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A Simple Theory of Predation

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A Simple Theory of Predation

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Abstract
We propose a simple theory of predatory pricing, based on incumbency advantages, scale economies and sequential buyers (or markets). The prey needs to reach a critical scale to be successful. The incumbent (or predator) has an initial advantage and is ready to make losses on earlier buyers so as to deprive the prey of the scale the latter needs, thus making monopoly profits on later buyers. Several extensions are considered, including cases where scale economies exist because of demand externalities or two-sided market effects, and where markets are characterized by common costs. Conditions under which predation may take place in actual cases are also discussed.

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1 Introduction

Standard models of predatory pricing, i.e. reputation, signalling, and financial predation models, rely on information asymmetries to explain why an incumbent firm may have an incentive to prey upon rivals. For instance, these models assume that the prey is an entrant firm who does not know the cost of the incumbent, or that external financiers do not observe the behavior of the prey once it has obtained outside funds.[1,2]

In this paper, we present a simple theory of predation which does not depend on information asymmetries, and which is based instead on the co-existence of *scale economies* and *sequential buyers* (or markets). Intuitively, our mechanism works as follows. In an industry where there exist scale economies (which can be either on the supply side or the demand side), the incumbent engages in below-cost pricing to some early buyers (or markets) to deprive the rival of the scale it needs to operate successfully. Once deprived the rival of key buyers (or markets), the incumbent will be able to raise prices on the remaining buyers (or markets), thereby recouping losses. The two usual ingredients of predation, early sacrifice of profits followed by later recoupment, are therefore present in our theory as well.

In our model, the incumbent may exclude a more efficient rival even if the latter can approach buyers and submit bids at the same time as the incumbent. It is the interaction between scale economies and an *incumbency advantage* which makes exclusion possible. To see why, consider a case where the two firms compete for two new consumers who buy in sequence. Imagine that the incumbent also serves some non-contestable buyers, who bought from it in the past and are not willing to switch to another supplier. Instead the rival, who is a recent entrant, has no (or fewer) captive buyers. Under scale economies, this asymmetry may imply that the incumbent is more efficient than the rival at supplying *one* new buyer, even though the rival is more efficient at supplying *both* of the new buyers. In turn, this implies that - if for some reason it were able to secure the first buyer - the incumbent would be able to extract higher rents than the rival from the second buyer. Hence, when firms compete for the first buyer - anticipating that who secures the first buyer will also supply the second - there will be two effects at play. On the one hand, higher overall efficiency makes the rival more aggressive; on the other hand, the perspective of higher rent extraction makes the incumbent more aggressive. We show that if the (overall) efficiency advantage of the rival is not strong enough, then it is the incumbent which will make the winning bid for the first buyer. Therefore, predation will arise at the equilibrium and is welfare detrimental.

Perhaps the simplest setting where to see this mechanism at work is one where the incumbent has already sunk an entry cost f, while the rival has not, but it has a lower (constant) marginal cost than the incumbent. Economies of scale imply that entry is profitable only if both buyers

[1] Kreps and Wilson (1982) are the main reference for reputation-based predation models. Milgrom and Roberts (1982) explain predation through a signalling model, which has later been used by Saloner (1987) to model predation for takeovers, by Scharfstein (1984) to model test-market predation, and Fudenberg and Tirole (1985) to show how predation might limit the ability of a new entrant to infer about its profitability. See Bolton and Scharfstein (1990) for a theory which models predation in (imperfect) financial markets, by putting on firmer grounds the so-called 'long purse' theory of predation.

[2] For a discussion on whether real-world cases fit the 'story' described by such models, see Bolton, Brodley and Riordan (2000, 2001) and Elzinga and Mills (2001).

buy from the entrant. Here, if the incumbent manages to serve the first buyer, it will extract monopoly profits from the second buyer (recall that entry is profitable only if both buyers are served), whereas if the entrant serves the first buyer, it will only make duopoly profits from serving the second buyer. If the entrant's efficiency advantage is small enough, the incumbent will bid more aggressively for the first buyer, and predation will take place at equilibrium, with the profit sacrifice on the first buyer outweighed by the profits made on the second buyer.

We intentionally keep our model as simple and parsimonious as possible, to highlight our predation mechanism, discuss conditions under which it holds, and show that it can be applied to several contexts. After presenting the basic model with supply-side scale economies (Section 2), we discuss the robustness of our results in Section 3. In Section 4 we show that predation may also occur in markets characterized by demand-side scale economies, due for instance to the existence of network externalities or of two-sided markets. Section 5 will conclude the paper.

The predation mechanism we highlight seems to be present in a number of recent predation cases that took place in Europe (in the US, after the 1993 Supreme Court judgment in *Brooke Group* and the requirement that plaintiffs prove recoupment, there have been no successful predatory cases) where both scale economies and strong initial advantages on the side of the incumbent play an important role. Let us briefly review some of these cases.

In May 2009, the European Commission imposed on Intel the highest fine in history (more than one billion euro), for implementing a strategy aimed at foreclosing competitors from the market of Central Processing Units for the x86 architecture.[3] More particularly, Intel had awarded rebates (and engaged in other restrictive practices) to major PC manufacturers (OEMs), and to Media Saturn Holding, Europe's largest PC retailer. According to the EC, these rebates were below costs, and were motivated by the growing competitive threat that the rival firm AMD represented for Intel. The EC does not spell out a theory of harm, but the mechanism we highlight in this paper is consistent with the facts of the case. Intel is strongly dominant in the relevant market and a vaste proportion of market demand is considered to be non-contestable, guaranteeing Intel a strong incumbency advantage over AMD. There are significant scale economies in the x86 CPU market due to the large sunk costs in R&D and in production facilities.[4] Also, the orders of some buyers seem to be crucial for the success of rivals:

> "(T)he Decision also indicates that certain OEMs, and in particular Dell and HP, are strategically more important than other OEMs in their ability to provide a CPU manufacturer access to the market. They can be distinguished from other OEMs on the basis of three main criteria: (i) market share; (ii) strong presence in the more profitable part of the market; and (iii) ability to legitimize a new CPU in the market." (para 32 of the Summary of Commission Decision.)

Finally, it is interesting to note how - similar to the 'auction' modelled in our paper - Intel and AMD were competing in prices for the contestable portion of the market.[5]

[3] European Commission Decision COMP/C-3/37.990 of 13 May 2009 (*Intel*).

[4] See section 3.3 of the Decision. Note that the EC stresses that "... once entry has taken place, a manufacturer's production capacity is limited by the size of the existing facilities. Expanding output requires additional (sunk) investment into new property, plant and equipment as well as several years' lead time." (para. 866 of the Decision.)

[5] For instance, at para 956 of the Decision, there is a reference to AMD competing with, but not being able to match, Intel's offers: 'AMD was not in a position to offer a compensating rebate of the size required by HP.'

In 2004 the Italian Antitrust Authority found that Telecom Italia (TI), the public monopolist before the liberalization process, had abused a dominant position.[6] Telecom Italia was found to set prices in a selective and aggressive way and to engage into cross-subsidization, with the aim of taking away key customers from its rivals,[7] thereby hindering their expansion. There are no doubts that scale economies are pervasive in telecommunications and that TI had strong incumbency advantages over new entrants, which still had to build up or fully develop their infrastructure (viable only if they reached sufficient scale) and customer basis.[8] Among other episodes, Telecom Italia was found guilty of price abuses in the 2002 CONSIP auction for supplying fixed and mobile telephony services to the Italian Public Administrations. The fact that firms competed in the pricing conditions to business customers and that formal tender auctions existed, also makes this market very similar to the one described in our model.

In November 2008 the UK Office of Fair Trading (OFT) found that Cardiff Bus had infringed Chapter II of the UK Competition Act 1998 by engaging in predatory conduct.[9] In response to 2 Travel's entry into the market with a new no-frills bus service, Cardiff Bus introduced its own no-frills bus service (the 'white service'), running on the same routes and at similar times of day as 2 Travel's services. The white services were run at a loss until shortly after 2 Travel's exit, when Cardiff Bus discontinued them. In this case as well, scale economies were important both at the level of single routes (consumers value frequency of services) and at the level of the bus network (consumers value the combinations of schedules and routes). While Cardiff Bus was the (dominant) incumbent and had already developed a strong network, other bus companies would have had to incur substantial costs to develop it.

In 2001 the OFT found that Napp, a pharmaceutical company, had contravened Chapter II of the UK Competition Act 1998 through its behavior in the market for the supply and distribution of sustained release morphine in the United Kingdom. This infringement involved both a charge of predatory pricing in the hospital segment and one of excessive pricing in the community segment (Napp had a market share well in excess of 90% in both segments). While it may appear odd that Napp could engage in too low prices in a market segment and too high prices in another market segment, our theory helps interpret the case. Sustained release morphine was sold to two completely different groups of buyers. One group is represented by hospitals, which have a high demand elasticity (pharmaceuticals have to be paid out of their budget) and can count on the advice of specialist doctors for an assessment of the competing products. The other group is represented by the so-called 'community segment', where buyers are general practitioners (GPs) who prescribe products for their patients (with the National Health Service paying the bills), and who - not being experts - tend to choose those products which have already been chosen by hospitals. This can be seen as an asymmetric two-sided market, where hospitals mostly care about prices (and do not care about choices made by GPs), while the demand of the community segment strongly depends on the choices made by hospitals.

[6] *Comportamenti abusivi di Telecom Italia.* Decision No. 13752, 16 November 2004.

[7] Internal documents showed TI's management was willing to incur losses in order to win - or win back - important business customers.

[8] For instance, at Para. 275 of the Decision, a cable rival, Fastweb, argues that Telecom Italia's strategy aimed at eliminating competitors' incentives to invest in new and non-recoverable alternative telecom infrastructure, with the ultimate effect of inhibiting the development of competitors in the long-run.

[9] Decision of the Office of Fair Trading No. CA98/01/2008 of 18 November 2008.

As we shall discuss in Section 4.2, an incumbent like Napp may want to sell below costs to the crucial side of the market (the hospital market in this case) to make sure the rival does not win it, thereby deterring the rival's activity also in the other side of the market (in this case, the community segment) - whose demand follows closely the choice made by hospitals. As a result, the incumbent can behave like a monopolist on the community side of the market, recouping any losses made to win the other (hospital) side.

Finally, in 2001, the European Commission found that Deutsche Post (DPAG) had abused a dominant position in the market of mail order parcel services.[10] The Commission argues that by making use of predatory pricing and fidelity rebates, DPAG tried to prevent competitors in the mail-order service from developing the infrastructure needed to compete successfully. The idea that the incumbent's pricing policy aimed at depriving the rivals of economies of scale and scope emerges clearly from the following quote (where 'cooperation partners' are customers with very large orders):

> "Contrary to what DPAG maintains, all of the disputed fidelity rebates are likely to have an effect on the opportunities that other suppliers of mail-order parcel services have to compete. Successful entry into the mail-order parcel services market requires a certain critical mass of activity (some 100 million parcels or catalogues) and hence the parcel volumes of at least two cooperation partners in this field. By granting fidelity rebates to its biggest partners, DPAG has deliberately prevented competitors from reaching the 'critical mass' of some 100 million in annual turnover. This fidelity rebating policy was, in precisely the period in which DPAG failed to cover its service-specific additional costs (1990 to 1995), a decisive factor in ensuring that the 'tying effect' of the fidelity rebates for mail-order parcel services maintained an inefficient supply structure [...]." (Deutsche Post, para. 37)

Although not specified by the European Commission, one rationale for predation may have been that, given the existence of important common costs with other postal services, mail-order operators could later start to compete with other services of Deutsche Post.[11] Hence, by predating in the market which opened first, Deutsche Post preserved its monopoly position in all the markets where it operated. The application of our base model discussed in Section 2.2 fits the facts of the Deutsche Post case.

Let us close the introduction with a note on the related literature. Obviously, our paper belongs to the literature on predatory pricing we have referred to above.[12] The mechanism we

[10]European Commission Decision COMP/35.141 of 20 March 2001 (*"Deutsche Post"*). Published in the Official Journal of the European Communities, OJ L 125/27 of 5 May 2001.

[11]For instance, Hermes Versand Service was initially created for the mail-order trade's own use, but its infrastructure was later used to convey parcels for third parties and in 2000 became one of the largest courier, express mail and parcels operator in Germany. (See Deutsche Post, para. 38 and footnote 64)

[12]See also Cabral and Riordan (1994) for a duopoly model with learning by doing where the firm that made larger sales in the past has an incentive to price aggressively to speed up learning and induce the rival's exit. In their model firms face a sequence of buyers with uncertain demand and are ex-ante symmetric. The predatory equilibrium is not necessarily welfare detrimental because quicker learning triggers lower production costs. A model which rationalizes *joint* predation is Harrington (1989) where active firms coordinate in implementing a policy of predatory prices in case of entry in order to sustain collusion in spite of the absence of high entry barriers. In this case joint predation is a credible threat to discourage entry. Instead Argenton (2010) shows, in a model where firms have increasing marginal costs, that some firms may *coordinate* on predatory prices in order to induce exit of an existing rival and earn larger profits in the future.

propose is a new one, which may help rationalize predation in particular cases where previous theories may not apply. In other cases, however, our mechanism might well co-exist with other rationales for predation. For instance, an incumbent may prey upon a rival in the initial stages of a market, both as an attempt to deprive it of key profits (and thus to prevent it from enjoying scale economies), and as a way to *signal* that it would behave aggressively in the future - consistent with what suggested by incomplete information models. Further, our mechanism is consistent with Bolton and Scharfstein (1990)'s financial predation model: predation, by denying profits to the rival, also reduces its assets, and therefore limits its access to outside funding.

Our paper is also very closely related to the more general literature on exclusion and may be seen as an application of Bernheim and Whinston (1998) where inefficient exclusion arises due to the existence of *contracting externalities* that agents fail to internalize. In our case, the agents who take their decisions in the early periods (the incumbent, the entrant and the early buyers) do not internalize the payoff of subsequent buyers, thereby finding it jointly profitable to exclude the more efficient entrant, even though exclusion reduces total welfare.

Contracting externalities are also at the basis of exclusion in Segal and Whinston (2000) where, under the presence of multiple buyers and supply-side economies of scale, the incumbent uses exclusive dealing contracts to deter efficient entry. An important difference, though, is that - in addition to the *incumbency advantage* which exists in our paper as well - in Segal and Whinston (2000) the incumbent also enjoys a *first-mover advantage* (i.e., it can make offers to buyers before the entrant could materialize and make counter-offers), which facilitates exclusion. Indeed, in the case where buyers are approached sequentially, where the timing of the game is the closest to our model, entry deterrence does not require any sacrifice of profits by the incumbent. In our paper, instead, the incumbent needs to sell below cost to early buyers to achieve exclusion (if the incumbent could make offers to buyers before the entrant materialised, exclusion without profit sacrifice would occur in our setting as well).[13] More generally, our paper is also related to models where exclusion occurs due to discriminatory offers. In this perspective, the main reference is probably Innes and Sexton (1994)'s "divide and conquer" strategy, a more recent paper being Karlinger and Motta (2007). Finally, the fact that exclusion takes place by depriving the entrant, in early periods, of profits it needs to operate successfully in the long run makes our exclusionary mechanism close also to Carlton and Waldman (2002)'s paper on exclusionary tying in complementary markets.

[13] Another paper where exclusion may arise in the absence of a first mover advantage is Gans and King (2002). Differently from our setting, suppliers are perfectly symmetric and their focus is on asymmetries in *contracting opportunities*: there exist large buyers that can contract ex-ante with suppliers and small buyers - whose demand is insufficient for a supplier to reach efficient scale - that can only trade ex-post on *a single price* mass market. In this environment, it is in the interest of large buyers to commit ex-ante to exclusivity with one supplier, to prevent the rival supplier from achieving the efficient scale. This will stifle competition in the mass market, thereby allowing to extract more rents from small buyers. These rents are appropriated by large buyers through the ex-ante contracting. Allocative inefficiencies arise because small buyers pay a too high price, but there is no exclusionary intent in suppliers' behaviour.

2 A simple model

In this Section, we introduce our basic model with supply-side scale economies. There are two contestable buyers/markets, B_1 and B_2. Each of them demands one unit of a homogeneous good for any price (weakly) lower than v.[14]

An incumbent firm (denoted as I) and a rival firm (denoted as R) compete for the two buyers. We denote as $C_i(q_i)$ the total cost function of firm $i = I, R$, and we assume that firm R is *more efficient* than the incumbent in producing the *two* contestable units (assumption A1), but is *less efficient* if it produces only one *unit* (assumption A2):

$$C_R(\overline{q}_R + 2) - C_R(\overline{q}_R) < C_I(\overline{q}_I + 2) - C_I(\overline{q}_I) \qquad \textbf{(A1)}$$

$$C_R(\overline{q}_R + 1) - C_R(\overline{q}_R) > C_I(\overline{q}_I + 1) - C_I(\overline{q}_I) \qquad \textbf{(A2)}$$

where $\overline{q}_I > \overline{q}_R \geq 0$ denote the demand of some captive (i.e. non contestable) buyers/markets the two firms may possibly supply. Captive buyers may be past customers who have arbitrarily high switching costs and thus continue to buy from firm i, or buyers located in other geographical areas where firm i is active and which are separated by arbitrarily high transportation costs, or even past buyers whose choice affects present production costs, for instance due to learning-by-doing effects. Note that we assume that firm I benefits from an *incumbency advantage*: it has been on the market for a longer period than the rival,[15] or it has developed a more extended activity in other geographical areas, which translates in a *larger number* of captive buyers than the rival firm. Finally, we assume that $v > C_R(\overline{q}_R + 1) - C_R(\overline{q}_R)$, and that $C_R(.)$ is strictly concave over the two contestable units, while $C_I(.)$ is weakly concave.[16]

The fact that the rival is less efficient than the incumbent on the first unit, in spite of being more efficient on the entire production, results from the interaction between the incumbency advantage discussed above and the existence of *scale/scope economies*. The fact the incumbent supplies a higher number of captive customers may allow it to better exploit scale/scope economies and operate at lower incremental costs than the rival on the first contestable unit. Similarly, under learning-by-doing effects, an incumbent who has produced more in the past can produce an additional unit at lower costs.

Finally, we assume that the two buyers are approached *sequentially*, the timing of the game being as follows:

1. First period.

   (a) Firms I, R simultaneously set prices p_I^1 and p_R^1 to buyer B_1.

   (b) B_1 decides from whom to buy and the transaction takes place.

[14] The extension to n buyers would not create any conceptual difficulty and would leave qualitative results unchanged. The assumption of inelastic demands is also done for simplicity: the main difference is that by assuming elastic demands exclusion would entail not only a productive inefficiency but also an allocative inefficiency.

[15] A natural interpretation is that the incumbent is the former monopolist in markets that have been liberalized.

[16] Weak concavity of the incumbent's cost function simplifies the exposition. Indeed, we could allow $C_I(q_I)$ to be 'moderately' convex so as to ensure that a firm is more efficient in producing its second unit than the rival in producing its first unit. This property follows directly from A1 and A2 when the incumbent cost function is weakly concave.

2. Second period.

    (a) Firms simultaneously set prices p_I^2 and p_R^2 to buyer B_2.

    (b) B_2 decides from whom to buy and the transaction takes place.[17]

The subgame perfect Nash equilibria of this game are described by the following proposition:

Proposition 1. *(Sequential - and discriminatory - offers) There exists a threshold level C_P of firm R's cost of producing the two units, with $C_P < C_I(\overline{q}_I + 2) - C_I(\overline{q}_I)$, such that:*

- ***(Predation)*** *If $C_R(\overline{q}_R + 2) - C_R(\overline{q}_R) > C_P$, then the incumbent supplies both buyers. It sells below cost to the first buyer, while recouping losses on the second: $p_I^{*1} = \widetilde{C}_R < C_I(\overline{q}_I + 1) - C_I(\overline{q}_I)$, $p_I^{*2} = C_R(\overline{q}_R + 1) - C_R(\overline{q}_R) > C_I(\overline{q}_I + 1) - C_I(\overline{q}_I)$.*
- ***(Entry/Expansion)*** *If $C_R(\overline{q}_R + 2) - C_R(\overline{q}_R) \leq C_P$, then firm R supplies both buyers. The price paid by the first buyer is lower than the price paid by the second: $p_R^{*1} = \widetilde{C}_I < C_I(\overline{q}_I + 1) - C_I(\overline{q}_I) = p_R^{*2}$.*

The threshold C_P is (weakly) decreasing in $\overline{q}_I$.

Proof. Let us move by backward induction. Let us consider first the subgame following B_1 choosing the incumbent. Standard Bertrand competition for the second buyer takes place, with the incumbent's cost to supply B_2 being lower than the rival's:

$$C_I(\overline{q}_I + 2) - C_I(\overline{q}_I + 1) \leq C_I(\overline{q}_I + 1) - C_I(\overline{q}_I) < C_R(\overline{q}_R + 1) - C_R(\overline{q}_R), \tag{1}$$

the first inequality following from weak concavity of $C_I(.)$ and the second from assumption A2. Hence, the incumbent serves the second buyer, at a price $p_I^{*2} = C_R(\overline{q}_R + 1) - C_R(\overline{q}_R)$. (Here, and in what follows, we disregard equilibria in weakly dominated strategies.)

Let us consider now the subgame following B_1 choosing the rival. In this case the rival's cost to supply B_2 is lower than the incumbent's cost:

$$C_R(\overline{q}_R + 2) - C_R(\overline{q}_R + 1) < C_I(\overline{q}_I + 2) - C_I(\overline{q}_I + 1) \leq C_I(\overline{q}_I + 1) - C_I(\overline{q}_I), \tag{2}$$

the first inequality following from assumptions A1 and A2, the second from weak concavity of $C_I(.)$. Hence, it is the rival that supplies the second buyer, at a price $p_R^{*2} = C_I(\overline{q}_I + 1) - C_I(\overline{q}_I)$.

Let us move to competition for the first buyer. Each firm anticipates that, by securing the first buyer, it will be able to supply also the second, thereby obtaining a total profit equal to:

$$\pi_i = p_i^1 + p_i^{*2} - (C_i(\overline{q}_i + 2) - C_i(\overline{q}_i)) \tag{3}$$

with $i = R, I$. We can thus denote as $\widetilde{C}_i = C_i(\overline{q}_i + 2) - C_i(\overline{q}_i) - p_i^{*2}$, with $i = I, R$, each firm's 'adjusted' cost to supply the first buyer, which corresponds to the total cost of producing the two units diminished by the rents extracted from the second buyer. Note that, by assumption A2, the incumbent extracts more rents than the rival from the second buyer (i.e. $p_I^{*2} > p_R^{*2}$). Hence, even though the rival is more efficient than the incumbent in producing the two units, it

[17] The results of the analysis would not change if both transactions took place at the end of the second period.

is not necessarily the case that its 'adjusted' cost is lower. More precisely, $\widetilde{C}_R \leq \widetilde{C}_I$ if and only if:

$$C_R(\overline{q}_R+2)-C_R(\overline{q}_R) \leq C_I(\overline{q}_I+2)-C_I(\overline{q}_I)-[C_R(\overline{q}_R+1)-C_R(\overline{q}_R)-(C_I(\overline{q}_I+1)-C_I(\overline{q}_I))] \equiv C_P \tag{4}$$

with $C_P < C_I(\overline{q}_I + 2) - C_I(\overline{q}_I)$ by assumption A2.

It follows that when $C_R(\overline{q}_R + 2) - C_R(\overline{q}_R) > C_P$, the incumbent secures B_1 and sells at a price $p_I^{*1} = \widetilde{C}_R$. If instead $C_R(\overline{q}_R + 2) - C_R(\overline{q}_R) \leq C_P$, firm R secures B_1 and sells at a price $p_R^{*1} = \widetilde{C}_I$.

Note that:

$$p_I^{*1} = \widetilde{C}_R = C_R(\overline{q}_R+2)-C_R(\overline{q}_R)-[C_I(\overline{q}_I+1)-C_I(\overline{q}_I)] < C_I(\overline{q}_I+2)-C_I(\overline{q}_I+1) \leq C_I(\overline{q}_I+1)-C_I(\overline{q}_I) \tag{5}$$

the first inequality following from assumption A1 and the second from weak concavity of $C_I(.)$. Also:

$$p_R^{*1} = \widetilde{C}_I = C_I(\overline{q}_I+2)-C_I(\overline{q}_I)-[C_R(\overline{q}_R+1)-C_R(\overline{q}_R)] < C_I(\overline{q}_I+2)-C_I(\overline{q}_I+1) \leq C_I(\overline{q}_I+1)-C_I(\overline{q}_I) \tag{6}$$

the first inequality following from assumption A2 and the second from weak concavity of $C_I(.)$.

Weak concavity of $C_I(.)$ also implies that the threshold C_P is weakly decreasing in $\overline{q}_I$.

□

Proposition 1 shows that - if the rival's cost advantage in producing *both* units is not too large - the game admits a unique equilibrium where exclusion of the (efficient) firm takes place due to a predatory strategy by the incumbent. Indeed, the incumbent sets a price below its own marginal costs of production in the first period of the game, therefore making losses on buyer B_1, to increase its price in the second period, therefore recouping its previous losses. The usual ingredients for predation, namely early profit sacrifice and subsequent recoupment, are thus present in this simple model.

Note that the exclusionary equilibrium arises even though the incumbent does not enjoy a first-mover advantage and the rival can submit bids at the same time as the incumbent. The source of exclusion is the interaction between the existence of *scale/scope economies* and the *incumbency advantage* enjoyed by firm I, which implies that the rival is less efficient than the incumbent in producing only one unit. Because of this, when it has already secured the first buyer, the incumbent is able to charge a price to the second buyer which is higher than the price that the rival is able to establish for B_2 when it has secured B_1. The expectation of higher rent extraction from the second buyer - *ceteris paribus* - will make the incumbent more aggressive when competing for the first buyer, an effect which may dominate the fact that the rival is more efficient overall and result in inefficient exclusion.[18]

Note also that, from the last item of Proposition 1, the stronger the incumbency advantage - as captured by an increase in the number of the incumbent's captive buyers $\overline{q}_I$ - the more

[18] If the incumbent also enjoys a *first-mover advantage* exclusion will be easier. This is because the incumbent can take actions to attract the early buyer before the entrant can react, and can therefore exploit in the most profitable way the negative externality that the first buyer exerts on the other when it decides to buy from the incumbent.

likely the predatory equilibrium. This is because a larger $\overline{q}_I$ makes the incumbent (weakly) more efficient in producing any of the two units. This, *ceteris paribus*, reduces the incumbent's overall cost disadvantage and limits the rival's rents extraction, thereby making it easier for the incumbent to win competition for B_1.

Finally, the above interaction may arise in situations where the rival is a potential entrant (like the one discussed in the application of Section 2.1) as well as in situations where the rival is already in the market and aims at expanding its activity by competing for new contestable units. Hence, this model predicts that the incumbent may adopt predatory pricing to deter entry but also to discipline a rival relegating it to a niche role.

2.1 Application 1: entry deterrence

In this section we illustrate a specific situation where the predation mechanism highlighted in Section 2 may arise. Imagine that firms' unit variable costs are constant, with $c_R = 0 < c_I$, and that entering the market requires a fixed sunk cost f, with $f < v$. Firm I has already supplied past buyers (i.e. $\overline{q}_I > 0$) and thus has already sunk the entry cost f when competition for the first buyer/market takes place, while firm R is a new entrant (i.e. $\overline{q}_R = 0$) and has not. The timing of the game is the same as the one described in Section 2, with the addition of an explicit entry decision for firm R at the end of each period (and with the transaction with firm E taking place after the entry decision). In this environment:

$$C_R(\overline{q}_R + 2) - C_R(\overline{q}_R) = C_R(\overline{q}_R + 1) - C_R(\overline{q}_R) = f \tag{7}$$

$$C_I(\overline{q}_I + 1) - C_I(\overline{q}_I) = C_I(\overline{q}_I + 2) - C_I(\overline{q}_I + 1) = c_I \tag{8}$$

Hence, assumptions $A1$ and $A2$ translate into:

$$c_I < f < 2c_I \tag{9}$$

Lemma 1. *Equilibria of this game are as follows:*

- ***(Predation)*** *If $f > 3c_I/2$, then firm R and I set $p_1^1 = p_R^1 = f - c_I < c_I$, the first buyer buys from I, entry in the first period does not occur, firm R and I set $p_R^2 = p_I^2 = f$, the second buyer buys from I and entry in the second period does not occur.*

- ***(Entry)*** *If $f \leq 3c_I/2$, then firm R and I set $p_R^1 = p_I^1 = 2c_I - f < c_I$, the first buyer buys from R, entry occurs, firm R and I set $p_R^2 = p_I^2 = c_I$, the second buyer buys from R.*

Proof. Direct application of Proposition 1. □

This scenario resembles markets where buyers decide on the basis of tender offers (such as public/private procurement markets), or where buyers are large business customers which negotiate prices with their suppliers, and where carrying out the entry investment takes time - think for instance of a situation where such an investment consists of building a large and complex infrastructure, carrying out construction work, obtaining licenses or working permits. In such cases it may be that the first market materializes and tender offers are solicited before the new entrant has had the time (or the ability) to sink (most of the) entry costs or to credibly commit to them. Examples of sectors which immediately come to mind are telecommunications, transportation, construction.

2.2 Application 2: scope economies

Another possible interpretation of the setting presented in Section 2, is that the two contestable buyers are each a buyer of a different product and that there are economies from joint production. In that case the cost functions could be reinterpreted as total cost functions of the two products, and the interaction between scope economies and incumbency advantage would lead us to rewrite assumptions $A1$ and $A2$ as:

$$C_R(\overline{q}_{R1}+1,\overline{q}_{R2}+1)-C_R(\overline{q}_{R1},\overline{q}_{R2})<C_I(\overline{q}_{I1}+1,\overline{q}_{I2}+1)-C_I(\overline{q}_{I1},\overline{q}_{I2}) \qquad (\tilde{A}1)$$

$$C_R(\overline{q}_{R1},\overline{q}_{R2}+1)-C_R(\overline{q}_{R1},\overline{q}_{R2})>C_I(\overline{q}_{I1},\overline{q}_{I2}+1)-C_I(\overline{q}_{I1},\overline{q}_{I2}) \qquad (\tilde{A}2)$$

It is easy to show that the main results of our model carry over to this revised setting: the incumbent may predate in the first market to preserve its dominant position in the other market.

Similarly, predation may arise if in the first period the rival can enter only in the market for product 1, while in the second period entry is allowed in both product markets. This may have been the case in some recently liberalized markets, such as postal services, where new entry is allowed in some segments of the market (mail-order parcel services, business-to-business mail), while the former public monopolist keeps a 'reserved area' for some period after the liberalization;[19] or it may be the case where tariffs or other barriers to trade are being phased out at different speeds in different markets, so that a new firm might be able to enter some markets immediately, but will be able to enter a particular foreign market only in the future. Hence, present scope economies and an incumbency advantage, predatory pricing may arise in the market which open first, to preserve the incumbent's dominant position across all the markets where it is active.[20]

3 Discussion

In this Section, we discuss which assumptions behind the model drive the predation result. We also study welfare effects.

3.1 Intertemporal discriminatory pricing v. uniform pricing

We have assumed that buyers can be charged different prices across periods, thus allowing for intertemporal price discrimination. If firms were instead obliged to charge the same price to all buyers, then predation would never occur. Intuitively, the incumbent has an incentive to price aggressively and suffer losses on the first buyer only if it can recoup such losses on the later buyer. Under intertemporal uniform pricing, instead, if the incumbent wanted to cut prices, it would have to do so for all buyers. Then, it will never want to sell at a common price $p = p_I^1 = p_I^2$ below $[C_I(\overline{q}_I + 2) - C_I(\overline{q}_I)]/2$ and, by assumption A1, it would not be able to exclude the rival.

[19] See *Deutsche Post*, where DP had exclusive rights to carry letters and items weighing less than 200 g.

[20] Also Carlton and Waldman (2002) shows that, in markets related by complementarity in consumption rather than by the existence of common costs, the incumbent can deter entry in the market which opens first in order to protect its dominant position in all the markets where it operates. Note, however, that in the supply-side version of their model, successful exclusion requires the incumbent to enjoy also a *first-mover advantage* and to adopt *irreversible* tying.

3.2 Consumer surplus and welfare

The case of (intertemporal) uniform pricing provides us with the natural benchmark for welfare analysis. Indeed, if the incumbent was not allowed to behave strategically so as to exclude, that is, if (intertemporal) price discrimination was forbidden, the unique equilibrium would be the one where the more efficient producer supplies both buyers at a total price equal to $p^{*1} + p^{*2} = C_I(\overline{q}_I + 2) - C_I(\overline{q}_I)$.

Thus predation harms consumers, as the total price paid by the two buyers is

$$p_I^{*1} + p_I^{*2} = \widetilde{C}_R + C_R(\overline{q}_R + 1) - C_R(\overline{q}_R) > C_I(\overline{q}_I + 2) - C_I(\overline{q}_I) \tag{10}$$

precisely when $\widetilde{C}_R > \widetilde{C}_I$, i.e. when $C_R(\overline{q}_R + 2) - C_R(\overline{q}_R) > C_P$ and predation takes place. The predatory equilibrium is also welfare-inferior as the two buyers are supplied at a higher cost, thereby entailing a productive inefficiency. Obviously, with any downward-sloping demand function in addition to the productive inefficiency the exclusionary equilibrium would also entail a deadweight loss.

Note, however, that policy implications are less straightforward than they may appear at first sight. Banning (intertemporal) price discrimination does not unambiguously increase consumer surplus. In fact, if $C_R(\overline{q}_R + 2) - C_R(\overline{q}_R) \leq C_P$ (i.e. if predation does not occur at equilibrium), then allowing for price discrimination induces the suppliers to compete intensively for the first buyer, which results in a total price paid by the two buyers which is lower than the price paid under uniform prices:

$$p_R^{*1} + p_R^{*2} = C_I(\overline{q}_I + 2) - C_I(\overline{q}_I) - [C_R(\overline{q}_R + 1) - C_R(\overline{q}_R)] + C_I(\overline{q}_I + 1) - C_I(\overline{q}_I) < C_I(\overline{q}_I + 2) - C_I(\overline{q}_I) \tag{11}$$

by assumption $A2$. Since firm R supplies both buyers anyhow, total welfare would be equal under price discrimination and under uniform pricing, but this is just because of inelastic demands. If we assumed elastic demands, total welfare would also be higher under price discrimination.[21]

Measures aimed at discouraging price aggressiveness by dominant firms, for instance forbidding them from discriminating across customers or from selling below cost, would therefore result in a trade-off. On the one hand, they would reduce the chances that anti-competitive exclusion would take place; on the other hand, when the entrant is sufficiently more efficient than the incumbent, they would chill competition and result in higher prices.

3.3 Simultaneous offers

A crucial ingredient in our model is that price offers to buyers are made sequentially. If the game was modified so that firms bid simultaneously for both buyers and then buyers simultaneously choose the supplier, exclusion might arise, but only if buyers suffer from *coordination failures*.[22] Consider, for instance, a situation where the incumbent offers a price $p_I^1 = p_I^2 = C_R(\overline{q}_R + 1) - C_R(\overline{q}_R)$ and both buyers buy from it. If a buyer expects the other to choose the incumbent, it has

[21] Forbidding below-cost pricing would lead to similar conclusions. In such a case firm R would supply both buyers and equilibrium prices would be $p_R^{1*} = p_R^{2*} = C_I(\overline{q}_I + 1) - C_I(\overline{q}_I)$. Hence, when predation does not take place anyway, the first buyer pays a higher price while the second buyer pays the same price as in the case where below-cost pricing is feasible.

[22] On this, see Fumagalli and Motta (2008).

no incentive to address firm R - even if it offers a lower price - because it anticipates that firm R's cost to produce its unit *alone* exceeds the offered price, and that firm R would thus prefer not to serve the deviant buyer. Note that the mechanism behind exclusion is completely different from the one identified in Section 2. For this reason, when it relies on coordination failures, pricing below costs is not necessary for exclusion. Indeed, a continuum of prices (including below-cost pricing to one buyer) can arise at equilibrium, each one supported by appropriate continuation equilibria concerning buyers' decisions.

If, instead, bids are simultaneous but buyers choose sequentially - so as to rule out coordination failures - exclusion will *not* arise at the equilibrium. The intuition is that the fact that prices for both buyers are set simultaneously expands the scope for profitable deviations with respect to the case of sequential bids. Consider, for instance, the price offers indicated in Proposition 1. Since $p_I^1 + p_I^2 > C_I(\overline{q}_I + 2) - C_I(\overline{q}_I)$, then firm R has an incentive to slightly undercut both prices: absent coordination failures, this would attract both buyers and would allow firm R to make positive profits. In order to block the rival's deviations the incumbent should bid a pair of prices such that $p_I^1 + p_I^2 \leq C_R(\overline{q}_R + 2) - C_R(\overline{q}_R)$ but such an offer would not be profitable for the incumbent by assumption $A1$. For a similar reason, however, equilibria where buyers are supplied by firm R - when they exist - exhibit prices $p_R^{*1} = p_R^{*2} = \widetilde{C}_I < C_I(\overline{q}_I + 2) - C_I(\overline{q}_I + 1)$ for *both buyers*, as both prices must be immune to the incumbent's deviation of undercutting on one buyer and recouping (i.e. setting $p = C_R(\overline{q}_R + 1) - C_R(\overline{q}_R)$) on the other.

3.4 Strategic buyers

In our model, buyers cannot coordinate their decisions and have to buy at exogenously given times. In this Section, we discuss what would happen if we relaxed these assumptions. Trivially, if buyers could decide jointly, then predation would not take place. In terms of Bernheim and Whinston's logic, inefficient exclusion could not occur because all agents would be represented in the negotiation. For instance, if the second buyer could ask the first buyer to purchase on its behalf as well, then the first buyer could buy two units and firm R would serve both buyers. Similarly, if the first buyer did not incur a loss in delaying its purchase and both buyers could jointly decide in the second period. In both cases, though, the first buyer will want to receive at least the same surplus as when decisions are decentralised, since it benefits from competition between suppliers in the first period.

Consider now the case where buyers take independent decisions and cannot contract among them, but are free to choose when to buy. Clearly, the first buyer would have no incentive to postpone its purchase because it obtains a higher surplus when buying first. However, the second buyer - if it could - would have an incentive to anticipate its purchase and be the first. Buyers will therefore engage in a race to be the first one to buy. If there was an initial date before which purchases were not possible, both buyers would buy at that date. We would therefore be back to the simultaneous moves case we discussed above, with exclusion which could take place because of miscoordination.

There is no general answer to the question of which of the settings discussed above would prevail in reality. Institutional features or legal constraints may explain the prevalence of a situation over another. For instance, the liberalisation process may be designed in such a way that a market would open before another, the existence of a patent may determine why a market may become contestable after another, bureaucratic rules may delay public procurement determining different purchase periods, financial constraints may delay purchase decisions of some consumers, and so on.

3.5 Growing markets

In this Section we relax the assumption that the two buyers/markets have equal size, and assume, instead, that the second buyer is larger than the first one. This may reflect situations where the product is new and demand is expected to grow over time, or where firms' time horizon expands and they expect demand to arise for a higher number of future periods (that we collapse into period 2). Let us assume that buyers' demands are, respectively, $1-k$ units for B_1 and $1+k$ units for B_2, with $k \in [0,1]$.

A first implication of this type of asymmetry is that inefficient exclusion cannot arise at equilibrium if the second buyer/market is large enough. To see why, consider that a necessary condition for (inefficient) exclusion is that the $1+k$ units are insufficient for the rival to reach the efficient scale and produce more efficiently than the incumbent:

$$C_R(\overline{q}_R + 1 + k) - C_R(\overline{q}_R) > C_I(\overline{q}_I + 1 + k) - C_I(\overline{q}_I), \tag{\textbf{A2'}}$$

that is what allows the incumbent to extract more rents than firm R from the second buyer, once secured the first one, which in turn is necessary for the incumbent to have an incentive to bid more aggressively for B_1. When $k=1$, the above condition cannot be satisfied as it would contradict assumption $A1$, which ensures that firm R is more efficient than the incumbent on the entire production and thus that exclusion (if any) is welfare detrimental. Instead, by assumption $A2$, the above condition is satisfied when $k=0$ and buyers are symmetric. By continuity, there exists a critical size of the second buyer $1+k^*$ such that the above condition does not hold and thus inefficient exclusion cannot arise if the size of the second buyer is above the threshold level.

Instead, when condition $A2'$ is satisfied, following the same logic of Section 2, one can easily show that predatory pricing and inefficient exclusion take place if (and only if) firm R's cost advantage is not too large, i.e. iff $C_R(\overline{q}_R + 2) - C_R(\overline{q}_R) > C_P(k)$ where

$$C_P(k) \equiv C_I(\overline{q}_I + 2) - C_I(\overline{q}_I) - [C_R(\overline{q}_R + 1 + k) - C_R(\overline{q}_R) - (C_I(\overline{q}_I + 1 + k) - C_I(\overline{q}_I))]. \tag{12}$$

Note that, without imposing specific restrictions on the slope of the cost functions, one cannot tell whether inefficient exclusion becomes more or less likely as buyers' asymmetry increases, i.e. as k increases. Indeed, an expansion of the second buyer's demand allows both suppliers to extract more rents from B_2, once secured B_1, thereby inducing a more aggressive bidding for the first buyer by both suppliers. The only possible claim is that for values of k sufficiently close to k^* the threshold $C_P(k)$ is increasing in k, and thus exclusion becomes less likely as the second period demand expands.[23]

[23]It is easy to show that in the particular example of entry deterrence examined in Section 2.1, predation is unambiguously more difficult as k increases.

3.6 Downstream competition

We have assumed so far that buyers are final consumers. This is not necessarily an innocent assumption in exclusionary models, as showed by Fumagalli and Motta (2006, 2008). When buyers are firms that are competing in a downstream market, we cannot assume any longer that the number of units they buy from their chosen supplier is fixed. In particular, consider the case where downstream markets are fully integrated, buyers are retailers and are perceived as homogeneous by final consumers. Then, the buyer-retailer who pays the lower wholesale price will be able to dominate the entire downstream market. In turn, this means that the incumbent cannot profitably exclude firm R.[24] The intuition is that even if the first buyer has committed to buy from the incumbent at a certain wholesale price, the rival firm may guarantee itself enough scale to operate more efficiently than I by selling to the second buyer at a slightly lower price. Hence, even though the incumbent secured the first buyer, firm R does not suffer any disadvantage when competing for B_2 and the incumbent cannot extract more rents than firm R from the second buyer. In turn, this implies that the incumbent has no incentive to bid more aggressively than firm R for the first buyer. On top of this, when competition is so fierce, the incumbent cannot recoup losses if it sells below-cost to the first buyer, as it cannot make profits by selling to the second buyer at a sufficiently large price. As long as $w_2 > w_1$, it is the first buyer who dominates the downstream market and the incumbent would sell its entire production to it. For these reasons, predation does not occur if there is sufficiently fierce downstream competition. If, instead, dowsntream firms are highly differentiated, or operate in independent markets (i.e. downstream competition is absent or weak), then the predatory outcome would continue to arise (as long as the rival cost advantage is not too large): each buyer could bring only a limited share of the total market to firm R, and if the incumbent managed to win the first buyer, the second buyer's order alone would no suffice for the rival to reach efficient scale.

3.7 Renegotiation

In the predatory equilibrium both buyers choose the incumbent even though the rival could supply the two units at lower costs. This raises the question of whether the predatory equilibrium would survive to the possibility of renegotiating the buyers' decisions. In our model, where transactions take place immediately each buyer's decision, renegotiation is impossible. Also in a context where transactions take place only after the choice of both buyers, there might be little scope for renegotiation. For instance, renegotiation might require some form of agreement/coordination between suppliers and anti-trust laws might prohibit or impose restrictions to this type of behaviour. Alternatively, renegotiation costs might be high because breaching the initial decision may involve substantial legal costs or because of the costs of delaying consumption and production until a new agreement is reached. In an environment where, instead, transactions take place after the choice of both buyers and renegotiation costs are sufficiently low, an equilibrium where both buyers choose the incumbent might still arise - sustained by the incumbent's ability to extract part of the gain from renegotiation - but it would not involve exclusion of the more efficient supplier.

[24] Proof available from the authors upon request.

4 Demand-side scale economies

In this Section we show that the mechanism identified in Section 2 may rationalize predation also when scale economies arise from the demand side and are due to network externalities (Section 4.1) or multi-sided market externalities (Section 4.2).

4.1 Network Externalities

Assume that the incumbent and the rival are equally efficient in producing two differentiated and incompatible network products, and have a constant unit cost equal to c. Each manufacturer has an installed base of customers b_i with $i = I, R$, i.e. old customers who are not buying any longer, but continue to use the network product. Also in this case we assume that the incumbent enjoys an *incumbency advantage* and can rely on a larger customer base than the rival: $b_I > b_R \geq 0$. There are two *new* buyers, B_1 and B_2, who enjoy utility $U_i = v_i(n_i) - p_i$ if they buy one unit of the network product from firm $i = I, R$, where $n_i \in N^+$ indicates the total number of users (including present and past buyers). There are direct network externalities in that the utility enjoyed by a user of network i increases with the total number of users of that network: $v_i^{'}(n_i) \geq 0$. Even if not necessary for our results, we also assume that $v_i^{''}(n_i) \leq 0$. Finally, similarly to the analysis of Section 2, we assume that the combination of network externalities and the incumbency advantage results in the following feature: even though at *full size* (i.e. when both of the new buyers add to it) the quality of the rival's network is superior to the incumbent's (assumption $A1^*$), with only *one* new buyer the quality of firm R's product is inferior (assumption $A2^*$):

$$v_R(b_I + 2) > v_I(b_I + 2) \tag{\textbf{A1*}}$$

$$v_I(b_I + 1) > v_R(b_R + 1) \tag{\textbf{A2*}}$$

The game is as follows.

1. First period.

   (a) Firms I, R simultaneously set prices p_I^1 and p_R^1 to the first buyer. (b) B_1 decides from whom to buy.

2. Second period.

   (a) Firms I, R simultaneously set prices p_I^2 and p_R^2 to the second buyer. (b) B_2 decides from whom to buy.

3. Third period.

   Consumption takes place and utilities are realized.

The following Proposition shows that also in this case - if the quality gap between the rival's and the incumbent's network at full size is not too large - by pricing below cost the incumbent can exclude the more efficient supplier. The intuition behind this result is similar to the case of supply side scale economies. Competition for the first buyer will be particularly intense because who secures the first buyer will supply also the second. The fact that at full size the quality of the rival's network is superior represents an advantage for firm R when competing for B_1.

However the fact that one buyer is insufficient for firm R to reach efficient scale may allow the incumbent to extract more rents than the rival from the second buyer which - *ceteris paribus* - makes the incumbent more aggressive when competing for B_1. When this latter effect dominates, the incumbent secures the first buyer and excludes the more efficient rival.[25] Similarly to the model with supply-side scale economies, also in this case the stronger the incumbency advantage - i.e. the higher b_I - the more likely predation to arise at the equilibrium.

Proposition 2. *There exists a threshold level v_P of the utility of firm R's network, with $v_P > v_I(b_I + 2)$ such that:*

- ***(Predation)*** *If $v_R(b_R + 2) < v_P$, then the incumbent supplies both buyers. It sells below cost to the first buyer, while recouping on the second buyer: $p_I^{*1} = \tilde{c}_R - [v_R(b_R + 2) - v_I(b_I + 2)] < c$ and $p_I^{*2} = c + v_I(b_I + 2) - v_R(b_R + 1) > c$.*
- ***(Entry/Expansion)*** *If $v_R(b_R + 2) \geq v_P$, then firm R supplies both buyers. The price paid by the first buyer is lower than the price paid by the second: $p_R^{*1} = \tilde{c}_I + [v_R(b_R + 2) - v_I(b_I + 2)] < c + v_R(b_R + 2) - v_I(b_I + 1) = p_R^{*2}$.*

The threshold v_P is (weakly) increasing in b_I.

Proof. See Appendix A. □

A distinction with the case of supply-side scale economies that is worth emphasizing is that, under network externalities, exclusion of the more efficient producer is not necessarily welfare detrimental. The reason is that old customers, who are still using the incumbent's product, benefit when the new buyers join the incumbent's network. Their welfare gain may be large enough to dominate both the efficiency loss associated to the fact that new buyers use the inferior product and the loss suffered by the old customers of the rival due to the lack of expansion of their network. When this is the case, i.e. when

$$b_I[v_I(b_I + 2) - v_I(b_I)] > 2[v_R(b_R + 2) - v_I(b_I + 2)] + b_R[v_R(b_R + 2) - v_R(b_R)] \tag{13}$$

predatory pricing *excludes* the *more efficient* producer but is welfare *beneficial.*

In a similar vein, it may be that the incumbent excludes a *less* efficient rival but this is welfare *detrimental.* Consider the case where firm R's network is inferior even at full size. The incumbent will *always* secure both buyers because not only more favourable rent extraction but also superior quality of the own network make it a stronger competitor. Also, the incumbent does not necessarly need to price below cost in order to exclude the rival. Still exclusion of the inefficient producer may be welfare detrimental. This is the case when the welfare loss suffered by the old customers of the rival, who fail to experience an expansion in their network, dominates both the efficiency gain due to new buyers using the higher quality product and the welfare gain

[25] Also in Carlton and Waldman (2002) - in the variant based on network externalities - the first cohort of consumers is the key one and competition for it may result in exclusion of the more efficient entrant. In their case, though, it is the fact that the incumbent is already active in the market for a complementary product to the network product that makes it more aggressive in bidding for the first cohort of customers. In turn, this occurs because the incumbent extracts the entire surplus generated by the system, if it dominates the market for the network product, while it is only partially able to do so if the entrant dominates such a market.

of the incumbent's old customers. Note that this situation is more likely to arise when the size of the incumbent's network is large enough to exhaust the externality generated by additional users. In such a case society may benefit from the expansion of an alternative, though inferior, network and exclusion of the less efficient supplier may be welfare detrimental.

4.2 Two-sided markets

In this Section we consider the case where each firm (or platform) can sell its product to two different groups of consumers, each group (or side of the market) benefiting from positive externalities from the number of users on the *other* side. We assume that a consumer on side k and using product i will receive a utility $U_{ki} = v_{ki}(n_{li}) - p_{ki}$, with $k, l = 1, 2, k \neq l$, $i = I, R$, with n_{li} being the total number of users (both old and new buyers) of platform i on side l and with $v_{ki}^{'}(n_{li}) \geq 0$. Platforms are incompatible.

The incumbent and the rival have a constant unit cost c. Each platform has an installed base of old customers b_{ki} with $k = 1, 2$, $i = I, R$, who are not buying any longer, but continue to use the product. For simplicity, we assume that a given platform has the same customer base on each side: $b_{1I} = b_{2I} = b_I$ and $b_{1R} = b_{2R} = b_R$, with the *incumbency advantage* amounting to $b_I > b_R \geq 0$. We also assume that $v_{1i}(\cdot) = v_{2i}(\cdot) = v_i(\cdot)$, with $i = I, R$.

When the game starts, there are two *new* buyers, B_1 and B_2, one on each side of the market, who are taking purchase decisions sequentially.

Finally, similarly to the previous sections, we assume that the rival is overall more efficient but it has an initial disadvantage:

$$v_R(b_R + 1) > v_I(b_I + 1) \qquad (A1\hat{})$$

$$v_I(b_I) > v_R(b_R) \qquad (A2\hat{})$$

The game is the usual one, with firms first competing for B_1 and then for B_2.

The following can be showed:

Proposition 3. *There exists a threshold level $v_P^{'}$ with $v_P^{'} > v_I(b_I + 1)$ such that:*

- ***(Predation)*** *If $v_R(b_R + 1) < v_P^{'}$, then the incumbent supplies both buyers. It sells below cost to the first buyer, while recouping on the second buyer: $p_I^{*1} = \tilde{c}_R - [v_R(b_R + 1) - v_I(b_I + 1)] < c$ and $p_I^{*2} = c + v_I(b_I + 1) - v_R(b_R) > c$.*

- ***(Entry/Expansion)*** *If $v_R(b_R + 1) \geq v_P^{'}$, then firm R supplies both buyers. The price paid by the first buyer is lower than the price paid by the second: $p_R^{*1} = \tilde{c}_I + [v_R(b_R + 1) - v_I(b_I + 1)] < c + v_R(b_R + 1) - v_I(b_I) = p_R^{*2}$.*

The threshold $v_P^{'}$ is weakly increasing in b_I.

Proof. See Appendix B. □

An application of this model can be used to rationalize the NAPP case briefly described in the introduction.[26] In that case, firms were selling to hospitals (our side-1) and to the community

[26] Another case involving a two-sided market is Aberdeen Journals case (Decision of the Director General of Fair Trading No. CA98/14/2002 of 16 September 2002. Upheld by Competition Appeal Tribunal in CAse No. 1009/1/1/02 of 23 June 2003.

segment (side-2). While hospitals' utility was not influenced by decision in the community segment, community decisions were heavily affected by hospitals'. In terms of our model, we would have $v_{1i}(\cdot) = \overline{v_i}$ while $v_{2i}(n_{1i})$.

5 Conclusions

We have presented a simple theory of predation which is based on the presence of scale economies (either on the supply- or the demand-side). The prey would need to reach a certain scale of operations in order to be viable. Knowing this, the incumbent-predator would have an incentive to incur losses on early buyers (or markets), so as to deprive the prey of the scale it needs, thus reducing competition on later buyers (or markets), where the incumbent could then make higher profits. Consistent with the standard description of predatory pricing, our model predicts that in an exclusionary (predatory) equilibrium, a profit sacrifice phase is followed by a recoupment phase. This equilibrium exists only if scale economies are sufficiently important and the incumbent is not too inefficient (at full scale) relative to the entrant.

Our paper provides competition agencies with a new theory of harm in predation cases, and helps them identify situations where it is possible that predation based on this mechanism may arise. An agency who believes that the present theory might apply to a given case should necessarily show that the following factors co-exist in the industry:

- economies of scale (whether due to fixed costs, learning effects, demand externalities or other reason) are important;
- there are strong incumbency advantages, which may be proxied by the current market share of the incumbent: note that the higher the proportion of captive buyers (or the larger the established base) of the incumbent relative to the rival the more likely that predation will occur. Also, note that incumbency advantages are reinforced by switching costs and by the infrequency of purchases;
- buyer power is weak (if few buyers command a large percentage of orders, or if they coordinate their purchases, they will internalise the externality which is at the basis of the exclusionary mechanism described here);
- downstream competition is weak;
- intertemporal price discrimination is possible;
- the market is sufficiently mature, in the sense that a rapidly growing market is one where the number of contestable buyers will be larger relative to the captive ones, making it easier for the prey to reach minimum efficient scale.

We have argued that in some recent predation cases pursued by EU antitrust agencies, our exclusionary mechanism might offer an economic rationale for predation.

We do not claim that our predation theory replaces or generalises the traditional theories of predation. In some cases, predation might be more likely motivated by the desire of an incumbent to build a reputation for aggressive behaviour or by the attempt of a well-funded dominant firm to make it more difficult for a new firm to obtain external funds. But in other cases, our scale-economies mechanism might fit the evidence better. Further, these rationales might co-exist: our theory does not exclude that an incumbent might want to deprive an actual entrant of the scale it needs while at the same time sending a message to other potential entrants that it is ready to do the same in the future; and being aggressive to an entrant to deprive it of the profits it needs might have the effect of reducing the entrant's assets, and therefore making it more difficult for it to obtain funds in an imperfect capital market.[27]

References

[1] Argenton, C. 2010. "Predation under perfect information". *Mimeo.* Tilburg University.

[2] Bernheim, B. D. and M. D. Whinston. 1998. "Exclusive Dealing." *The Journal of Political Economy.* 106(1): 64-103.

[3] Bolton, P. and D. Scharfstein. 1990. "A Theory of Predation Based on Agency Problems in Financial Contracting." *American Economic Review.* 80: 93–106.

[4] Bolton, P., J. Brodley, and M. Riordan. 2000. "Predatory Pricing: Strategic Theory and Legal Policy." *Georgetown Law Journal.* 89: 2495-2529.

[5] Bolton, P., J. Brodley, and M. Riordan. 2001. "Predatory Pricing: Response to Critique and Further Elaboration." *Georgetown Law Journal.* 88: 2239-2330.

[6] Cabral, L. and M. H. Riordan. 1994. "The Learning Curve, Market Dominance, and Predatory Pricing." *Econometrica.* 62(5): 1115-1140.

[7] Carlton, D.W. and M. Waldman. 2002. "The Strategic Use of Tying to Preserve and Create Market Power in Evolving Industries." *Rand Journal of Economics.* 33: 194-220.

[8] Elzinga, K.G. and D.E. Mills. 2001. "Predatory Pricing and Strategic Theory". *Georgetown Law Journal.* 89: 2475-2494.

[9] Fudenberg, D. and J. Tirole. 1986. "A Signal-Jamming Theory of Predation." *Rand Journal of Economics.* 17: 173–190.

[10] Fumagalli, C. and M. Motta. 2006. "Exclusive dealing and entry, when buyers compete." *American Economic Review.* 96: 785-795.

[27] Consider the most important EC predation case, *ECS/Akzo.* (Commission Decision IV/30.698 of 14 December 1985. Published in OJ L 374, 31 December 1985.) According to the European Commission, Akzo started to prey upon its smaller rival ECS when the latter firm - previously limiting itself to sell organic peroxides as a flour additive in the UK - started to target a bigger market and made offers to BASF, one of the biggest clients of Akzo. The Decision reports - among other things, including some documental evidence of a predation plan - instances of Akzo's making below-cost offers to ECS most important business clients, with serious effects on ECS, that was unable to make the investments in capacity and R&D necessary to expand its operations, and was obliged to increase its bank borrowings thereby incurring additional costs (see para. 50). A reputation motive might also be present, with Akzo conveying the signal to potential entrants that it would not have tolerated threats to its most important markets (see para. 86).

[11] Fumagalli, C. and M. Motta. 2008. "Buyers' Miscoordination, Entry, and Downstream Competition." *Economic Journal.* 118 (531): 1196-1222.

[12] Gans J. S. and S. King. 2002. "Exclusionary contracts and competition for large buyers" *International Journal of Industrial Organization.* 20: 1363-1381.

[13] Harrington J. E. 1989. "Collusion and predation under (almost) free entry" *International Journal of Industrial Organization.* 7: 381-401.

[14] Innes, R. and R. J. Sexton. 1994. "Strategic Buyers and Exclusionary Contracts". *American Economic Review,* 84(3): 566 - 584.

[15] Karlinger, L. and M. Motta. 2007. "Exclusionary Pricing and Rebates when Scale Matters." CEPR D.P. No. 6258.

[16] Kreps, D. and R. Wilson. 1982. "Reputation and Imperfect Information." *Journal of Economic Theory.* 27: 253–279.

[17] Milgrom, P. and J. Roberts. 1982. "Predation, Reputation and Entry Deterrence." *Journal of Economic Theory.* 27: 280–312.

[18] Rasmusen, E.B., J.M. Ramseyer and J.S. Wiley Jr. 1991. "Naked Exclusion." *American Economic Review.* 81: 1137–1145.

[19] Saloner, G. 1987. "Predation, Mergers, and Incomplete Information". *Rand Journal of Economics.* 18: 156–186.

[20] Scharfstein, D.S. 1984. "A Policy to Prevent Rational Test–Marketing Predation". *Rand Journal of Economics.* 2: 229–243.

[21] Segal, I.R. and M.D. Whinston. 2000a. "Naked Exclusion: Comment." *American Economic Review.* 90: 296–309.

A Appendix

Proof of Proposition 2

Proof. Let us move by backward induction. The outcome of competition for the second buyer, B_2, depends on the choice made by the first one. Let us consider first the subgame following B_1 choosing the incumbent. From assumption $A2^*$ and from $v_I(n_i)$ being (weakly) increasing in the total number of users, it follows that the quality of the incumbent's network when B_2 joins is superior to the quality of the rival's network when B_2 joins:

$$v_I(b_I + 2) \geq v_I(b_I + 1) > v_R(b_R + 1) \tag{14}$$

Hence, in order to attract B_2, the rival should discount the incumbent's price by an amount equal to the quality gap between the two network products: $p_R^2 < p_I^2 - [v_I(b_I+2) - v_R(b_R+1)]$. Bertrand competition results in the incumbent serving B_2 at a price $p_I^{*2} = c + v_I(b_I + 2) - v_R(b_R + 1)$.

If, instead, B_1 chose the rival, from assumption $A1^*$ and from $v_I^{'}(n_i) \geq 0$, it follows that for the second buyer the quality of the rival's network is superior to the incumbent's:

$$v_R(b_R + 2) > v_I(b_I + 2) \geq v_I(b_I + 1) \tag{15}$$

In this case it is the incumbent that suffers a competitive disadvantage and must offer a discount in order to attract B_2: $p_I^2 < p_R^2 - [v_R(b_R + 2) - v_I(b_I + 1)]$. In equilibrium, the rival supplies the second buyer at a price $p_R^{*2} = c + v_R(b_R + 2) - v_I(b_I + 1)$.

Let us move to the first period. Agents anticipate that the second buyer will follow the choice of the first one. Hence, B_1 is willing to address the incumbent if (and only if) $v_I(b_I + 2) - p_I^1 > v_R(b_R + 2) - p_R^1$. By assumption $A1^*$, at full size the rival's network exhibits higher quality than the incumbent's. This represents a disadvantage for the incumbent when competing for B_1 and calls for a discount relative to firm R's price in order to win B_1: $p_I^1 < p_R^1 - [v_R(b_R+2) - v_I(b_I+2)]$. However, the supplier who wins the first buyer will win also the second, thereby obtaining a total profit equal to:

$$\pi_i = p_i^1 + p_i^{*2} - 2c \tag{16}$$

with $i = I, R$. We can thus denote as $\tilde{c}_i = 2c - p_i^{*2} = c - [v_i(b_i + 2) - v_j(b_j + 1)]$ with $i \neq j = I, R$ each firm's 'adjusted cost' to supply the first buyer, which corresponds to the total cost to supply the two buyers diminished by the rents extracted from the second one. Note that, even though higher quality at full size favours rents extraction by the rival, the fact that one buyer is insufficient for firm R to achieve efficient scale is favourable to the incumbent. If the latter effect is sufficiently strong, the incumbent extracts more rents than the rival from the second buyer and may manage to win the first buyer despite the discount it has to offer. This is the case if (and only if):

$$\tilde{c}_I < \tilde{c}_R - [v_R(b_R + 2) - v_I(b_I + 2)] \tag{17}$$

which is equivalent to

$$v_R(b_R + 2) < v_I(b_I + 2) + \frac{v_I(b_I + 1) - v_R(b_R + 1)}{2} \equiv v_P \tag{18}$$

with $v_P > v_I(b_I + 2)$ by assumption $A2^*$.

It follows that when $v_R(b_R + 2) < v_P$, the incumbent wins B_1 and sells at a price $p_I^{*1} = \tilde{c}_R - [v_R(b_R + 2) - v_I(b_I + 2)] = c - [v_R(b_R + 2) - v_I(b_I + 1)] - [v_R(b_R + 2) - v_I(b_I + 2)] < c$ by assumptions $A1^*$. If instead $v_R(b_R + 2) \geq v_P$, then firm R secures B_1 and sells at a price $p_R^{*1} = \tilde{c}_I + [v_R(b_R + 2) - v_I(b_I + 2)] = c - [v_I(b_I + 2) - v_R(b_R + 1)] + [v_R(b_R + 2) - v_I(b_I + 2)]$. □

B Appendix

Proof of Proposition 3

Proof. Proceed by backward induction and consider the second period. (a) If in the first period B_1 bought from I, then B_2's utility from buying from I and from R respectively will be: $U_{2I} = v_I(b_I + 1) - p_I^2$ and $U_{2R} = v_R(b_R) - p_R^2$. Note that B_2 enjoys the additional benefit from one extra user on side-1 if she buys from I, but not from R. From assumption $A2\hat{}$ and from $v_I(n_i)$ being (weakly) increasing in the total number of users, it follows that in order to attract B_2

the rival must offer a sufficiently large discount as compared to the incumbent's price: $p_R^2 < p_I^2 - [v_I(b_I+1) - v_R(b_R)]$. Bertrand competition results in the incumbent serving B_2 at a price $p_I^{*2} = c + v_I(b_I+1) - v_R(b_R)$. (b) If in the first period B_1 bought from R, then B_2's utility from buying from I and from R respectively will be: $U_{2I} = v_I(b_I) - p_I^2$ and $U_{2R} = v_R(b_R+1) - p_R^2$. This time, B_2 enjoys the additional benefit from one extra user on side-1 if she buys from R. From assumption $A1\hat{}$ and from $v_I^{'}(n_i) \geq 0$, it follows that it is the incumbent that suffers a competitive disadvantage and must offer s discount to attract B_2: $p_I^2 < p_R^2 - [v_R(b_R+1) - v_I(b_I)]$. In equilibrium, the rival supplies B_2 at a price $p_R^{*2} = c + v_R(b_R+1) - v_I(b_I)$.

Consider now competition for B_1. Agents anticipate that the second buyer will follow the choice of the first one. Hence, B_1 is willing to buy from the incumbent if (and only if) $v_I(b_I + 1) - p_I^1 > v_R(b_R+1) - p_R^1$. By assumption $A1\hat{}$, overall efficiency represents an advantage for firm R when competing for B_1 and the incumbent must offer a discount relative to firm R's price in order to win B_1: $p_I^1 < p_R^1 - [v_R(b_R+1) - v_I(b_I+1)]$. However, the platform that serves the side-1 buyer will also serve the side-2 buyer, thereby making *total* profits $\pi_i = p_i^1 + p_i^{*2} - 2c$, with $i = I, R$. Also in this case we can denote as $\tilde{c}_i = 2c - p_i^{*2} = c - [v_i(b_i+1) - v_j(b_j)]$, with $i \neq j = I, R$, each firm's 'adjusted cost' to supply the first buyer. Again, higher overall efficienct favours rents extraction by the rival, but the initial advantage is favourable to the incumbent. If the latter effect is sufficiently strong, the incumbent extracts more rents than the rival from the second buyer and may manage to win the first buyer despite the discount it has to offer. This is the case if (and only if):

$$\tilde{c}_I < \tilde{c}_R - [v_R(b_R+1) - v_I(b_I+1)] \tag{19}$$

which is equivalent to

$$v_R(b_R+1) < v_I(b_I+1) + \frac{v_I(b_I) - v_R(b_R)}{2} \equiv v_P^{'} \tag{20}$$

with $v_P^{'} > v_I(b_I+1)$ by assumption $A2\hat{}$.

Then, when $v_R(b_R+1) < v_P^{'}$, platform I wins competition for B_1 and sells at a price $p_I^{*1} = \tilde{c}_R - [v_R(b_R+1) - v_I(b_I+1)] = c - [v_R(b_R+1) - v_I(b_I)] - [v_R(b_R+1) - v_I(b_I+1)] < c$ by assumptions $A1\hat{}$. When instead $v_R(b_R+1) \geq v_P^{'}$ it will be platform R which obtains B_1, with $p_R^{*1} = \tilde{c}_I + [v_R(b_R+1) - v_I(b_I+1)] = c - [v_I(b_I+1) - v_R(b_R)] + [v_R(b_R+1) - v_I(b_I+1)]$.

□