purchases from the incumbent. Thus, when the rival enters, the incumbent sets the price of each buyer's restricted purchases of the good ($s_i m$ units) so that the incumbent extracts the monopoly profit also from the buyer's purchases ($(1 - s_i)\, m$ units) from the rival.[17] As a result the buyer does not benefit from entry. In the RRW-SW model market share exclusion contracts and exclusive dealing contracts are thus equivalent from the buyers' perspective, and thereby also unprofitable for the incumbent when only non-discriminatory contracts are considered.[18]

In our model too the incumbent still extracts some surplus from the buyers' unrestricted purchases from the rival. However, all buyers now benefit from entry, as the analysis in the next section shows. We also note that extracting surplus from buyers' purchases from the rival is distinct from extracting surplus from a more efficient rival. In our analysis the incumbent does not extract rent from the rival because the rival sets its price equal to the incumbent's marginal cost. This property is in common with RRW-SW but in sharp contrast with Aghion and Bolton (1987).

3 Equilibrium Analysis

We focus on perfectly coalition-proof subgame-perfect Nash equilibria. We assume that if a buyer's expected surplus is the same when the buyer accepts a market share exclusion contract and when the buyer rejects the contract, the buyer will then reject the contract. This rules out exclusionary equilibria in which the incumbent is no better off than it is without

[17] Formally: a buyer that must purchase the share s_i of its purchases from the incumbent has willingness to pay θ_i for acquiring s_i units of the good from the incumbent, as it allows the buyer to also purchase $(1 - s_i)$ units from rival. From the incumbent's perspective, the buyer's demand curve is therefore $q\,(p)$ as opposed to $s_i q\,(p)$. Accordingly, abstracting away from production costs, instead of setting the price of s_i units of the good at $s_i p_M$, where p_M is the monopoly price, the incumbent sets the price of s_i units at p_M.

[18] The incumbent may also be able to remove the prospect of ex-post opportunism also through reputation and through the enforcement of contractual intent by courts (see Kraus and Scott, 2009) if the intent of the contract is to enable the incumbent to extract monopoly profit only from a buyer's restricted purchases.

exclusionary contracts. We also assume that there exists an arbitrarily small smallest possible increment δ for the payments t_i. This implies that an exclusionary equilibrium may exist.

3.1 Equilibrium in Stage 3

In stage 3 firms set prices and buyers subsequently make their purchase decisions.

Consider first the case when the rival does not enter. As is shown in Appendix 1, the incumbent sets the price of m units of the base good equal to mv and the price of m units of the upgrade good equal to $m(v + p_M)$, where $p_M \equiv \arg\max_p pq(p)$. The incumbent's expected profit from each buyer is $\pi + \pi_M$, where $\pi \equiv m(v - \bar{c})$ and $\pi_M \equiv mp_M q(p_M)$.

Consider next the case when the rival enters. A buyer who rejected the contract purchases m units of the upgrade good from the entrant at price $m\bar{c}$, which equals the incumbent's marginal cost.[19] A buyer who accepted the contract must purchase the share s_i of its purchases from the incumbent. Price competition for the unrestricted share of the buyer's purchases drives the price for $m(1 - s_i)$ units of the upgrade good to the incumbent's marginal cost $m(1 - s_i)\bar{c}$. Because this equilibrium price is not lower than the incumbent's marginal cost, the incumbent does *not* extract any rent from the rival when it enters. However, the incumbent does extract surplus from the buyer's purchases from the rival through its pricing of the restricted share s_i of the buyer's purchases. The incumbent is able to achieve this because the buyer can take advantage of the low price $m(1 - s_i)\bar{c}$ for the unrestricted share $(1 - s_i)$ of its purchases only if the buyer purchases the restricted share s_i of its total purchases from the incumbent. Of course, any market share exclusion contract must compensate buyers also for this loss in their expected surplus. Consequently, the feature that the incumbent extracts surplus from the buyers' purchases from the rival is *not* the reason for why market share exclusion is profitable.

Equilibrium pricing is solved in Appendix 1. All buyers who accepted their offers (t_i, s_i)

[19] That no buyer purchases the base good from the entrant is due to the assumption – made for expositional convenience – that for each firm the marginal costs of producing the two goods are the same.

purchase $m(1-s_i)$ units of the upgrade good from the rival at price $m(1-s_i)\bar{c}$. Buyers who accepted their offer and have marginal valuation $\theta < p_M$ for the upgrade good purchase ms_i units of the base good from the incumbent at price $ms_i v + m(1-s_i)(v-\bar{c})$, where the latter term $m(1-s_i)(v-\bar{c})$ represents the surplus that the incumbent extracts from the buyer's purchases from the rival. Similarly, buyers who accepted their offers and have marginal valuation $\theta \geq p_M$ for the upgrade good purchase ms_i units of the upgrade good from the incumbent at price $ms_i(v+p_M)+m(1-s_i)(v-\bar{c})$. The latter term $m(1-s_i)(v-\bar{c})$ again represents the surplus that the incumbent extracts from the buyer's purchases from the rival. With this equilibrium pricing, the incumbent's expected profit from each buyer who accepted the contract is $\pi + s_i\pi_M$.

The rival's profit from each unit of sales is Δc. Let S denote the set of buyers who accepted their offer in stage 1. The rival's expected reward for entry is given by $\Pi_R = \Delta c\left[(N-n)m + \sum_{i\in S}(1-s_i)m\right]$. Because $m \times N = 1$ by assumption, the reward for entry can then be rewritten as

$$\Pi_R = \frac{N - \sum_{i\in S} s_i}{N}\Delta c. \tag{1}$$

3.2 Equilibrium in Stage 2

In stage 2 the rival makes its entry decision. As explained above, we have adopted the reduced-form expression $\mu = F(\Pi_R)$ to capture the equilibrium entry threat. Let μ_S denote the rival's probability of entry when S is the set of buyers who accepted their offers. Using expression (1) for the reward for entry Π_R, we have $\mu_S = F\left(\frac{N-\sum_{i\in S}s_i}{N}\Delta c\right)$.

3.3 Equilibrium in Contract-Acceptance Subgame of Stage 1

In stage 1, after observing the incumbent's exclusionary contract offers, buyers decide simultaneously and non-cooperatively whether to accept their offers.

Consider first the expected surplus of buyer i when it rejects its offer. When the rival does not enter, the buyer's expected surplus is $CS_M \equiv m \int_{p_M}^{\bar{\theta}} q(p)\, dp$. When the rival enters, the buyer's expected surplus is $CS_C \equiv m \left[v + \int_0^{\bar{\theta}} q(p)\, dp - \bar{c} \right]$. Let S_k denote a fixed set of k buyers among the $N-1$ other buyers who accept their offers. The buyer's expected surplus $U_R(S_k)$ in stage 1 is then

$$U_R(S_k) = (1 - \mu_{S_k})\, CS_M + \mu_{S_k} CS_C. \tag{2}$$

Consider now the expected surplus of buyer i when it accepts its offer. When the rival does not enter, the buyer's expected surplus is $CS_M + t$. When the rival enters, the buyer's expected surplus is higher, namely $s_i CS_M + (1 - s_i)(CS_C - \pi) + t_i$, where "$-\pi$" indicates that the incumbent extracts surplus also from the buyer's purchases from the rival. Let $S_k \cup i$ denote the set of buyers that now accept their offers (buyer i and the fixed set S_k of k other buyers). The buyer's expected surplus $U_A(S_k, s_i, t_i)$ in stage 1 is then

$$U_A(S_k, s_i, t_i) = (1 - \mu_{S_k \cup i})\, CS_M + \mu_{S_k \cup i} \left[s_i CS_M + (1 - s_i)(CS_C - \pi) \right] + t_i. \tag{3}$$

A buyer's acceptance constraint is $U_A(S_k, s_i, t_i) > U_R(S_k)$. Using expressions (2) and (3) for $U_R(S_k)$ and $U_A(S_k, s_i, t_i)$, respectively, the acceptance constraint can be written as

$$t_i > \mu_{S_k} \left[s_i (\pi + \pi_M + DL_M) + (1 - s_i)\, \pi \right] + (\mu_{S_k} - \mu_{S_k \cup i})(1 - s_i)(\pi_M + DL_M), \tag{4}$$

where $DL_M \equiv CS_C - (CS_M + \pi + \pi_M)$ is the deadweight loss from monopoly pricing. When the rival enters, the expected surplus of a buyer is $s_i(\pi + \pi_M + DL_M) + (1 - s_i)\, \pi$ less when it accepts its offer than when it rejects the offer. This effect of an acceptance directly decreases the buyer's expected surplus and is captured by the first term on the right-hand side of (4). A buyer's acceptance also decreases the rival's potential market size and the associated probability that the rival enters and the buyer receives the benefit $(1 - s_i)(\pi_M + DL_M)$ from entry. This effect is captured by the second term on the right-hand side of (4).

Consider the acceptance condition (4) and how a buyer's preference to accept its offer is affected by another buyer's decision to accept. Each acceptance by other buyers expands the set of buyers who accept the contract among the $N-1$ other buyers from a set S_k to a set S_{k+1}, decreases the rival's reward for entry, and decreases the associated probability of entry from μ_{S_k} to $\mu_{S_{k+1}}$. The resulting decrease in the first term on the right-hand side of the acceptance condition (4) renders buyer i more eager to accept its offer. Each additional acceptance by other buyers also changes the factor $\mu_{S_k} - \mu_{S_k \cup i}$ in the second term of the acceptance condition (4), unless the entry threat $F(\Pi_R)$ is linear in the reward for entry. If $F(\Pi_R)$ is strictly convex (strictly concave) each additional acceptance decreases (increases) the impact $\mu_{S_k} - \mu_{S_k \cup i}$ that the acceptance of buyer i has on the probability of entry. Therefore, when the entry threat $F(\Pi_R)$ is strictly convex (strictly concave), the change in the second term of the acceptance condition (4) that is associated with each additional acceptance by other buyers renders buyer i more (less) eager to accept its offer.

Combining these observations implies that when the entry threat $F(\Pi_R)$ is either linear or strictly convex in the reward for entry Π_R, each acceptance by other buyers renders buyer i unambiguously more eager to accept its offer.[20] In the terminology of Segal (2003), in this case the externalities among buyers are increasing. In contrast, when the entry threat $F(\Pi_R)$ is strictly concave in the reward for entry Π_R, each acceptance by other buyers can render buyer i either more eager or less eager to accept its offer depending on the magnitudes of the two effects which now have opposite signs.

When it is not known whether externalities among agents are increasing or decreasing, and when externalities among agents are interchangeably increasing and decreasing within

[20] Most of the reward-elasticity of entry estimates in Acemoglu and Linn (2004) indicate an elasticity greater than 1. When interpreted as estimates of an entry threat with a constant reward-elasticity, this supports the idea that an entry threat may be strictly convex in the reward for entry. From a theoretical perspective, a strictly convex entry threat indicates that, though the marginal cost of increasing the probability of entry is increasing in the probability of entry (due to, for example, the scarcity of fertile research opportunities), it increases at decreasing pace (due to, for example, increasing spillovers among research projects).

the same example, equilibrium analysis is, to say the least, cumbersome. Even Segal (2003) only examines cases where externalities among agents are either increasing everywhere or decreasing everywhere. Accordingly, we focus on the case when the entry threat $F(\Pi_R)$ is either linear or strictly convex in the reward for entry Π_R so that externalities among buyers are increasing everywhere regardless of the number of buyers N. However, in the case that the number of buyers N is large, our analysis allows for an arbitrary entry threat $F(\Pi_R)$ because externalities among buyers are increasing also in this case, as the next Lemma shows.

Lemma 1 *Suppose that the incumbent offers buyers exclusionary contracts. Suppose also that either 1) the probability of entry is convex (i.e. either linear or strictly convex) in the reward for entry, or 2) the number of buyers N is large enough. Then: a buyer's preference to accept a contract is never reversed by another buyer's decision to accept a contract.*

Proof. See the appendix. ■

The next Lemma shows that, under the same assumptions as in the previous Lemma, an equilibrium exists in the contract-acceptance subgame.

Lemma 2 *Suppose that the incumbent offers buyers exclusionary contracts. Suppose also that either 1) the probability of entry is convex (i.e. either linear or strictly convex) in the reward for entry, or 2) the number of buyers N is large enough. Then: a perfectly coalition-proof Nash equilibrium exists in the contract-acceptance subgame.*

Proof. See the appendix. ■

The proof of Lemma 2 is constructive. An equilibrium in the contract-acceptance subgame is solved by first determining which set of buyers prefer to accept their offers when all other buyers reject their offers, and then recursively determining which set of additional buyers prefer to accept their offers conditional on the previously identified set(s) of buyers accepting their offers. The recursion stops when either all buyers accept their offers or when no additional buyers who prefer to accept their offers are identified.

3.4 Equilibrium in Stage 1 with Non-Discriminatory Contracting

In stage 1 the incumbent offers buyers exclusionary contracts. The incumbent's relevant strategy space in stage 1 is obviously compact as it is never profitable to offer any buyer a payment t_i greater than the maximum total surplus. Hence, as long the conditions in Lemma 2 hold, so that an equilibrium exists in the contract-acceptance subgame, equilibrium exists also in the whole game.

We now determine the conditions under which market share exclusion occurs in equilibrium when the incumbent is restricted to offering all buyers the same exclusionary contract (s, t). We continue to assume that either the entry threat is convex in the reward for entry or that the number of buyers N is large enough, so that externalities among buyers are increasing.

Non-discriminatory contracting and increasing externalities among buyers imply that in constructing the coalition-proof equilibrium using the recursive procedure described above after Lemma 2, the set of buyers identified first (i.e. the set of buyers who prefer to accept when all other buyers reject) includes either all buyers or no buyers. Accordingly, in the coalition-proof equilibrium in the contract-acceptance subgame either all buyers accept or all buyers reject. The general acceptance condition (4) implies that the payment that just induces a buyer to accept a contract when all other buyers reject the contract satisfies

$$t = \mu_0 \left[s \left(\pi + \pi_M + DL_M \right) + (1 - s) \pi \right] + (1 - s) \left(\mu_0 - \mu_1 \right) \left(\pi_M + DL_M \right) + \delta, \tag{5}$$

where μ_n denotes the probability of entry when n buyers accept the contract. For a given s the second term in the above inequality (5) is arbitrarily small compared to the first term if the number of buyers N is large enough. Therefore, when the number of buyers N is large, the expression (5) for the optimal payment simplifies to

$$t = \mu_0 \left[s \left(\pi + \pi_M + DL_M \right) + (1 - s) \pi \right] + \delta. \tag{6}$$

When n buyers accept the contract, the incumbent's expected profit is

$$\Pi_I = (N-n)(1-\mu_n)(\pi+\pi_M) + n\left[(1-\mu_n)(\pi+\pi_M) + \mu_n(s(\pi+\pi_M)+(1-s)\pi) - t\right]. \tag{7}$$

The first (second) term in this expression (7) represents the incumbent's expected profit from buyers who reject (accept) the contract. The difference in the incumbent's expected profit between when all buyers accept the contract ($n = N$) and when all buyers reject the contract ($n = 0$) is denoted by $\Delta\Pi_I$ and is

$$\Delta\Pi_I = N(\mu_0-\mu_N)\pi_M(1-s) + N\left[\mu_0(s(\pi+\pi_M)+(1-s)\pi) - t\right]. \tag{8}$$

The first term in expression (8) represents the incumbent's motive for market share exclusion: when buyers limit their purchases from the entrant to the share $(1-s)$ of their purchases, the rival's probability of entry decreases from μ_0 to μ_N, which benefits the incumbent because its profit from a buyer is higher when the rival does not enter $(\pi+\pi_M)$ than it is when the rival does enter $(s(\pi+\pi_M)+(1-s)\pi)$. The second term in expression (8) in contrast represents the incumbent's cost of inducing buyers to accept market share exclusion contracts, holding the probability of entry constant at μ_0. Expression (8) thus shows that market share exclusion is profitable if the associated increase in the incumbent's expected profit from the buyers' unrestricted purchases is greater than the net cost of inducing buyers accept the exclusionary contracts, holding the probability of entry constant. Moreover, it indicates that market share exclusion is profitable if the externality that each acceptance has on other buyers through its impact on the probability of entry is strong enough.

The payment t must compensate buyers for the decrease in the buyer's expected surplus when the rival enters. Substituting expression (5) for t in the second term in (8) yields

$$\Delta\Pi_I = N(\mu_0-\mu_N)\pi_M(1-s) - N\left[\mu_0 s DL_M + (1-s)(\mu_0-\mu_1)(\pi_M+DL_M)\right]. \tag{9}$$

One buyer's acceptance of the contract (s,t) decreases the rival's potential market share by $\frac{s}{N}$ percent. Hence, when s is small, by the definition of the reward-elasticity of the probability of entry ε_μ (see Section 2.2) one buyer's acceptance decreases the rival's probability of entry by approximately $\varepsilon_\mu|_{\mu=\mu_0} \times s \times \frac{1}{N}$ percent. Similarly, all buyers' accepting the market share exclusion contract decreases the rival's probability of entry by approximately $\varepsilon_\mu|_{\mu=\mu_0} \times s$ percent. Substituting these approximations $\varepsilon_\mu|_{\mu=\mu_0} \times s \times \frac{1}{N} \times \mu_0$ and $\varepsilon_\mu|_{\mu=\mu_0} \times s \times \mu_0$, which are arbitrarily good approximations when s is small enough, for $\mu_0 - \mu_1$ and $\mu_0 - \mu_N$, respectively, in expression (9) yields condition

$$s(1-s)\, \varepsilon_\mu|_{\mu=\mu_0} \mu_0 \left(\pi_M - \frac{1}{N}(\pi_M + DL_M)\right) - s\mu_0 DL_M > 0 \tag{10}$$

for the profitability of market share exclusion with non-discriminatory contracting.

A sufficient condition for the profitability of market share exclusion is that $\left.\frac{d(\Delta\Pi_I)}{ds}\right|_{s=0} > 0$. Using expression (10) this condition becomes $\varepsilon_\mu|_{\mu=\mu_0} > \frac{DL_M}{\pi_M - \frac{1}{N}(\pi_M + DL_M)}$. When the number of buyers N is large this condition is particularly intuitive, as it is then simply $\varepsilon_\mu|_{\mu=\mu_0} > \frac{DL_M}{\pi_M}$. This expression reflects the incumbent's gain from a buyer's non-restricted purchases, $\varepsilon_\mu|_{\mu=\mu_0} \pi_M$, and the buyer's loss of surplus DL_M from its restricted purchases for which the incumbent must compensate the buyer.

The next proposition collects these results on a set of sufficient conditions under which non-discriminatory market share exclusion is profitable.

Proposition 1 *Suppose that the incumbent can only offer buyers non-discriminatory exclusionary contracts. Suppose also that either 1) the probability of entry is convex (i.e. either linear or strictly convex) in the reward for entry, or 2) the number of buyers N is large enough. Then: a perfectly coalition-proof Nash equilibrium exists, and market share exclusion (with $s^* \in (0,1)$) occurs in any perfectly coalition-proof Nash equilibrium if $\varepsilon_\mu|_{\mu=\mu_0} > \frac{DL_M}{\pi_M - \frac{1}{N}(\pi_M + DL_M)}$.*

The next result in turn characterizes a set of necessary conditions under which non-discriminatory market share exclusion is profitable.

Proposition 2 *Suppose that the incumbent can only offer buyers non-discriminatory exclusionary contracts. Suppose also that either 1) the probability of entry is linear in the reward for entry, or 2) the number of buyers N is large enough and the reward-elasticity of the probability of entry is constant. Then: market share exclusion (with $s^* \in (0,1)$) occurs in any perfectly coalition-proof Nash equilibrium only if* $\varepsilon_\mu|_{\mu=\mu_0} > \frac{DL_M}{\pi_M - \frac{1}{N}(\pi_M + DL_M)}$.

Proof. See the appendix. ■

We now illustrate market share exclusion through two examples. We maintain the restriction to non-discriminatory contracting. In both examples we set the entry threat as $\mu = A\left(\Pi_R\right)^\varepsilon$ so that the reward-elasticity of entry is constant, we set the demand function for the upgrade good as $q\left(p\right) = 1 - p$, and we set we set the cost parameters $\bar{c}$ and Δc and the entry threat parameter A so that without market share exclusion the probability of entry is $\mu = 0.5$. In both examples we also set the number of buyers N sufficiently high for externalities among buyers to be increasing even if $\varepsilon < 1$ and for the payment t that just induces each buyer to accept a market share exclusion contract to be well approximated by expression (6).

In the first example we illustrate the profitability of market share exclusion contracts as a function of the restricted share of purchases s. The payment t is set as the most profitable payment that just induces each buyer to accept a contract with restricted market share s (regardless of whether it is profitable for the incumbent to actually offer such contracts). We set the reward-elasticity of entry as $\varepsilon = 2$.

Figure 1 shows the probability of entry (top panel) and the change in the incumbent's expected profit (middle panel) as well as change in the buyers' total expected surplus (bottom panel) compared to the case when no contracts are offered in stage 1. The middle panel demonstrates that in this example market share exclusion is profitable as there exists a range of values for the restricted market share s for which the change in the incumbent's expected profit is positive. The optimal share of restricted purchases is found at the peak of this curve ($s = 0.29$).

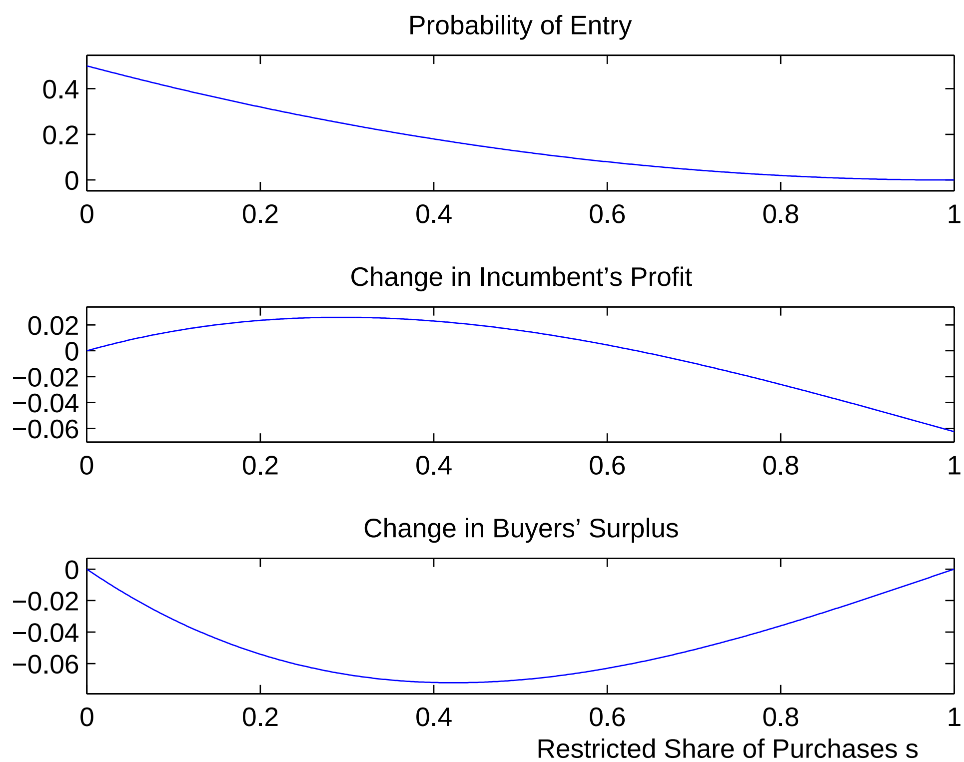

Figure 1: Impact of Market Share Exclusion Contracts on Incumbent Profit and Buyer Surplus.

The middle panel in Figure 1 also demonstrates the general result that non-discriminatory exclusive dealing contracts ($s = 1$) are not profitable. The intuition for this result is the same as in RRW-SW. A buyer's acceptance of an exclusive dealing contract has a negative externality only on buyers who reject the contract because only buyers who reject the contract benefit from entry. A buyer's acceptance of an exclusive dealing contract can therefore only make other buyers more eager to accept the contract. Thus, either all buyers reject the contract or all buyers accept the contract. This together with the observation that each acceptance of the contract has a negative externality only on buyers who reject the contract implies that in equilibrium there are no negative externalities among buyers. The absence of such negative externalities is reflected in the bottom panel in Figure 1, which shows that if the incumbent offers buyers contracts with $s = 1$ and payments t that would just induce the buyers to accept the offers, buyers would be just as well off when they accept the contracts as they are when no contracts are offered. The absence of negative externalities among buyers in turn implies that the incumbent cannot recoup from other buyers the cost of inducing a given buyer to accept an exclusive dealing contract.

In the second example we illustrate how the market share exclusion impacts equilibrium probability of entry and the incumbent's expected profit as a function of the reward-elasticity of entry. Figure 2 shows the equilibrium value of the share of restricted purchases s (top panel), the equilibrium probability of entry (middle panel), and the incumbent's expected profit in the equilibrium (bottom panel). The results in the bottom panel show that market share exclusion is profitable when $\varepsilon > 0.5$. This result is as expected, given that the assumption of a linear demand for the upgrade good implies that $\frac{DL_M}{\pi_{M\cdot}} = 0.5$, and given that Propositions 1 and 2 together imply that when the number of buyers N is large and the reward-elasticity of entry is constant the condition $\varepsilon_\mu|_{\mu=\mu_0} > \frac{DL_M}{\pi_{M\cdot}}$ is a necessary and sufficient condition for market share exclusion to be profitable.

The results in the middle panel of Figure 2 illustrate that the higher is the reward-elasticity of entry the higher is the impact of market share exclusion on the equilibrium probability of entry. The results in the bottom panel in turn demonstrate that as the reward-elasticity of entry increases the optimal s eventually decreases. When reward-elasticity of entry is high, the incumbent need only increase s little from $s = 0$ to induce a large decrease in the rival's probability of entry. Furthermore, when the reward-elasticity of entry is high, any further decrease in the rival's potential market size will have a much smaller impact on

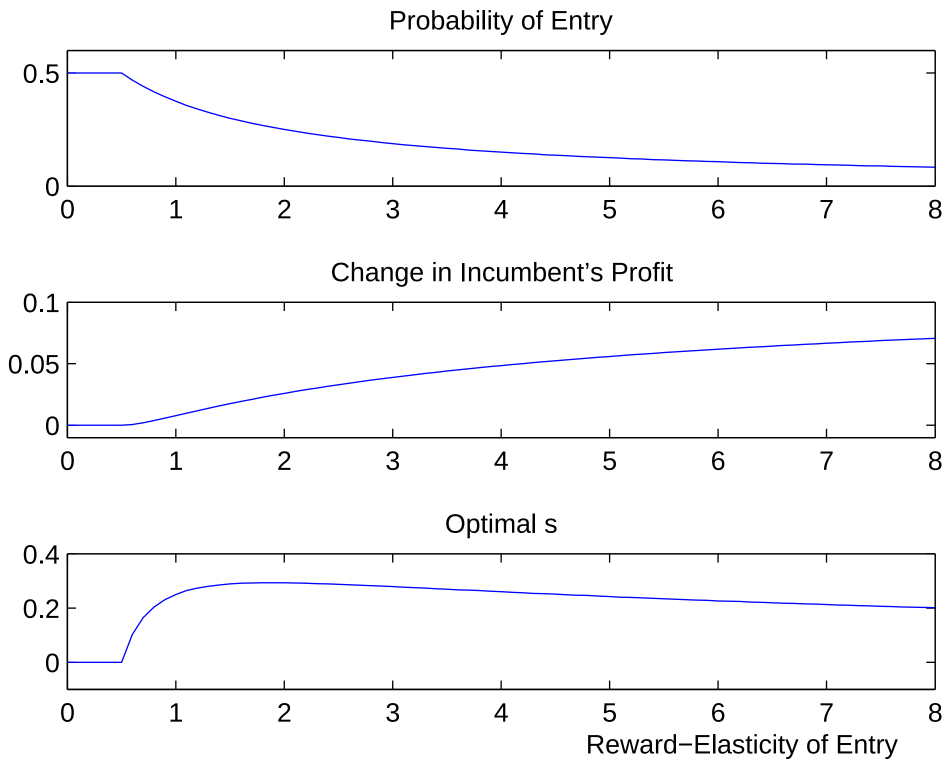

Figure 2: Equilibrium Market Share Exclusion as a Function of Reward-Elasticity of Entry.

the rival's probability of entry. As a result, while increasing the restricted share of purchases s from $s = 0$ is profitable whenever $\varepsilon_\mu|_{\mu=\mu_0} > \frac{DL_M}{\pi_M}$, further increases in s become quickly unprofitable for the incumbent when the reward-elasticity of entry is high.

Before proceeding to examine the equilibrium with discriminatory contracting, we note the consequences of market share exclusion on buyer and total surplus.

Proposition 3 *If market share exclusion occurs in a perfectly coalition-proof Nash equilibrium, the buyers' expected surplus in equilibrium is smaller compared to the buyers' expected surplus in equilibrium when market share exclusion contracts are prohibited.*

Proof. See the appendix. ■

The intuition for this result is the following. Due to the presence of deadweight loss from monopoly pricing of the upgrade good when the rival does not enter, the rival's entry increases each buyer's expected surplus more than it decreases the incumbent's expected profit from the buyers' unrestricted purchases. Hence, the buyers' and the incumbent's combined expected surplus is increasing in the rival's probability of entry. As market share exclusion decreases the rival's probability of entry, market share exclusion therefore decreases the buyers' and the incumbent's combined expected surplus. This implies that when market share exclusion is profitable for the incumbent, it decreases the buyers' expected surplus.

Market share exclusion obviously also decreases the rival's expected surplus. Hence, an immediate corollary of the above result is that market share exclusion also decreases total expected surplus.[21]

3.5 Equilibrium in Stage 1 with Discriminatory Contracting

Let $\hat{t}$ be the payment necessary to induce a buyer to accept a market share exclusion contract in equilibrium when all other buyers reject the contract. When externalities among buyers are increasing, with discriminatory contracting the incumbent need only offer one buyer the payment $\hat{t}$. The incumbent can offer lower payments $t_i < \hat{t}$ to all other buyers and still induce the other buyers to accept their offers. This is one reason why market share exclusion is more profitable with discriminatory contracting than with non-discriminatory contracting. We now determine whether the incumbent offers market share exclusion contracts (with $s_i \in (0,1)$) or exclusive dealing contracts (with $s_i = 1$) with discriminatory contracting. We continue to assume that either the entry threat is convex in the reward for entry or the number of buyers N is large enough, so that the externalities among buyers are increasing.

Let N_s denote the number of buyers that accept exclusionary contracts (with $s_i \in (0,1]$). When buyers 1 through i, where $i \in \{1, ..., N_s\}$, accept their offers, the rival's probability

[21] A more dynamic welfare perspective would also consider how the incumbent's increased profit from market share exclusion increases the probability that the base and upgrade goods are invented by the incumbent in the first place. Market share exclusion then improves the ex-ante buyer surplus and total surplus if the reward-elasticity of the incumbent's probability that the goods are invented is sufficiently high.

of entry is denoted $\mu_{\{1,...,i\}}$.[22] For notational convenience we use similar notation $\mu_{\{1,...,0\}}$ to denote the rival's probability of entry when all buyers reject the contracts.

With increasing externalities among buyers, in any perfectly coalition-proof Nash equilibrium there must be at least one buyer for whom the acceptance condition holds (with equality) when all other buyers reject their offers. Without the presence of such a buyer it would be a Nash equilibrium for all buyers to reject their offers, and buyers would coordinate on this equilibrium. We refer to this buyer as "buyer 1". Because buyer 1 will then accept its offer regardless of the other buyers' decisions, the contracts are coalition-proof to deviations by any coalition that includes buyer 1. The contracts offered to the $N-1$ other buyers must in turn be coalition-proof also to deviations by the coalition that all these $N-1$ other buyers. To accomplish this the incumbent offers one of these $N-1$ other buyers a contract that the buyer prefers to accept provided that buyer 1 accepts its offer but regardless of whether any of the other $N-2$ buyers accept their offers. We refer to this buyer as "buyer 2".

Continuing this reasoning reveals that the optimal exclusionary contracts are such that for each buyer $i \leq N_s$, the buyer's acceptance condition holds with equality when only buyers $1, ..., i-1$ accept their offers. Therefore, for buyer i the equality

$$\begin{aligned} & \left(1-\mu_{\{1,...,i\}}\right) CS_M + \mu_{\{1,...,i\}} \left[s_i CS_M + (1-s_i)(CS_C - \pi)\right] + t_i^*(s_1, ...s_i) \\ = \; & \left(1-\mu_{\{1,...,i-1\}}\right) CS_M + \mu_{\{1,...,i-1\}} CS_C + \delta \end{aligned} \tag{11}$$

holds. The two sides of the above equality are derived in the same manner as the expressions (2) and (3) were derived in the case of non-discriminatory contracting. Solving the above equality for the optimal payment function $t_i^*(s_1, ...s_i)$ yields

$$t_i^*(s_1, ...s_i) = \left[\mu_{\{1,...,i-1\}} - \mu_{\{1,...,i\}}(1-s_i)\right](\pi_M + DL_M) + \mu_{\{1,...,i-1\}}\pi + \delta. \tag{12}$$

[22] The identity of buyers 1 through i who accept their offers influences the rival's probability of entry only through the shares $s_1, ..., s_i$ specified these buyers' offers.

The incumbent's sets N_s and $(s_1, ..., s_{N_s})$ to maximize its expected profit

$$\Pi_I = N\left(1 - \mu_{\{1,...,N_s\}}\right)(\pi + \pi_M) + \sum_{i=1}^{N_s} \mu_{\{1,...,N_s\}}(\pi + s_i\pi_M) - \sum_{i=1}^{N_s} t_i^*(s_1, ...s_i), \tag{13}$$

where $t_i^*(s_1, ...s_i)$ is the optimal payment function given by the expression (12).[23]

The next proposition characterizes the equilibrium.

Proposition 4 *Suppose that the incumbent can offer buyers discriminatory exclusionary contracts. Suppose also that either 1) the entry threat is convex (i.e. either linear or strictly convex) in the reward for entry, or 2) the number of buyers N is large enough. Then: a perfectly coalition-proof Nash equilibrium exists, and a market share exclusion contract (with $s_i^* \in (0,1)$) is offered to at most one buyer in any perfectly coalition-proof Nash equilibrium.*

Proof. See the appendix. ■

The intuition for this result is the following. An increase in s_i decreases the rival's potential market size and the associated threat of entry when the buyer i accepts the contract. Hence, an increase in s_i decreases the payment $t_j^*(s_1, ...s_j)$ that the incumbent must offer any buyer $j > i$ to induce the buyer j to accept the contract $\left(s_j, t_j^*\right)$. The size of the impact of an increase in s_i on the payments to other buyers is thus highest for an increase in s_1, second highest for an increase in s_2, etc. Therefore, the incumbent sets $s_i^* > 0$ for some $i \in \{2, 3, ..., N_s\}$ only if it sets $s_j^* = 1$ for all $j < i$.

This result implies that firms have a disincentive to offer buyers market share exclusion contracts (with $s_i^* \in (0,1)$) compared to offering buyers only exclusive dealing contracts (with $s_i^* = 1$). However, given that formal analyses of exclusionary contracting have focused on exclusive dealing contracts, exclusive dealing contracts may be more likely to face scrutiny by

[23] The term $N(1 - \mu_{\{1,...,N_s\}})(\pi + \pi_M)$ in (13) reflects the incumbent's total revenue when the rival does not enter. The term $\sum_{i=1}^{N_s} \mu_{\{1,...,N_s\}}(\pi + s_i\pi_M)$ in (13) reflects the incumbent's total revenue when the rival enters and only buyers who accepted an exclusionary contract in stage 1 purchase from the incumbent. The term $\sum_{i=1}^{N_s} t_i^*(s_1, ...s_i)$ in (13) represents the incumbent's payments to buyers.

competition authorities than market share exclusion contracts. To avoid such scrutiny, firms may offer market share exclusion contracts instead of the more profitable discriminatory exclusive dealing contracts.

4 Conclusion

Existing analyses of exclusionary contracting have mostly focused on exclusive dealing. These analyses have shown that non-discriminatory exclusive dealing contracts can never be profitable for a seller when buyers coordinate on their most preferred equilibrium. In contrast, we show that market share exclusion with non-discriminatory contracting can be profitable for the excluding seller and always decreases both buyer surplus and total surplus. Because market share exclusion contracts restrict only a share of each buyer's potential purchases, the excluding seller can recoup the cost of inducing buyers to accept the contracts in the form of increased profit from the buyers' unrestricted purchases. Importantly, our results characterize the condition for the profitability of market share exclusion in terms of straightforward economic concepts, namely the number of buyers, the ratio of deadweight loss and monopoly profit, and the reward-elasticity of the probability of entry.

We also find that discriminatory market share exclusion contracts are less profitable than discriminatory exclusive dealing contracts. This finding, together with the popularity of market share exclusion in practice, opens a challenge for future analyses of exclusionary contracting. The popularity of market share exclusion may be explained in part by the fact that because formal analyses of exclusionary contracting have focused on exclusive dealing, exclusive dealing is more susceptible to scrutiny by competition authorities than market share exclusion. This advantage of market share exclusion is exemplified by the outcome of the recent case against Canada Pipe that prevents the firm from engaging in complete exclusion through exclusive dealing but allows the firm to offer buyers rebates and discounts as long as they are not conditioned on complete exclusivity. In contrast, our finding that also market share exclusion is anti-competitive implies that competition authorities should not view exclusive dealing as a pre-requisite for the possibility of anti-competitive effect from exclusionary contracting.

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Appendix: Proofs

Proof of Pricing Equilibrium in Section 3.1 when the Rival Does Not Enter. We first solve for the incumbent's optimal pricing when it sells both goods. We then solve for the incumbent's optimal pricing if it sells only the upgrade good and show that the incumbent's profit in this sub-game is lower than when the incumbent sells both goods. For expositional convenience we omit the subscript i from s_i here.

Let p_B denote the unit mark-up for the base good and let p_U denote the upgrade fee. A buyer is better off purchasing m units of the base good at price $m(\bar{c}+p_B)$ and than being an inactive buyer if $mv - m(\bar{c}+p_B) \geq 0$. Buyers therefore rather purchase m units of the base good than remain inactive buyers if $p_B \leq v - \bar{c}$. Similarly, a buyer is better off purchasing m units of the upgrade good at price $m(\bar{c}+p_B+p_U)$ than purchasing m units of the base good at price $m(\bar{c}+p_B)$ if $m(v+\theta) - m(\bar{c}+p_B+p_U) \geq msv - ms(\bar{c}+p_B)$. Buyers with $\theta \geq p_U$ therefore rather purchase m units of the upgrade good than purchase m units of the base good. The incumbent's expected profit is $\pi_{INC} \equiv m[p_B + p_U q(p_U)]$, provided that $p_B \leq v - \bar{c}$. Obviously, the incumbent never sets $p_B < v - \bar{c}$. Thus, it is optimal for the incumbent to set $p_B^* = v - \bar{c}$ and $p_U^* = p_M \equiv \arg\max_p pq(p)$. The associated unit mark-ups $v - \bar{c}$ and $v - \bar{c} + p_M$ for the base and upgrade goods, respectively, correspond to the incumbent's equilibrium pricing in the main text.

We now solve for the incumbent's optimal pricing if it sells only the upgrade good. Let p denote the incumbent's unit mark-up for the upgrade good. Buyers are active buyers if $m(v+\theta) - m(\bar{c}+p) \geq 0$, which can be rewritten as $\theta \geq p - (v - \bar{c})$. The incumbent's profit is $mpq(p - (v - \bar{c}))$ for all $p \geq v - \bar{c}$. Given the assumption $q(p) = 1 - \frac{p}{\bar{\theta}}$, we have $\frac{d\pi_{INC}}{dp} = m[1 - \frac{2p-(v-\bar{c})}{\bar{\theta}}]$. The assumption $v - \bar{c} > \bar{\theta}$ in turn implies that $\frac{d\pi_{INC}}{dp} < 0$ for all $p \geq v - \bar{c}$. The incumbent therefore sets $p^* = v - \bar{c}$ when it sells only the upgrade good. The incumbent's associated profit $\pi = m(v - \bar{c})$ in this sub-game is less than the profit $\pi + \pi_M$ which the incumbent obtains when it sells both goods. ■

Proof of Pricing Equilibrium in Section 3.1 when the Rival Enters. Here we solve for equilibrium pricing for buyers who accepted a market share equilibrium contract. For expositional convenience we omit the subscript i from s_i here. The assumption $\bar{c} - \Delta c > \bar{\theta}$ implies that the cost of purchasing a unit of the upgrade good from the rival is always higher than a buyer's *marginal* valuation for the upgrade good. Thus, it is never optimal for a buyer to purchase more than ms units of the base good from the incumbent to merely satisfy the contractual requirement and then purchase more than $m(1-s)$ units of the upgrade good from the rival for actual use. We also note that Δc was assumed to be small enough for the rival to always set its unit price equal to the incumbent's marginal cost $\bar{c}$. Without the assumption there might also be other equilibria than the one solved here (see footnote 15).

Next we solve for equilibrium pricing for the restricted share of purchases when the incumbent sells both goods. We then solve for equilibrium pricing for the restricted share of purchases if the incumbent sells only the upgrade good and show that the incumbent's profit in this sub-game is lower than when it sells both goods.

Let p_B denote the unit mark-up for the base good and let p_U denote the upgrade fee. A buyer is better off purchasing ms units of the base good from the incumbent at price $ms(\bar{c} + p_B)$ and $m(1-s)$ units of the upgrade good from the rival at price $m(1-s)\bar{c}$ than being an inactive buyer if $msv + m(1-s)(v+\theta) - ms(\bar{c} + p_B) - m(1-s)\bar{c} \geq 0$. Buyers with $\theta \geq \frac{sp_B - (v - \bar{c})}{1-s}$ therefore rather purchase ms units of the base good from the incumbent than remain inactive buyers. Similarly, a buyer is better off purchasing ms units of the upgrade good from the incumbent at price $ms(\bar{c} + p_B + p_U)$ and $m(1-s)$ units of the upgrade good from the rival at price $m(1-s)\bar{c}$ than purchasing ms units of the base good from the incumbent at price $ms(\bar{c} + p_B)$ and $m(1-s)$ units of the upgrade good from the rival at price $m(1-s)\bar{c}$ if $ms(v+\theta) + m(1-s)(v+\theta) - ms(\bar{c} + p_B + p_U) - m(1-s)\bar{c} \geq msv + m(1-s)(v+\theta) - ms(\bar{c} + p_B) - m(1-s)\bar{c}$. Buyers with $\theta \geq p_U$ therefore rather purchase from incumbent ms units of the upgrade good than purchase from the incumbent

ms units of the base good.

As buyers with $\theta \geq \frac{sp_B-(v-\bar{c})}{1-s}$ are active buyers, and active buyers with $\theta \geq p_U$, where $p_U \geq \frac{sp_B-(v-\bar{c})}{1-s}$, purchase the upgrade good from the incumbent, the incumbent's expected profit is $\pi_{INC} \equiv ms[p_B q(\frac{sp_B-(v-\bar{c})}{1-s})+p_U q\left(p_U\right)]$. Obviously, it is not optimal for the incumbent to set p_B such that $sp_B < v - \bar{c}$. Given the assumption $q\left(p\right) = 1 - \frac{p}{\bar{\theta}}$, we have $\frac{d\pi_{INC}}{dp_B} = ms[1-\frac{2sp_B-(v-\bar{c})}{\bar{\theta}(1-s)}]$. The assumption $v-\bar{c} > \bar{\theta}$ in turn implies that $\frac{d\pi_{INC}}{dp_B} < 0$ for all $sp_B \geq v-\bar{c}$ and for all $s \in \left(0, 1\right)$. Hence, in equilibrium p_B^* satisfies $sp_B^* = v - \bar{c}$ and p_U^* satisfies $p_U^* = p_M \equiv \arg\max_p pq\left(p\right)$. The associated incumbent's equilibrium unit mark-ups $\frac{v-\bar{c}}{s}$ and $\frac{v-\bar{c}}{s} + p_M$ for the base and upgrade goods, respectively, correspond to the incumbent's equilibrium pricing in the main text.

We now solve for the pricing equilibrium if the incumbent sells only the upgrade good. Let p denote the incumbent's unit mark-up for the upgrade good. Buyers are active buyers if $ms\left(v+\theta\right)+m\left(1-s\right)\left(v+\theta\right)-ms\left(\bar{c}+p\right)-m\left(1-s\right)\bar{c} \geq 0$. In this sub-game buyers are thus active buyers if $\theta \geq sp-\left(v-\bar{c}\right)$, and the incumbent's profit is $\pi_{INC} \equiv mspq\left(sp-\left(v-\bar{c}\right)\right)$. Having assumed that $q\left(p\right) = 1 - \frac{p}{\bar{\theta}}$ and $v - \bar{c} > \bar{\theta}$, the condition $\frac{d\pi_{INC}}{dp_B} < 0$ holds for all $sp \geq \left(v-\bar{c}\right)$ and for all $s \in \left[0,1\right]$. The incumbent's equilibrium price p^* for the upgrade good thus satisfies $sp^* = v - \bar{c}$ when it sells only the upgrade good. The incumbent's associated profit $\pi = m\left(v-\bar{c}\right)$ in this sub-game is less than the profit $\pi + s\pi_M$ which the incumbent obtains when it sells both goods. ■

Proof of Lemma 1. Rewrite the acceptance condition (4) as $t_i > \mu_{S_k}\left[\left(\pi+\pi_M+DL_M\right)\right] - \mu_{S_k \cup i}\left(1-s_i\right)\left(\pi_M+DL_M\right)$ when among the other buyers the fixed set of k other buyers S_k accept their offers, and as $t_i > \mu_{S_{k+1}}\left[\left(\pi+\pi_M+DL_M\right)\right] - \mu_{S_{k+1}\cup i}\left(1-s_i\right)\left(\pi_M+DL_M\right)$ when among the other buyers one additional buyer accepts its offer. The additional acceptance renders buyer i more eager to accept its offer if the right-hand side of the latter inequality is less than the right-hand side of the former inequality, which is formally stated as $\mu_{S_{k+1}}\left[\left(\pi+\pi_M+DL_M\right)\right] - \mu_{S_{k+1}\cup i}\left(1-s_i\right)\left(\pi_M+DL_M\right) < \mu_{S_{k+1}}\left[\left(\pi+\pi_M+DL_M\right)\right]$

$-\mu_{S_{k+1}\cup i}\left(1-s_i\right)\left(\pi_M+DL_M\right)$. Rearranging yields $\frac{\mu_{S_{k+1}}-\mu_{S_k}}{\mu_{S_{k+1}\cup i}-\mu_{S_k\cup i}}-\left(1-s_i\right)\frac{\pi_M+DL_M}{\pi+\pi_M+DL_M}>0$. When the entry threat $F\left(\Pi_R\right)$ is linear in the reward for entry, the effect of a buyer's acceptance on the probability of entry is the same regardless of other buyers' acceptance decisions and thus $\frac{\mu_{S_{k+1}}-\mu_{S_k}}{\mu_{S_{k+1}\cup i}-\mu_{S_k\cup i}}=1$, implying that the above condition always holds. When the entry threat $F\left(\Pi_R\right)$ is strictly convex in the reward for entry, $\frac{\mu_{S_{k+1}}-\mu_{S_k}}{\mu_{S_{k+1}\cup i}-\mu_{S_k\cup i}}>1$, implying that the above condition always holds. For an arbitrary number of buyers N this inequality may not hold if the entry technology is strictly convex and if, as a result, $\left(\mu_{S_{k+1}\cup i}-\mu_{S_k\cup i}\right)$ is sufficiently large compared to $\left(\mu_{S_{k+1}}-\mu_{S_k}\right)$. However, when the number of buyers N is sufficiently large, each buyer's acceptance has an arbitrarily small impact on the probability of entry and, consequently, the factors $\mu_{S_{k+1}}-\mu_{S_k}$ and $\mu_{S_{k+1}\cup i}-\mu_{S_k\cup i}$ are arbitrarily close to one another, implying that $\frac{\mu_{S_{k+1}}-\mu_{S_k}}{\mu_{S_{k+1}\cup i}-\mu_{S_k\cup i}}$ is arbitrarily close to 1 so that the above inequality is satisfied. ■

Proof of Lemma 2. By Lemma 1, a buyer's decision to accept its offer never reverses another buyer's preference to accept its offer under the two alternative sets of assumptions present in both Lemma 1 and Lemma 2. This allows us to define sets of buyers $S_0, S_1, ..., S_P$ recursively until either $P=N-1$ or S_P is an empty set. Let S_0 denote the set of buyers who prefer to accept their offers when the $N-1$ other buyers reject their offers, and let S_j for $j>0$ denote the set of buyers who are not in any of the sets of buyers $S_0, S_1, ..., S_{j-1}$ but who prefer to accept their offers when buyers in the sets of buyers $S_0, S_1, ..., S_{j-1}$ accept their offers. Using these sets $S_0, S_1, ..., S_P$, we next determine coalition-proof acceptance decisions for all buyers in the contract-acceptance subgame for a given profile of contract offers by the incumbent, thus showing that a coalition-proof Nash equilibrium exists in this subgame.

Consider first the case that the set of buyers S_0 is empty. Then it is a Nash equilibrium for all buyers to reject their offers. To see that this equilibrium would also be coalition-proof, consider the deviation by some coalition of buyers. By the property that each acceptance has a negative externality on all other buyers, a deviation (from rejection to acceptance) by a coalition of buyers would be even less profitable than a unilateral deviation. As a unilateral deviation is already unprofitable by the assumption that the set of buyers S_0 is empty, there is thus no profitable deviation for any coalition of buyers.

Consider now the case that the set of buyers S_0 is non-empty. Then in any Nash equilibrium all buyers in the set of buyers S_0 accept their offers. Moreover, given that another buyer's decision to accept its offer never reverses a buyer's preference to accept its offer, buyers in the set of buyers S_0 will not find deviations as part of any coalition profitable. Thus, a Nash equilibrium in which buyers in the set S_0 accept the contract is coalition-proof to a deviation by any coalition that includes one or more buyers from the set of buyers S_0.

The coalition-proof equilibrium is then constructed through recursion as follows.

If the sets of buyers $S_{0,}S_1, ..., S_{j-1}$ are all non-empty but the set of buyers S_j is empty, it is a Nash equilibrium for buyers in the sets of buyers $S_{0,}S_1, ..., S_{j-1}$ to accept their offers and for the rest of the buyers to reject their offers. To see that this equilibrium would be coalition-proof, note first that buyers in the set S_{j-1} will never find deviations as part of any coalition profitable given that buyers in the sets $S_{0,}S_1, ..., S_{j-2}$ will never find deviations as part of any coalition profitable and given that another buyer's decision to accept its offer never reverses a buyer's preference to accept its offer. Then consider a deviation by a coalition of buyers who are not in the sets of buyers $S_{0,}S_1, ..., S_{j-1}$. Because each acceptance has a negative externality on all other buyers, deviation (from rejection to acceptance) as part of such a coalition would be even less profitable for these buyers than a unilateral deviation, which is unprofitable by the assumption that the set of buyers S_j is empty. Hence, there is no profitable deviation for any coalition buyers if it is a Nash equilibrium that buyers in the sets of buyers $S_{0,}S_1, ..., S_{j-1}$ accept their offers and the rest of the buyers reject their offers.

If all of the sets of buyers $S_{0,}S_1, ..., S_{j-1}$ are non-empty and also the set of buyers S_j is non-empty, in any Nash equilibrium all buyers in the sets of buyers $S_{0,}S_1, ..., S_{j-1}$ and S_j accept the contract. Moreover, given that another buyer's decision to accept its offer never reverses a buyer's preference to accept its offer and given that buyers in the sets of buyers $S_0, S_1, ..., S_{j-1}$ will not find deviations as part of a coalition profitable, buyers in the set of buyers S_j will not find deviations as part of a coalition profitable either. Thus, a Nash equilibrium in which buyers in the sets of buyers $S_0, S_1, ..., S_{j-1}$ and S_j accept their offers is also coalition-proof to any deviation that includes one or more buyers in the sets of buyers $S_0, S_1, ..., S_{j-1}$ and S_j. ■

Proof of Proposition 2. When the entry threat is linear, $\mu_n = \max\{a + b\Pi_{R,n}, 0\}$, where $b > 0$ and $\Pi_{R,n}$ denotes the reward for entry when n buyers accept the market share exclusion contract, $\mu_0 - \mu_n = b(\Pi_{R,0} - \Pi_{R,n})$. Using the result $\varepsilon_\mu|_{\mu=\mu_0} = b \times \frac{\Pi_{R,0}}{\mu_0}$, this can be rewritten as $\mu_0 - \mu_n = \mu_0 \, \varepsilon_\mu|_{\mu=\mu_0} \frac{(\Pi_{R,0} - \Pi_{R,n})}{\Pi_{R,0}}$. Because $\Pi_{R,n} = \left(\frac{N - ns}{N}\right)\Delta c$, this can in turn be rewritten as $\mu_0 - \mu_n = \mu_0 \, \varepsilon_\mu|_{\mu=\mu_0} \frac{n}{N} s$. Hence, whereas for a general entry technology the relationships $\mu_0 - \mu_1 = \mu_0 \, \varepsilon_\mu|_{\mu=\mu_0} \frac{s}{N}$ and $\mu_0 - \mu_N = \mu_0 \, \varepsilon_\mu|_{\mu=\mu_0} s$ hold only approximately when s is small (see the discussion preceding Proposition 1 in the text) for a linear entry technology they hold with equality and for all s. Consequently, expression $\Delta\Pi_I = N\mu_0 \, \varepsilon_\mu|_{\mu=\mu_0} s\pi_M(1-s) + N(-\mu_0 s DL_M - (1-s)\mu_0 \, \varepsilon_\mu|_{\mu=\mu_0} \frac{s}{N}(\pi_M + DL_M) - \delta)$, where δ is arbitrarily small, now gives the impact of a market share exclusion contract on profit for all s. Because $\frac{d^2(\Delta\Pi_I)}{ds^2} < 0$, the sufficient condition for the profitability of market share exclusion when the entry technology is linear is therefore $\left.\frac{d(\Delta\Pi_I)}{ds}\right|_{s=0} = N\mu_0[\varepsilon_\mu|_{\mu=\mu_0} \pi_M - DL_M - \varepsilon_\mu|_{\mu=\mu_0} \frac{1}{N}(\pi_M + DL_M)] > 0$, which can be rewritten as $\varepsilon_\mu|_{\mu=\mu_0} > \frac{DL_M}{\pi_M - \frac{1}{N}(\pi_M + DL_M)}$.

Consider now the case that the entry threat has constant reward-elasticity, $\mu = A(\Pi_R)^\varepsilon$ with $\varepsilon > 0$ and $A > 0$, and the number of buyers N is large. The presence of a large number of buyers again implies that externalities among buyers are increasing, so that in the coalition-proof equilibrium either all buyers reject the contract or all buyers accept the contract, and that buyers only accept the contract if they prefer to accept the contract when all other buyers reject the contract. For a given s, the most profitable market share exclusion contract satisfies $t = \mu_0[\pi + s(\pi_M + DL_M)] + \delta$ (see the equality (6)) when the number of buyers N is large enough. Combining this with the effect that buyers' acceptance of the market share exclusion contract has on the incumbent's expected profit (see the expression (8)) when the number of buyers N is large yields $\Delta\Pi_I = N(\mu_0 - \mu_N)\pi_M(1-s) + N(-\mu_0 sDL_M - \delta)$. Substituting $\mu_0 = A\left(\frac{N}{N}\right)^{\varepsilon}$ for μ_0 and $\mu_N = A\left(\frac{N(1-s)}{N}\right)^{\varepsilon}$ for μ_N, this becomes $\Delta\Pi_I = NA(1-(1-s)^{\varepsilon})\pi_M(1-s) + NA(-sDL_M - \delta)$. Therefore, $\frac{d(\Delta\Pi_I)}{ds} = NA((-1+(\varepsilon+1)(1-s)^{\varepsilon})\pi_M - DL_M + \tilde{\delta})$, where $\tilde{\delta}$ is arbitrarily small when the number of buyers N is large enough, and $\frac{d^2\Delta\Pi_I}{ds^2} = NA(-\varepsilon(\varepsilon+1)(1-s)^{\varepsilon-1}\pi_M + \hat{\delta})$, where $\hat{\delta}$ is arbitrarily small when the number of buyers N is large enough. Because $\frac{d^2\Delta\Pi_I}{ds^2} < 0$ for all $s \in [0, 1-\bar{\delta}]$, where $\bar{\delta}$ is arbitrarily small, when the number of buyers N is large enough, the condition $\left.\frac{d(\Delta\Pi_I)}{ds}\right|_{s=0} = NA\left(\varepsilon\pi_M - DL_M + \hat{\delta}\right) > 0$ is a necessary condition for market share exclusion to be profitable when the number of buyers N is large enough. Because $\hat{\delta}$ is arbitrarily small, this implies that when the number of buyers N is large enough market share exclusion is profitable only if $\varepsilon\pi_M - DL_M > 0$. ■

Proof of Proposition 3. Suppose that n buyers accept the market share exclusion contract in equilibrium. The incumbent's expected profit from a buyer who rejects the contract is $(1-\mu_n)(\pi+\pi_M)$. The expected surplus of a buyer who rejects the contract is $CS_M + \mu_n(\pi + \pi_M + DL_M)$. The sum of these two surpluses is $CS_M + \pi + \pi_M + \mu_n DL_M$. The incumbent's expected profit from a buyer who accepts the contract is $(1-\mu_n)(\pi+\pi_M) + \mu_n(\pi + s\pi_M) - t$. The expected surplus of a buyer who accepts the contract is $CS_M + \mu_n[(1-s)(\pi_M + DL_M)] + t$. The sum of these two surpluses is $CS_M + \pi + \pi_M + \mu_n(1-s)DL_M$. The combined expected surplus of the incumbent and the buyer is thus increasing in μ_n for both types of buyers. For buyers who accept the contract the combined expected surplus of the incumbent and the buyer is also decreasing in s. The total expected surplus of the incumbent and all buyers is therefore increasing in μ_n and decreasing in s. Because $\mu_n < \mu_0$ and $s > 0$ the total expected surplus of the incumbent and all the buyers is smaller when market share exclusion occurs in equilibrium compared to the case when market share exclusion is prohibited. If market share exclusion is profitable for the incumbent, it must therefore decrease the buyers' total expected surplus. ■

Proof of Proposition 4. That an equilibrium exists follows again directly from Lemma 2 and the fact that the incumbent's relevant strategy space in stage 1 is compact. Substituting expression (12) for $t_i^*(s_1,...s_i)$ into expression (13) yields the expression $\Pi_I = N\left(1-\mu_{\{1,...,N_s\}}\right)(\pi+\pi_M)+\sum_{i=1}^{N_s}[\mu_{\{1,...,N_s\}}(\pi+s_i\pi_M)-[\mu_{\{1,...,i-1\}}-\mu_{\{1,...,i\}}(1-s_i)](\pi_M+DL_M)+\mu_{\{1,...,i-1\}}\pi+\delta]$ for the incumbent's expected profit, and this can be rewritten as $\Pi_I = N(\pi+\pi_M)-\mu_{\{1,...,N_s\}}[N(\pi+\pi_M)-N_s\pi-\pi_M\sum_{i=1}^{N_s}s_i]-(\pi_M+DL_M)(\mu_0+\sum_{i=1}^{N_s}s_i\mu_{\{1,...,i\}}-\mu_{\{1,...,N_s\}})-\pi\sum_{i=0}^{N_s-1}\mu_{\{1,...,i\}}-N_s\delta$.

Suppose now that the incumbent changes s_i and s_{i+k}, where $k>0$ and $i+k\leq N_s$, so that s_i+s_{i+k} remains constant, i.e. $s_i+s_{i+k}=c$, where $c\in(0,2)$. The impact on the incumbent's expected profit is $\left.\frac{d\Pi_I}{ds_i}\right|_{s_i+s_{i+k}=C} = -(\pi_M+DL_M)[\sum_{j=i}^{j=i+k-1}s_j\frac{d\mu_{\{1,...,j\}}}{ds_i}+\mu_{\{1,...,i\}}-\mu_{\{1,...,i+k\}}]-\pi\sum_{j=i}^{i+k-1}\frac{d\mu_{\{1,...,i\}}}{ds_i}$. Because $\frac{d\mu_{\{1,...,j\}}}{ds_i}<0$ and $\mu_{\{1,...,i\}}-\mu_{\{1,...,i+k\}}<0$, we have $\left.\frac{d\Pi_I}{ds_i}\right|_{s_i+s_{i+k}=C}>0$, which implies that the incumbent sets $s_i=\max\{c,1\}$. Hence, the incumbent offers an exclusionary contract to buyer i (with $s_i>0$) only if the incumbent offers all buyers $j<i$ exclusive dealing contracts (with $s_j=1$). ■