NOTA DI LAVORO

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A Simple Theory of Predation[*]

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Abstract

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

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1   Introduction

Existing models of predatory pricing rely on information asymmetries to explain why an incumbent firm may have an incentive to prey upon rivals. In reputation, signalling, and financial market predation models,[1] information asymmetries are required for predation to take place (for instance, the entrant does not know the cost of the incumbent; or external financiers do not observe the behaviour of the entrant once it has obtained outside funds). In turn, this makes predation models (relatively) sophisticated.[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 entrant of key profits it would need to operate successfully, thereby deterring its entry into the industry. Once secured those early buyers and pre-empted entry, the incumbent will be able to raise prices on the remaining buyers (or markets), thereby recouping losses. The two usual ingredients of predation,

[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 applied by Saloner (1987) to model predation for takeovers, by Scharfstein 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 there are real-world cases which fit the 'story' described by such models, see Bolton, Brodley and Riordan (2000, 2001) and Elzinga and Mills (2001).

early sacrifice of profits followed by later recoupment once the prey has exited, are therefore present in our theory as well.

In our model, the incumbent may exclude an entrant even if the latter is more efficient and if it has the possibility to match the former's offers. When the incumbent and the entrant 'fight' to win the early buyers, the entrant will benefit of higher cost efficiency, but it will at most get duopoly profits on the later buyers, since the incumbent has already sunk its entry costs (or it has already the minimum customer base needed to operate profitably) and will therefore not exit the market. Instead, the incumbent knows that by deterring early entry it will enjoy monopoly profits in the future, and this - other things being equal - prompts it to cut prices more on the earlier buyers (or markets). As long as its efficiency disadvantage is not very large, the incumbent will be able to successfully prey upon the rival. Otherwise, the early buyers will buy (at prices lower than the incumbent's marginal costs) from the entrant and predation will not succeed.

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 (Section 2), where scale economies take the form of fixed entry cost that the entrant needs to pay, we show in Section 3 that our predation results are robust to a number of changes: predation may take the form of limiting the prey's expansion, rather than deterring its entry; it may deter entry in adjacent markets related by common costs; it may occur in markets characterised by demand-side scale economies (consumers have network externalities) or even in two-sided markets (one consumer group's utility increases with the number of consumers of the other side).

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). Let us briefly review some of these cases.

In 2004 the Italian Antitrust Authority found that Telecom Italia, the public monopolist before the liberalisation process, had abused a dominant position.[3] Telecom Italia was found to set prices in a selective and aggressive way and to engage into cross-subsidisation, with the aim of taking away key customers from its rivals (internal documents showed Telecom Italia's management was willing to incur losses in order to win - or win back - important business customers), thereby hindering their expansion.[4] Among other episodes, it 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, makes this market very similar to the one described in our base model, which can be seen as a sequence of auctions.

In 2003 the European Commission adopted a decision against Wanadoo Interactive, a subsidiary of France Télécom, for abuse of a dominant position in the form of predatory pricing in ADSL-based Internet access services for the general public.[5] The Commission found that Wanadoo's retail

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

[4] For instance, at Para. 275, 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.

[5] European Commission Decision COMP/38.233 of 16 July 2003. Upheld by the Court of First Instance in Case

prices were well below average variable costs between March 2001 and August 2001 and that in the subsequent period up to October 2002 they were approximately equivalent to average variable costs, but significantly below average total costs. As a result, Wanadoo's market share grew from 46% to 72%, while its main competitor's market share fell considerably, one ADSL service provider (Mangoosta) went out of business, and no competitor had more than 10% of the market.

Paras. 351-352 of the *Wanadoo* Decision describe a setting which emphasises the importance of incumbency advantages and scale economies, making it close to the mechanism pinned down in our paper, and perhaps especially so to the network externality version of the model (see Section 3.3):

> "[...] Service providers must, during this high-speed market development phase, build an image as the default supplier of a product viewed by the consumer as technically sophisticated and become large enough to benefit from economies of scale.
>
> In this process, the chronological sequence of entry into the market is far from neutral. Clearly, a service provider that has a considerable head start over its competitors during the initial phase of market growth is able to capitalise on the momentum thus gained. By contrast, laggards must make a much bigger effort to acquire customers if they wish to make up for lost time and bridge the resulting image gap and confer on their high-speed service the same notoriety as that of the dominant undertaking's flagship offering. In these circumstances, new competitors are confronted with the need not only to carry out the expenditure technically necessary in order to provide the service but also to undertake substantial advertising and promotional expenditure both to raise their product's profile and to undermine loyalty to the dominant undertaking's brand."

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 during the period from 19 April 2004 to 18 February 2005.[6] 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 and at the level of developing the bus network. 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 behaviour 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 at first sight it may appear odd that Napp could engage in too low prices in a market segment and too high prices in

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T-340/03 of 30 January 2007.
[6]Decision of the Office of Fair Trading No. CA98/01/2008 of 18 November 2008.

another market segment, our mechanism fits this case very well. 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 the 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. As we shall show in Section 3.4, 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 buyers on the other side of the market (in this case, the community segment) - whose demand is characterised by a positive externality with that of the former side - from buying from the entrant. As a result, they will be obliged to buy from the incumbent, which can behave like a monopolist on this (community) side of the market, recouping any losses made to win the other (hospital) side.

In a 2002 case, the OFT found that Aberdeen Journals adopted predatory behaviour in the pricing of advertising space in its Aberdeen Herald & Post newspaper.[7] This practice was aimed at driving the Aberdeen & District Independent newspaper (its only competitor) out of the market. Aberdeen Journals was found dominant in the market for the supply of advertising space in local newspapers (paid-for and free) within the Aberdeen area. In this case as well limiting the scale of operations of the prey appears to have a crucial role. The OFT acknowledged that while the costs of launching a local free newspaper are relatively low, the cost of sustaining and expanding presence is higher (the costs of establishing a distribution network are also high). Entrants typically incur losses in the first years until sufficient levels of credibility and acceptability by advertisers are reached. By taking readers away from a rival, an incumbent newspaper reduces the rival's demand for advertising space, undermining its operations.

Finally, in 2001, the European Commission found that Deutsche Post (DPAG) had abused a dominant position in the market of mail order parcel services.[8] 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

[7]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.
[8]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.

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)

In Section 3.2 we formalise a predation model which 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. However, the mechanism we propose is a new one, which may help rationalise predation in particular cases where previous theories of predation 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 market predation model: predation, by denying profits to the rival, also reduces the assets available to it, and therefore limits its possibility to obtain outside funding.

Our paper is also closely related to the more general literature on exclusion and, in particular, to the principle established by Bernheim and Whinston (1998) where inefficient exclusion arises due to the existence of *contracting externalities* that agents fail to internalise. In our case, the agents who take their decisions in the early periods (the incumbent, the entrant and the early buyers) do not internalise 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. 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.

2 A simple model

In this Section, we introduce our basic model with supply-side scale economies, solve it, and briefly discuss the results, especially underlining the role of some of the assumptions made.

There are 2 buyers, $B1$ and $B2$, with unit demand and valuation $v = 1$ for a homogeneous product. The extension to n buyers would not create any conceptual difficulty and would leave qualitative results unchanged. While we assume here that *both* buyers are necessary for entry to be profitable, in the extension to n buyers we would limit ourselves to assume that one buyer is not enough to attract entry. The assumption of inelastic demand 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.[9]

An incumbent firm, I, has already sunk its entry costs, and a potential entrant, E, is considering entry.

Firm E is more cost-efficient than firm I, as marginal costs are respectively given by $c_E = 0 < c_I < 1/2$, but firm E still needs to pay its entry cost, f. We assume that:

$$c_I < f < 2c_I, \qquad\qquad (A1)$$

which ensures that there are scale economies: by selling at the Bertrand equilibrium price, the entrant would be able to operate profitably if it sold to both buyers, but not if it sold to only one. Furthermore, $f < 2c_I$ implies that entry would be socially efficient (there are higher costs when the Incumbent serves the buyers than when the Entrant does).

2.1 The game

1. First period.

   (a) Firms I, E simultaneously set prices p_I^1 and p_E^1 to buyer 1.

   (b) Buyer 1 decides from whom to buy and commits to her choice.

   (c) Firm E decides whether to enter (and pay f) or not.

   (d) Transactions take place. If E got the order from buyer 1 but did not enter, buyer 1 purchases from I at the offered price p_I^1.[10]

2. Second period.

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

   (b) Buyer 2 decides from whom to buy and commits to her choice.

   (c) If it has not entered yet, firm E decides whether to enter (and pay f) or not.[11]

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[9] Fumagalli and Motta (2008) analyse the model under n buyers and elastic demands, but considers a simultaneous game and uniform pricing, rather than a sequential one (with possible intertemporal price discrimination) as in this paper.

[10] The results would not change if we assumed that the buyer whose order remains unfulfilled is forced to buy from the incumbent which would then charge the monopoly price.

[11] Allowing the entrant to enter also at the end of the second period only affects the 'maximum' price that firm I could charge to the second buyer after it has already served the first buyer. Allowing for a second chance of entry implies that instead of charging price $p = 1 > f$, the incumbent will charge the 'limit price' $p = f$ (if the price was

(d) Transactions take place. If E got the order from buyer 2 but did not entered, buyer 2 purchases from I at the offered price p_I^2.

This game has the following equilibria.

Proposition 1 *(Sequential - and discriminatory - offers) Equilibria of this game are as follows:*

- ***(Exclusion)*** *If $f > 3c_I/2 \equiv \widetilde{f}_s$ then firm E and I set $p_1^1 = p_E^1 = f - c_I < c_I$, buyer 1 buys from I, entry in the first period does not occur, firm E and I set the price $p_E^2 = p_I^2 = f$, the second buyer buys from I and entry in the second period does not occur.*

- ***(Entry)*** *If $f \leq \widetilde{f}_s$ then firm E and I set $p_E^1 = p_I^1 = 2c_I - f < c_I$, buyer 1 buys from E, entry occurs, firm E and I set $p_E^2 = p_I^2 = c_I$ with the second buyer buying from E.*

Proof. Let us move by backward induction. In the second period, if entry occurred in period 1, then standard Bertrand competition between cost-asymmetric firms takes place and the more efficient entrant obtains the second buyer at the price $p_E^2 = c_I$ (now and in the rest of the paper we disregard equilibria in weakly dominated strategies). If instead entry did not occur in period 1, then firm E has still to pay the entry cost when it competes for the second buyer. It follows that the entrant's unit cost to serve B_2 is equal to f, while the incumbent's unit cost amounts to $c_I < f$ by assumption $A1$. Hence, in this case it is the incumbent the low-cost supplier. In equilibrium the incumbent serves the second buyer at the price $p_I^2 = f = p_E^2$ and entry does not occur in the second period either.

In the first period, given the price offers and the decision of the first buyer, firm E decides whether to enter the market. If B_1 decided to buy from firm E, entry is profitable as long as rents collected in the first period, together with the ones that it anticipates to obtain in the second one are larger than f, i.e. $\pi_E(p_E^1) = p_E^1 + c_I - f \geq 0$. This inequality identifies the minimum price at which firm E is willing to supply B_1 :

$$\widetilde{p}_E^1 = f - c_I < c_I \quad \text{(by assumption } A1\text{)}.$$

If instead B_1 decided to buy from the incumbent, entry is not profitable as firm E anticipates that the second-period rents alone are insufficient to cover the entry cost: $f > c_I$ by assumption $A1$. Lack of entry implies that the incumbent's second-period profits amount to $f - c_I$, and that the incumbent's total profits are equal to $\pi_I(p_I^1) = p_I^1 - c_I + f - c_I$. Then, the minimum price at which the incumbent is willing to supply B_1 is:

$$\widetilde{p}_I^1 = 2c_I - f < c_I \quad \text{(by assumption } A1\text{)}$$

The comparison between $\widetilde{p}_E^1$ and $\widetilde{p}_I^1$ reveals that

$$\widetilde{p}_E^1 \geq \widetilde{p}_I^1 \text{ if (and only if) } f > \frac{3c_I}{2} \equiv \widetilde{f}_s.$$

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higher, the entrant would undercut the incumbent and enter). Note that by assuming that entry is possible also at the second period we make it more difficult for exclusion to take place, since after having deterred entry in the first period, the incumbent is not able to make the monopoly price 1 but only the lower price f.

Differently stated, competition for the first buyer is like an asymmetric Bertrand case where the incumbent and the entrant have respectively costs $2c_I - f$ and $f - c_I$. The following situations can then arise:

(i) (**Exclusion**) If $f > \widetilde{f}_s$ the equilibrium is such that $p_I^1 = p_E^1 = f - c_I$, B_1 buys from the incumbent and entry does not occur. By the definition of $\widetilde{p}_E$, the entrant has no incentive to undercut.

(ii) (**Entry**) If $f \leq \widetilde{f}_s$ the equilibrium is such that $p_I^1 = p_E^1 = 2c_I - f$, B_1 buys from the entrant and entry occurs in the first period. By the definition of $\widetilde{p}_I$, the incumbent has no incentive to undercut. $\blacksquare$

Proposition 1 shows that - if the incumbent is not too inefficient relative to the entrant, or equivalently if the entrant has fixed costs which are not too low - the game admits a unique equilibrium where exclusion of the (efficient) entrant takes place due to a predatory strategy by the incumbent. Indeed, the incumbent sets a price below its own costs of production in the first period of the game, therefore making losses, to increase its price in the second period, therefore recouping its previous losses, when it knows that the prey will not be able to enter. 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 more efficient entrant can submit bids at the same time as the incumbent. The sources of exclusion are: (i) the *incumbency advantage* enjoyed by firm I, i.e. the fact that the entrant has still to sink the fixed cost f when offers are made, while the incumbent has already sunk it; (ii) the fact that the revenues earned in the second period *alone* are insufficient to cover such a cost ($c_I < f$ by assumption $A1$). This implies that firm E will not find it profitable to pay the entry cost unless first-period revenues are large enough, which creates scope for the incumbent to bid aggressively in the first period and to offer a price which is immune to the entrant's undercutting. Why bidding such a low price is instead profitable for the incumbent, despite its variable cost disadvantage? The reason is that, by bidding aggressively in the first period, the incumbent removes competition from the entrant in the second period and will be able to charge a high price to the second buyer. Instead, firm E will always face competition by the incumbent in the second period, which limits the revenues that it can collect from the second buyer. If the efficiency gap between the incumbent and the entrant is not too large (or if the entry cost f is not too low), such asymmetry in favour of the incumbent is strong enough to enable recoupment and to cause exclusion.[12]

If instead firm E could sink the entry cost before bids to the first buyer are made, then the incumbency advantage of firm I would be eliminated, and the unique equilibrium would be one with E serving both buyers.

Which markets fit this model? The base model presented in this Section resembles markets where buyers decide on the basis of tender offers (such as public procurement markets), or

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[12] 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.

where buyers are large business customers which negotiate prices with their suppliers, and where one or more firms have not had the time (or willingness) to develop their infrastructure or build the necessary production or sales capacity (examples of sectors which immediately come to mind are construction, transportation, telecommunications).

In the real world there may be situations where a precommitment to entry and building infrastructure is possible, and others where it would not. Think for instance of a situation where it would take time to carry out certain investments to enter in a given sector or country (licenses to be obtained, working permits, a large and complex infrastructure to be built, machines to be bought, construction work to be carried out, and so on), so that the tender offers have to be made before (most of the) entry costs are sunk. In that case, the timing would be as in our base model, and exclusion may take place. In other cases, an entrant may instead be able to sink its entry costs before competing for buyers: exclusion would then be unlikely in our base model with supply-side scale economies. Note, further, that a simple announcement is not enough: a credible commitment to enter, with corresponding sunk costs being paid, is necessary to persuade buyers that entry is irreversible.

While in our base model a precommitment to enter would rule out predation, we show in Sections 3.1, 3.3 and 3.4 below that the same mechanism based may lead to predation also in cases (where the entrant does not have excess capacity, or where scale economies are created by demand externalities) where the entrant is already in the market.

Note also that strategic behaviour by the buyers would not necessarily prevent predation. For instance, one might think that the first buyer might delay its purchase decision so as to allow entry. In fact, there is no incentive for her to do so because buying first guarantees prices strictly below c_I, while by delaying purchases she would get the price c_I.

2.2 Comments

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

2.2.1 Renegotiation (or breach of orders)

The existence of the predatory equilibrium relies on the assumption that buyers cannot modify their orders after the entry decision. Suppose instead that buyers could breach their initial decision and change supplier. Also, imagine that in the first period entry takes place even if the first buyer chose the incumbent. Then B_1, I and E would have an incentive to find an agreement that allows firm E to supply the first buyer: due to the entrant's higher productive efficiency the joint welfare of the three agents in such a case is larger relative to the case where the incumbent is the supplier, and they all can (weakly) improve their situation as compared with that case. Anticipating this, firm E might have an incentive to sink the fixed cost even though the first buyer chose the incumbent (more precisely, this incentive exists if firm E expects to extract enough surplus from the renegotiation). In turn, the incumbent loses the incentive to undercut any price equal or below c_I, since subsequent entry removes the possibility to recoup by charging a high price to the second buyer.

This implies that in contexts where renegotiation of contracts is possible and cheap, exclusion would be less likely to take place. In other contexts, particularly in industries where buyers are

smaller and less concentrated, there may be important transaction costs involved for breaching orders, resulting in exclusion to be more likely.

Finally, note that absence of renegotiation is a crucial assumption for exclusion in models where scale economies are on the supply-side, as in the base model analysed in this Section. However, we shall see in Section 3.3 below that when scale economies are due to network effects, the possibility of breaching orders does not eliminate the potential for exclusion.

2.2.2 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 each buyer, then predation will never occur. Intuitively, the incumbent has an incentive to make losses on earlier buyers only if it can recoup them on later buyers, after it is clear that the prey will not be able to enter. Under intertemporal uniform pricing, this predatory strategy is not possible: if the incumbent wanted to cut prices, it would have to do so for all buyers, thus implying that it would never want to sell below cost. The following Lemma proves this point.

Lemma 1 *(Sequential - but uniform - prices). For all parameter values, firm E and I set $p_E = p_I = c_I$, both buyers buy from E, and entry will occur.*

Proof. Let us move by backward induction. At the last stage, the second buyer will face the same prices p_I, p_E paid by the first buyer. The second buyer will buy from I only if $p_I \leq p_E$ or if $p_E < p_I$ but firm E did not enter in the first period and $p_E < f$. The first buyer will buy from I only if $p_I \leq p_E$ or if $p_E < p_I$ but it anticipates that firm E will not make sufficient profits to cover its costs, that is, if $2p_E < f$ (recall that the price for the second buyer coincides with the one offered to the first buyer). Note however that, by assumption $A1$, $f < 2c_I$. Hence equilibria exhibiting exclusion should be such that the incumbent offers a price p_I below cost to *both* buyers, which is unprofitable. The firms will therefore play the standard Bertrand game and $p_E = p_I = c_I$ is the equilibrium of the game (we disregard weakly dominated strategies.) ∎

2.2.3 Price Commitment

If the game was modified so that first firms bid simultaneously for both buyers and then buyers choose the supplier sequentially, *exclusion cannot arise*.[13] Indeed, the fact that prices for both buyers are set simultaneously expands the scope for profitable deviations as compared with the case of sequential bids. Then, whenever the incumbent bids a pair of prices such that $p_I^1 + p_I^2 > f$ the entrant has an incentive to slightly undercut both prices: this would attract both buyers and would make entry profitable. In order to block the entrant's deviations the incumbent should bid a pair of prices such that $p_I^1 + p_I^2 \leq f$, but such an offer would not be profitable for the incumbent either. For a similar reason, however, entry equilibria exhibit prices below c_I for *both buyers* (namely, $p_E^1 = p_E^2 = 2c_I - f < c_I$), as both prices must be immune to the incumbent's deviation of undercutting on one buyer and recouping on the other.

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[13]If buyers' decisions were also simultaneous, then exclusion might arise because of miscoordination failure. See for instance Fumagalli and Motta (2008).

2.2.4 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 retailers who are competing for consumers, we cannot assume any longer that the number of units they buy from their chosen supplier is fixed. In particular, if the downstream markets are integrated and retailers are perceived as homogeneous, the buyer-retailer who pays the lower wholesale price will be able to win all the market demand. In turn, this means that even if the first buyer has committed to buy from the incumbent, the entrant may guarantee itself enough scale if it induces the second buyer to buy from it. For this reason, when there exists sufficiently fierce downstream competition predation will not occur. If, instead, buyers-retailers were highly differentiated, or operated in different markets (i.e., downstream competition would be weak or absent), then the predation result would continue to hold (as long as f is high enough): each retailer could bring only a share of the total market to the entrant, and if the incumbent managed to win the first buyer, the second buyer's order would not be sufficient for the entrant to cover its entry cost.

To formalise this situation, keep the same assumptions on parameters as in the base model, but assume that in each market $i = 1, 2$ there is a mass of consumers normalised to 1 and with unit valuation and demand for the product. Consider the following timing of the game.

In the first period, firms I, E set wholesale prices w_I^1 and w_E^1 to retailer $B1$, who decides from whom to buy (but does not commit on the size of the order). Firm E decides on entry.

In the second period, firms simultaneously set prices w_I^2 and w_E^2 to retailer 2, who decides from whom to buy. If it has not entered yet, firm E decides whether to enter (and pay f) or not.

In the third period, retailers set prices p_1 and p_2. Consumers in each market decide. Transactions take place.

In what follows, we limit ourselves to state the result for two extreme cases: (a) independent markets: consumers in market i can buy only from retailer Bi; (b) perfect substitutes with Bertrand competition: consumers can buy from each retailer.[14] For intermediate competition cases, we would expect that - as in Fumagalli and Motta (2008) - if there is sufficiently fierce competition downstream, predation may not take place at equilibrium.

Proposition 2 *(Downstream competition) Suppose buyers are retailers who sell to final consumers. Equilibria of this game are as follows:*

- *(Independent market areas) If each retailer sells in a separate final market of size 1 and with unit valuation, then the equilibria are the same as in the base model (in particular, predation arises if $f > 3c_I/2 \equiv \widetilde{f}_s$).*

- *(Fierce competition) If the two markets are integrated and retailers compete in prices for final customers, only the entry equilibrium exists, with wholesale prices $w_E^i = w_I^i = c_I$ $(i = 1, 2)$, each buyer-retailer buying from the entrant, and final consumers paying c_I.*

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[14]One can rationalise the two cases as due to transportation costs. If retailer Bi is located in market i, the independent markets case corresponds to segmented geographical markets with arbitrarily large transportation costs, the perfect competition case corresponds to integrated markets with zero transportation costs.

Proof. (Independent market areas) If retailers are selling in independent markets, then each retailer can sell at most one unit of the product. Hence, everything will be as in the base model where buyers are final consumers who buy at most one unit.

(Fierce competition) First, we show that this is an equilibrium,[15] as there is no incentive to deviate from it. At this equilibrium E would enter as $\pi_E = 2c_I - f > 0$. If firm E changed its price(s) it could only reduce its profits: if the price is increased to one buyer only, π_E would be at best unchanged if the other buyer still buys from E; if the price is increased to both, buyers will buy from I and $\pi_E = 0$. If E reduced its wholesale price to one or both buyers, it would still sell both units but at lower profits. If firm I undercuts to buyer Bi only ($w_I^i < c_I, w_I^{-i} = c_I$), that buyer would choose to buy from it and would have the lowest cost. Buyer Bi would then sell both units, and I would have negative profits. Note that a deviation with lower wholesale price to Bi while increasing price to Bj would still give negative profits to I: all units would be sold by Bi who pays $w_I^i < c_I$. Similarly, if undercutting took place on both buyers. Finally, buyers have no incentive to deviate at the candidate equilibrium (which would be the standard Bertrand game played downstream).

Next, we show that an exclusionary equilibrium does not exist. Suppose there is an equilibrium where, similarly to the base model, firm E does not enter and $w_I^i < c_I$, $w_I^{-i} > c_I$. Given competition downstream, all units would be sold by buyer-retailer Bi, and $\pi_I = 2(w_I^i - c_I) < 0$. More generally, there cannot exist any exclusionary equilibrium where firm I charges $w_I^i < c_I$ to at least one buyer. Consider next a candidate equilibrium where $c_I \leq w_I^i \leq w_I^{-i}$. This price pair would not survive the deviation from firm E, who would set $w_E^i = w_I^i - \epsilon$, making Bi the lowest cost retailer: Bi would buy from E and sell both units on the final market, so that $\pi_E = 2w_E^i - f \geq 2c_I - f > 0$. ■

2.2.5 Consumer surplus and welfare

The case of (intertemporal) uniform pricing (see Section 2.2.2 above) provides us with the natural benchmark for welfare analysis. Indeed, if the incumbent was not allowed to behave strategically so as to deter entry, that is, if either (intertemporal) price discrimination was forbidden, or the incumbent was not allowed to set below-cost pricing, the unique equilibrium would be the one where entry would occur and both buyers would pay c_I. Predation would clearly harm consumers, as total consumer surplus under predation would be given by $2 - (2f - c_I) < 2 - 2c_I$, which holds for $f > 3c_I/2$, the latter being precisely the condition under which predation takes place. The predatory equilibrium is also welfare-inferior, as it entails a productive inefficiency. Due to inelastic demands, the price level just determines the distribution of surplus between buyers and firms, but not the overall level of surplus. But at the predatory equilibrium the cost of serving the buyers is $2c_I$, whereas at the entry equilibrium it is $f < 2c_I$. 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 welfare implications are more delicate than they may appear at first sight. Banning (intertemporal) price discrimination, or banning below-cost pricing by the incumbent does not unambiguously increase welfare. In fact, it would reduce it if $f \leq 3c_I/2$ - that is when entry takes place also when price discrimination is feasible - because it would chill competition

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[15] More precisely, it is the unique entry equilibrium which survives the elimination of weakly dominated strategies.

and (weakly) lead to higher price. Indeed, if $f \leq 3c_I/2$, the fact that the incumbent can price aggressively under price discrimination will result in the first buyer buying at prices below c_I, and the second buyer at c_I, while both would buy at c_I if the incumbent were prevented from (intertemporal) price discriminating or from selling below cost. Since entry occurs 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, welfare would also be higher under price discrimination. The following Proposition summarises these results.

Proposition 3 *Banning intertemporal price discrimination (or below-cost pricing) would have ambiguous effects:*

- *If $f \leq 3c_I/2$, it would decrease consumer surplus (leaving total welfare unchanged).*

- *If $f > 3c_I/2$, it would increase consumer surplus and total welfare.*

Proof. Follows from text above. ∎

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, exclusion would not occur and they would chill competition and result in higher prices.[16]

3   Extensions

In this Section, we propose other settings where the same basic mechanism for predation, hinging on scale economies and externalities among buyers, also applies. Section 3.1 looks at the case where the entrant has already paid its set-up costs, but would need to make further investments to increase its capacity; Section 3.2 analyses the case of products which develop over time, but are related because of common costs; Section 3.3 deals with scale economies on the demand side, created by the existence of network externalities; finally, Section 3.4 shows that predation may also appear in two-sided markets.

3.1   Entry v. expansion (predation without exit of the prey)

So far, we have assumed that the incumbent firm can prey upon a firm which has not started production yet. In this Section, we show that predation might also occur in a market where the 'prey' is already established, but needs to sink new costs if it wants to expand its scale of operation (while the incumbent has already established larger capacity). In other words, predation may be rational not only to deter entry, but also to relegate a smaller rival to a niche market, preventing it from expanding its scale.

To formalise this idea, consider the following minor variation of the model analysed in Section 2, where firm I and firm E have *two* captive buyers each, i.e. buyers who already bought from them in the past and do not want to change supplier. This might be because they have sufficiently

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[16]See Karlinger and Motta (2007) for similar conclusions in a model with (simultaneous) price discrimination and network effects.

high switching costs or because they are located too far from the alternative supplier. In addition, there are *two* buyers, B_1 and B_2, who have bought from I in the past but have zero switching costs, and therefore are ready to buy from the supplier who offers the better price (alternatively, B_1 and B_2 might be new buyers who materialize for the first time and did not buy in the past). All buyers have a valuation $v = 1$ for the (homogeneous) product.

Finally, assume that firm I has already incurred the costs $2f$ necessary to produce *four* units of the product, while firm E has incurred only the fixed cost f necessary to produce *two* units. As usual, we assume that firm E is more cost-efficient: $c_E = 0 < c_I$.[17] Also, non-captive buyers are approached sequentially, with the same timing as in Section 2.[18]

It is easy to see that except that firms must establish also the price for captive buyers, the game is the same as the sequential one analysed before. Then, it also admits the same equilibria (and under the same conditions), with 'predation' occurring or not depending on how large is the fixed cost f or the efficiency gap between the incumbent and firm E.

However, there are two interesting features in this simple extension. First, here predation takes place without firm E exiting the market: the prey will continue to operate and serve the captive buyers, but predation relegates it to its niche market, that is, to its captive buyers. Firm E would have had the opportunity to expand and serve the contestable buyers, but the incumbent's predatory strategy prevents it from expanding. This is important for policy implications: it is not necessary that the prey exits the market for predation to take place.

Second, we observe here that in equilibrium there is more price discrimination than in the previous model. We observe more extensive *selective price cuts*, with captive buyers ending up paying the pure monopoly price $p_M = 1$ and being deprived of all their surplus, and buyers who are contestable benefiting (relative to the captive buyers) in a different measure: the first free buyer is always buying below c_I, whereas the second buyer pays at or above c_I, but never a higher price than $f < 1$.

3.2 Predation in markets with common costs

The same logic described in the previous Sections applies when there are *different* relevant (either product or geographic) markets which are related by the existence of common costs. Suppose that an incumbent firm is already active in all of them, but that the entrant needs time to enter some of them. This may have been the case in some recently liberalised 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 liberalisation (exclusive rights to carry letters and items weighing less than 200 g);[19] or it may be the case where tariffs or other barriers to trade are being phased out, or where it would take a long time to get all permits needed to operate locally, 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. The novel insight is that - present economies of scope (in the postal service, common infrastructure, in

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[17] Note that the larger capacity does not result in lower marginal costs, to maintain the usual assumption that exclusion is inefficient.

[18] Since there is no competition for captive buyers, it is irrelevant whether they are approached and decide before or at the same time as free buyers.

[19] See *Deutsche Post AG*, Commission Decision of 20 March 2001.

the international markets example a common R&D or technology) - the incumbent may predate in the markets which open first, to preserve its monopoly position in *all* the markets.[20]

To formalize this situation let us assume that there are *two* markets denoted as L and M, with market M being the market which opens first (in the postal service, market L is the market for letters, market M that for mail-orders). There is independence on the demand side. There is one consumer on market L and one in market M, and each of them attaches a unit valuation to the product. (Population size is normalised to 1 in each market.) Firm I is already established in the industry and produces both products. Firm E can enter market M in both the first and the second period, but can enter market L only in the second period. There is a common fixed cost of entry, f: once paid f for entering market M, a firm does not need any other set-up costs. Firm E is more efficient than I: in both markets, marginal costs are given by $c_E = 0 < c_I < 1/2$. Finally, we assume that

$$2c_I < f < 3c_I \qquad (A2)$$

The game is as follows:

1. First period.

   (a) Firms I, E simultaneously set prices $p_I^{L,1}$, $p_I^{M,1}$ and $p_E^{M,1}$ to the buyers, who decide if and from whom to buy.

   (b) Firm E decides whether to enter market M (and pay f) or not.

   (c) Transactions take place. If E got the order in market M but did not enter, the buyer purchases from I at the offered price $p_I^{M,1}$.

2. Second period.

   (a) Firms I, E simultaneously set prices $p_I^{L,2}$, $p_I^{M,2}$ and $p_E^{L,2}$, $p_E^{M,2}$ to the buyers, who decide if and from whom to buy.

   (b) Firm E decides whether to enter in either market L, or market M, or both. If it has not entered market M yet, by paying the cost f firm E can enter both markets. If it has already entered market M, it does not need to pay any additional set-up cost to operate in market L.

   (c) Transactions take place. If E got orders in some market but did not enter that market, the buyer purchases from I at the offered price $p_I^{j,2}$ with $j = M, L$.

In what follows, we show that if the fixed cost f is large enough there will be a predatory equilibrium with deterred entry; otherwise, firm E will enter market M in the first period, and market L in the second. As in the model of Section 2, there is scope for predation because the incumbent - but not firm E - has already sunk the common fixed cost when offers are made, and because the second-period profits alone are insufficient for firm E to cover such cost.

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[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 that open first in order to protect its monopoly position in all the markets where it operates. Note, however, that in the supply-side scale economies version of their model, successful exclusion requires the incumbent to enjoy also a *first-mover advantage* and to adopt *irreversible* tying.

Proposition 4 *(Predation in sequential markets with common costs.) Equilibria of this game are as follows:*

- *(Entry) If $f < 5c_I/2$ then: in the first period, firm E and I set $p_E^{M,1} = p_I^{M,1} = c_I$, I sets $p_I^{L,1} = 1$, E supplies market M, I market L. In the second period, firm E and I set $p_E^{L,2} = p_I^{L,2} = p_E^{M,2} = p_I^{M,2} = c_I$, and E supplies both markets.*

- *(Predation) If $f \geq 5c_I/2$ then: in the first period, firm E and I sets $p_E^{M,1} = p_I^{M,1} = f - 2c_I < c_I$, $p_I^{L,1} = 1$, firm I supplies both markets and E does not enter M. In the second period, firm E and I set $p_E^{L,2} = p_I^{L,2} = k$, $p_E^{M,2} = p_I^{M,2} = f - k$ (with $k \in [0, f]$), and I supplies both markets. Firm E does not enter any market.*

Proof. By backward induction. Consider the second period first. If E already entered market M in period 1, then it does not have to incur any cost to enter market L. Standard Bertrand competition with cost-asymmetric firms takes place, and the more efficient firm E supplies both markets fixing the price $p_E^{L,2} = p_E^{M,2} = c_I$. If E did not enter M in period 1, then it has still to pay the common entry cost when it competes with the incumbent in the second period. Since $f > 2c_I$ (by assumption $A2$), in equilibrium firm I sets any pair of prices that satisfies $p_I^{L,2} + p_I^{M,2} = f$ and entry will not occur.

Consider now the first period. Since second-period rents alone are insufficient to cover the entry cost, in the first period firm E finds it profitable to pay f if the rents collected in market M are large enough: $p_E^{M,1} + 2c_I - f \geq 0$. The minimum price that firm E is willing to offer to supply market M in the first period is then: $\widetilde{p}_E^{M,1} = f - 2c_I < c_I$ (by assumption $A2$). In turn, the incumbent's minimum price is $\widetilde{p}_I^{M,1} = 3c_I - f < c_I$ because if it captures market M in the first period, it will dominate both markets in the second period (at a total price f), thereby making profits $p_I^{M,1} - c_I + f - 2c_I$. It is easy to check that when $f \geq 5c_I/2$ it is the incumbent who is willing to bid more aggressively for market M in the first period. (Since there is no threat of entry in market L in the first period, the price established by the incumbent is $p_I^{L,1} = 1$ irrespective of the outcome in market M). ∎

The model presented here is consistent with the facts of an important EU predatory case, *Deutsche Post*. Deutsche Post - which had exclusive rights on the market for letters and small parcels, was found to have abused a dominant position by the use of predatory pricing and fidelity rebates in the mail-order market. Although the European Commission does not spell any theory of harm, 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. For instance, Hermes Versand Service, the parcel delivery service subsidiary of a mail-order firm, 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.[21]

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[21]See *Deutsche Post*, at paragraph 38 and footnote 64.

3.3 Network effects

One of the limitations of the exclusionary model analysed so far is that for predation to take place, it is required that the entrant is not able to pre-commit to production (or additional capacity), or does not have the time to sink its entry (or expansion) costs. In this Section, we show that under demand-side scale economies, the entrant may have already sunk its cost (equivalently, one could assume that there is no entry cost), but this is not sufficient to avoid exclusion. Indeed, as in the previous Sections, it turns out that exclusion will be the only equilibrium if the incumbent does not have a very strong marginal cost disadvantage vis-à-vis the entrant.

Consider the following model, which is a simplified (sequential) version of Karlinger and Motta (2008). There are 2 *new* buyers, B_1 and B_2, who are considering to buy a product, and are characterised by a utility $U_i = v(n_i) - p_i$ if they buy one unit of good $i = I, E$, where $n_i \in N^+$ indicates the total number of buyers who buy the product in the present period, or have bought in the past and still use it.[22] There are direct network externalities in that $v(1) = 0$ and $v(n_i) > 0$ for $n_i > 1$. We assume that $v(n_i) = v(n_i+1) = \overline{v}$ for any $n_i > 1$. In other words, there are demand-side scale economies because a firm needs to have *at least two* consumers for them to reach a positive utility from the network good, but as soon as there are two buyers, all economies are attained. This is to keep the analysis as simple as possible, and to make exclusion more difficult.[23] The incumbent firm I has already a customer base $b_I \geq 2$ - the old buyers are not buying any longer, but continue to use the network product - while the new firm E has no customer yet when the game starts. Apart from possible differences in their sizes, the two networks are homogeneous but incompatible.

Firm E is more cost-efficient than firm I: marginal costs are respectively given by $0 = c_E < c_I < \overline{v}$. Note that to focus on the role of network effects, we assume away entry cost. Finally, we do not impose restrictions on prices which can be also negative. The game is as follows.

1. First period.

   (a) Firms I, E simultaneously set prices p_I^1 and p_E^1 to buyer 1.

   (b) Buyer 1 decides from whom to buy.

2. Second period.

   (a) Firms I, E simultaneously set prices p_I^2 and p_E^2 to buyer 2.

   (b) Buyer 2 decides from whom to buy.

3. Third period

   Consumption takes place and utilities are realized.

The following Proposition illustrates the results of the analysis.

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[22]Here again, the extension to n buyers and the consideration of elastic demands would leave qualitative results unchanged.

[23]By making the more general assumption that $v(n_i)$ is an increasing and concave function, results would not qualitatively change, though. The simpler formulation we adopted has also the additional advantage that the utility of customers who have bought in the past is not affected by the outcome of the game, thus simplifying any welfare analysis one might want to do.

Proposition 5 *(Network market, sequential - and intertemporal discriminatory - offers) Equilibria are as follows:*

- **(Entry)** *If $\overline{v} \leq 3c_I$, then both buyers buy from E, the first paying a price $p_E^1 = 2c_I - \overline{v} < c_I$, the second paying a price $p_E^2 = c_I$.*

- **(Exclusion)** *If $\overline{v} > 3c_I$, then both buyers buy from I, the first paying a price $p_I^1 = -c_I$, the second paying a price $p_I^2 = \overline{v}$.*

Proof. In the second period, competition for B_2 results in different outcomes depending on the choice of the first buyer. (i) If B_1 bought from E, the second buyer does the same if (and only if) $U_E^2 = v(2) - p_E^2 \geq v(b_I + 1) - p_I^2 = U_I^2$. Given that $b_I \geq 2$ and $v(2) = v(b_I + 1) = \overline{v}$, the firm setting the lowest price gets B_2. Standard Bertrand competition with cost-asymmetric firms takes place and firm E supplies the second buyer at a price $p_E^2 = c_I$. (ii) If B_1 bought from the incumbent, the second buyer buys from firm E if (and only if) $v(1) - p_E^2 \geq v(b_I + 2) - p_I^2$. Given that $v(1) = 0$, the second buyer buys from firm E iff $p_E^2 \leq p_I^2 - \overline{v}$. Lack of customer base implies that, in order to capture B_2, firm E cannot simply slightly undercut the incumbent, but it has to grant a sufficiently large discount. In equilibrium, the incumbent supplies B_2 at a price $p_I^2 = \overline{v}$.

In the first period, B_1 anticipates that the supplier she chooses will serve also the second buyer. Then, the critical size necessary to enjoy utility from the network product will be achieved whatever her choice and B_1 is willing to buy from the supplier offering the lowest price. In turn, suppliers anticipate that failing to serve the first buyer implies failing to serve also the second, thereby losing the profits that can be extracted in the second period. Also, the incumbency advantage creates an asymmetry between such profits, with the incumbent earning $\overline{v} - c_I$ while the entrant earning c_I. Together with the difference in production costs, this generates asymmetric Bertrand competition for the first buyer, with the minimum prices at which the incumbent and firm E are willing to supply B_1 being equal, respectively, to

$$\begin{aligned} \widetilde{p}_I^1 &= c_I - (\overline{v} - c_I) = 2c_I - \overline{v} < c_I \\ \widetilde{p}_E^1 &= 0 - c_I. \end{aligned}$$

The comparison between $\widetilde{p}_I^1$ and $\widetilde{p}_E^1$ determines who gets the first buyer and the equilibrium price. If $\widetilde{p}_I^1 < \widetilde{p}_E^1$, it will be the incumbent that serves the first buyer at a price which equals $\widetilde{p}_E^1$. Otherwise, the entrant will serve the buyer, who will pay E the price which equals $\widetilde{p}_I^1$. ∎

Note that in this simple network externality model the *incumbency advantage* enjoyed by firm I - which is the source of exclusion - is now due to the incumbent already having a customer base when the game starts, whereas the entrant still needs to reach a minimum critical mass in order for consumers to derive any utility from sponsoring it. Also the entrant needs both buyers to achieve such a critical mass. This creates an asymmetry in the profits that the two firms earn in the second period, which translates into asymmetric competition for the first buyer. When the incumbent's marginal cost disadvantage is not too strong, the incumbent ends up capturing the first buyer, thereby excluding the rival supplier.[24]

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[24] Also in Carlton and Waldman (2002) - the variant based on network externalities - suppliers compete intensively

Note also that in this simple model the price that the entrant is willing to offer to the first buyer is negative, implying that below-cost pricing is not sufficient to exclude: the incumbent needs to subsidise the first buyer.[25]

3.4 Predation in two-sided markets

In this Section we propose a simple model of predation in a two-sided market, meant to capture the essence of the Napp and Aberdeen Journal cases referred to in the introduction. The two platforms I and E sell to two sides. We normalise to 1 the size of new consumers on each side. Side-1 consumers have a utility function which does not depend on the number of side-2 consumers, similar to a hospital whose utility is unaffected by how many general practitioners buy the pharmaceutical product (or to readers who do not care about advertising in their newspaper): $U_{1i} = \theta - p_{1i}$ if they buy one unit of the good from platform $i = I, E$. Side-2 consumers' utility, instead, increases with the number of consumers on the other side of the market, similarly to the 'community market' whose demand raises with the hospital demand in the Napp case (or to advertisers whose demand increases with the number of readers of a newspaper). Side-2 utility function is accordingly given by $U_{2i} = v_2(n_{1i}) - p_{2i}$ if they buy one unit from platform $i = I, E$, where $n_{1i} \in N^+$ is the total number of side-1 consumers who buy from platform i at present or that bought in the past. We assume that $v_2(n_{1i})$ is weakly increasing in n_{1i} and that a critical mass of at least *one* side-1 consumer is required to achieve a positive utility from consumption: $v_2(0) = 0$ and $v_2(n_{1i}) > 0$ for $n_{1i} \geq 1$; in particular, to be consistent with the previous section, we maintain the simplification that $v_2(n_{1i}) = v(n_{1i} + 1) = \overline{v}$ for any $n_{1i} \geq 1$. Also, we assume that the incumbent firm I has already a side-1 customer base $b_{1I} = 1$, while the new firm E has no customer yet when the game starts. (The old buyers are not buying any longer, but continue to use the product.) Firm E is more cost-efficient than firm I - marginal costs are respectively given by $0 = c_E < c_I < \overline{v}$ - and it does not need to pay any fixed cost to enter the market. Finally, apart from possible differences in their sizes, the two platforms are homogeneous and incompatible.[26] The game is as follows.

1. First period.

   (a) Firms I, E simultaneously set prices p_I^1 and p_E^1 to side-1 buyer.

   (b) Side-1 buyer decides from whom to buy.

2. Second period.

   (a) Firms I, E simultaneously set prices p_I^2 and p_E^2 to side-2 buyer.

   (b) Side-2 buyer decides from whom to buy.

3. Utilities are realised.

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for the first cohort of consumers, and such a competition may result in exclusion of the more efficient entrant. In their case, though, the asymmetry between the incumbent and the entrant is created by the former being already active in the market for a complementary product to the network product, rather than by already having a customer base when the game starts.

[25]If prices were restricted to be non-negative predation may still arise but there may be multiple equilibria for any given parameter space.

[26]Motta and Vasconcelos (2009) study exclusion in two-sided markets in a more general context where two-sided externalities arise and where purchasing decisions are simultaneous rather than sequential.

The analysis is quite similar to the case of network effects, and results can be summarised in the following way.

Proposition 6 *(Two-sided markets) Equilibria are as follows:*

- *(Entry) If $\overline{v} < 3c_I$, then both buyers buy from E, the side-1 paying the price $p_E^1 = 2c_I - \overline{v} < c_I$ and the side-2 paying the price $p_E^2 = c_I$.*

- *(Exclusion) If $\overline{v} \geq 3c_I$, then both buyers buy from I, the side-1 paying the price $p_I^1 = -c_I$ and the side-2 buyer paying the price $p_I^2 = \overline{v}$.*

Proof. Let us start from the second period. If the side-1 consumer bought from E, then the side-2 consumer is willing to buy from E if (and only if) $U_{2E} = v_2(1) - p_E^2 \geq v_2(b_{1I}) - p_I^2 = U_{2I}$. Since $b_{I1} = 1$, the side-2 consumer buys from the supplier offering the lowest price, as long as such price is below $v_2(1) = \overline{v} > c_I$ (by assumption). The equilibrium prices are then $p_I^2 = p_E^2 = c_I$ with firm E supplying the side-2 buyer. If instead the side-1 consumer buys from the incumbent, then the side-2 consumer is willing to buy from E if (and only if) $U_{2E} = v_2(0) - p_E^2 \geq v_2(b_{1I}+1) - p_I^2 = U_{2I}$. From $v_2(0) = 0 < \overline{v} = v_2(2) = v_2(b_{1I} + 1)$ it follows that firm E has to offer a sufficiently large discount in order to capture the side-2 buyer: $p_E^2 \leq p_I^2 - \overline{v}$. In equilibrium $p_I^2 = \overline{v} > c_I$ and $p_E^2 = 0$, with the the incumbent supplying the the side-2 consumer.

In the first period, the side-1 consumer is willing to buy from the supplier bidding the lowest price (her utility being unaffected by the number of buyers addressing a given platform). Suppliers anticipate that who gets the side-1 buyer will also get the side-2 buyer. As shown above, the incumbency advantage together with the production cost asymmetry make the incumbent and firm E extract different profits from the side-2 consumer, with I earning $\overline{v} - c_I$ while firm E earning c_I. Then, the minimum prices at which they are willing to supply the side-1 consumer are respectively:

$$\begin{aligned} \widetilde{p}_I^1 &= 2c_I - \overline{v} < c_I \\ \widetilde{p}_E^1 &= -c_I \end{aligned}$$

When $3c_I \leq \overline{v}$ the former is lower and the incumbent captures the side-1 buyer by subsidising her purchase. ∎

4   Conclusions

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

We have showed that this simple mechanism applies to a number of settings: economies of scale may exist on the supply-side or on the demand side (due to network effects); markets might be related by the existence of common costs or being two-sided; predation might aim at excluding the prey from the market altogether, or at relegating it to a niche market.

Testing the robustness of the model by modifying a number of assumptions, we have also obtained insights as to conditions and markets where it is more likely that predation based on this mechanism may arise. For instance, in the case where scale economies are on the production side, we would expect predation to exist in situation where actual entry takes time (the entrant would find it more difficult to pre-commit to entry), where breach of contracts is more difficult (due to high transaction costs, legal costs, and buyers' fragmentation), where downstream competition is less fierce. If scale economies are on the demand side, predation is more likely to occur when there are important switching costs for past buyers, or where purchase is infrequent (these conditions increase the value of the installed base of the incumbent) and where of network externalities are important.

We have argued that in several of the recent predation cases pursued by EU antitrust agencies, the economic rationale for predation lies on the exclusionary mechanism we have described. Our paper provides competition agencies with a new theory of harm in predation cases, and help them understand whether the actual evidence fits with the conditions under which predation might take place. Obviously, 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, to discourage further entry, 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 different rationales are not necessarily inconsistent with each other and might co-exist: our theory does not exclude that an incumbent might want to deprive a particular 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 entrants' assets, and therefore making it more difficult for it to obtain funds in an imperfect capital market.

For instance in what is probably the most important EC predation case, Akzo Chemie was found guilty of predation in the market for organic peroxides, a chemical product used as a flour additive in the UK and more generally in the chemical industry.[27] 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. To substantiate the allegations, the Commission 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:

> "The value of ECS' flour additives sales in the United Kingdom had by 1984 declined
> to 70 % of its 1980 sales (...). In effect the "independents" and Allied Mills lost to

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[27] Commission Decision IV/30.698 (*ECS/Akzo*) of 14 December 1985. Published in OJ L 374, 31 December 1985.

AKZO UK accounted for almost one-third of its flour additive business in the United Kingdom.

The general decline in prices of flour additives also involved a reduction in the margins on the business which ECS retained. In order to remain in business (says ECS) it was obliged to increase its bank borrowings substantially thereby incurring additional bank charges and interest.

The lack of available funds also caused ECS to reduce its budget for research and development and to delay modifications to its plant intended to deal with new organic peroxide business." (para. 50)

This seems to be consistent with both the mechanism characterised in this paper (target some key customers so as to deprive the prey of the profits it needs to pay fixed costs necessary to operate, expand operations, or enter other markets) and with the financial market predation motive as presented by Bolton and Scharfstein (by reducing ECS' profits, it became more costly for it to acquire funds in the financial markets).[28]

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[28] 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. In the words of the European Commission (para. 86): "the elimination of ECS would have a dissuasive effect upon any other small producer which might be minded to attack AKZO's established market position."

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