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Strategic nonparticipation

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We study a model that involves identity-dependent, asymmetric negative external effects. Willingness to pay, which can be computed only in equilibrium, will reflect, besides private valuations, also preemptive incentives stemming from the desire to minimize the negative externalities. We find that the best strategy of some agents is simply not to participate in the market, although they cannot in this way avoid the negative external effects. An illustration is made for the acquisition of patents in oligopolistic markets. Finally, we show that even when we allow full communication and side payments between agents, all coalitional agreements are unstable.

1. Introduction

■   A variety of economic, political, and social conflict situations involve real or perceived negative external effects that are nonanonymous and asymmetric. In these situations the exact identity of the "winner" greatly affects the utility of other participants.

Consider, for example, the following story (*The Economist,* 1992a). The French food conglomerate BSN and the Italian Agnelli group (owner of FIAT) bitterly fought for control of the prestigious maker of mineral water, "Source Perrier." After months of debate in board rooms, courts, and the media, BSN proposed a deal that would place control over Perrier in the hands of the Swiss food giant Nestlé. According to *The Economist,* "Why does BSN want a powerful rival such as Nestlé to take control of Perrier? . . . Mr. Riboud [the boss of BSN] fears the Agnellis more than Nestlé."

We study a simple market situation in which an owner of an indivisible good may sell to one of several potential buyers. Our only addition to this setting is a matrix of nonpositive externalities whose entries express the effect on buyer j if buyer i, $i \neq j$, acquires the good. The externalities may represent a physical effect, like pollution, or may stand as a reduced form for the consequences of some future interaction.

We develop an application that deals with the introduction of a cost-reducing innovation protected by a patent in an oligopolistic market. Other situations that fit in

our framework include battles for market share where competitors acquire existing firms operating in the same market; the privatization of a firm operating in an oligopolistic environment; the sale of some input where there is downward competition between buyers; the market for highly qualified professionals where potential employers are in tough competition (for example, "star" baseball players or economic professors); and international negotiations over the siting of a prestigious institution (recall the recent discussion about the location of the future European Central Bank, and the German (English) "fears" about possible locations in London (Frankfurt)).

Models with endogenous valuations have been studied by, among others, Funk (1992), Jehiel and Moldovanu (1995), and Krishna (1993). The literature on patent licensing explicitly considers the negative external effects (see, for example, Katz and Shapiro (1986) or Kamien and Tauman (1986)) but these effects are considered to be anonymous, dependent only on the number of other licensees. When asymmetries were considered, the number of involved firms was usually limited to two (for example, an incumbent and a potential entrant competing for an innovation—see Gilbert and New-bery (1982) and the survey in Tirole (1988)). An exception is Rockett (1990), who looks at an incumbent that "chooses its competition" by strategic licensing.

An important point not perceived in the literature, and which constitutes our main subject, is that the presence of identity-dependent and asymmetric external effects in situations with more than two potential buyers may create intricate strategic effects with respect to the willingness (or unwillingness) of the agents to participate in the market process. We assume that nonparticipating agents still suffer from the potential negative effects created by the interaction between the seller and participating buyers, i.e., no one can "escape to the moon." Indeed, in the innovation example, if a firm decides not to participate but a competitor acquires the patent, the firm will make a lower profit.

It is well known that when positive externalities are present, some agents may find it optimal to "free ride" by not participating in a market process. We find in the exactly opposite situation (i.e., with negative externalities) that optimally behaving agents should commit not to participate in a market transaction, even if by doing so they are sure to obtain negative payoffs (relative to the status quo). The reason for this is that the mere presence of agents in the market has an influence on the identity of the final buyer and on the price these agents themselves will have to pay if they wish to acquire the good.

There are no fixed reservation prices in our framework. What an agent is prepared to pay depends not only on the individual valuation, but also on the perceived danger that other agents will obtain the good. This is a well-known phenomenon in the theory of preemptive patenting (see, for example, Gilbert and Newbery (1982)).

We stress that in our model, all agents are completely informed about their own and other agents' relevant characteristics. This allows us to clearly attribute the strategic effects to the presence of externalities, as opposed to, say, problems of incomplete information. The classical "winner's curse" is a well-known phenomenon in the theory of common value auctions where individual estimates are private information. There, learning that one has acquired the good (and hence that others have bid less) invariably conveys bad news about the true value of the auctioned item. For more details see Milgrom and Weber (1982) and the surveys by Milgrom (1987) and McAfee and McMillan (1987). Sophisticated bidders will take the potential curse into account, and will adjust their bids downward.

Unlike the above-mentioned literature, we do not describe an informational "curse": in our model the winner may find, in equilibrium, that she has paid "much too much" because her mere presence in the market frightened some other agent. If the winner herself is very afraid of that agent, she must by all means prevent him from

acquiring the good. The "cursed" winner cannot adjust her bid downward—this will, invariably, be nonoptimal. The only possibility to avoid the curse is by credibly committing to stay out of the market. This nonparticipation has an influence on the identity of the winner in the new situation, and a more favorable outcome (from the point of view of the nonparticipant) may be reached.

A related "curse" may afflict a loser if he does not perceive that his mere presence has an influence on the identity of the potential winner, and hence, by staying out, a more favorable outcome (i.e., lesser negative effect) is achieved.

The phenomena described here are not confined to the specific model of auctions chosen for illustration. We can obtain the same effects in a variety of models with endogenous valuations. For example, they can appear in alternative auction settings, or in a dynamic model of negotiation with externalities (see Jehiel and Moldovanu, 1995). There we also show how externalities lead to other peculiar phenomena, such as the emergence of long delays.

Other real-life situations may yield strategic opportunities having the flavor of directed preemption as illustrated here. For example, Rockett (1990) reports the following case: In 1947, shortly after an antitrust suit was filed against an alleged monopoly in cellophane production, Du Pont canceled its major planned expansion of cellophane capacity and licensed Olin Industries (besides renegotiating an existing license with Sylvania). Clearly, one of Du Pont's goals was to win the lawsuit by arguing that there were now three firms in the field. But its other main motive seems to have been to deter the entry of Dow Chemical. Olin was a relatively small firm, obviously less dangerous than the powerful Dow.

Our previous discussion was based on examples of institutional settings that do not allow communication between buyers. This is a realistic assumption in many situations where a "market for the externality" does not exist for legal, institutional, or physical reasons. Nevertheless, there are instances when certain agreements between buyers, possibly containing side payments, may be advantageous to all parties involved, and thus may remove some of the instability created by the negative external effects. We shall show that the instability is much more intrinsic: in all interesting situations, given any possible agreement (including those with monetary transfers), there are always coalitions that can do better for their respective members by deviating from the agreement, and this irrespectively of what nondeviating members do in response to the deviation.

The article is organized as follows. In Section 2 we describe the basic model and the matrix of externalities. In Section 3 we prove several useful results for sealed-bid, first-price auctions. In Section 4 we show how participation decisions are influenced by the fine structure of the externalities. In Section 5 we illustrate the ideas in a specific environment—the appearance of a cost-reducing innovation, protected by a patent, in an oligopolistic market. In Section 6 we discuss the coalitional instability of markets with externalities. Section 7 gathers our conclusions.

2. The basic model

■ The market we consider consists of one seller and n different buyers. We keep the structure at a necessary minimum. The seller, S, owns an indivisible good. The buyers will be denoted by B_i, B_j, etc., where $1 \leq i, j \leq n$. If no trade takes place, then, for the theoretical discussion, the utilities of all agents are normalized to zero (in applications the no-trade situation will be called the status quo). If buyer B_i buys the indivisible good at a price p, then his utility is given by the term $\pi_i - p$, where π_i represents the profit made by B_i when owning the good. The seller's utility is given by p.

Our main addition is a matrix

$$\{ \ \alpha_{ij} \ \}_{\substack{1 \le i,j \le n \\ i \ne j}}$$

of external effects. The interpretation is that if buyer B_i buys the object, then the utility of B_j is given by $-\alpha_{ij}$, where $\alpha_{ij} \ge 0$. We can easily allow for the case where the seller himself suffers from potential externalities, i.e., the payoff to the seller if he sells at price p to buyer B_i is given by $p - \alpha_{is}$. Because it involves only a change in variables, we do not explicitly consider this possibility, and we concentrate on the externalities between buyers—they are responsible for the strategic effects.

For example, consider n firms competing in an oligopoly. The cost functions may differ from firm to firm. A technical innovation becomes available whose effect is a reduction in the marginal costs. Again, the effect of that innovation may differ from firm to firm. The firm that acquires the innovation will increase its market share and its profit. The market share and profit of the other firms will decrease. Formally, denote by Π_i the profit of firm i before the innovation appears (this is the "status quo" profit). Denote by Π_j^i the profit of firm j if firm i acquires the innovation. This situation exactly fits in our framework by setting

$$\pi_i = \Pi_i^i - \Pi_i, \quad \text{for all } i \text{ such that } 1 \le i \le n \tag{1}$$

and

$$\alpha_{ij} = \Pi_j - \Pi_j^i, \quad \text{for all } i, j \text{ such that } 1 \le i,j \le n \text{ and } i \ne j. \tag{2}$$

3. First-price auctions

■   We have chosen, for illustration, the sealed-bid first-price auction. We next prove several simple results that will be useful for the study of the nonparticipation effects.

To avoid problems related to existence of Nash equilibria, we assume here that there exists a smallest money unit, denoted by ϵ. We assume that ties are randomly broken, that is, if several buyers bid the same highest amount, then each of them has equal probability of obtaining the good. Our proofs are given for generic situations where all equalities of the type $\pi_i + \alpha_{ki} = \pi_j + \alpha_{ij}$ are ruled out. The smallest money amount, ϵ, is chosen such that all inequalities are preserved if an ϵ is added or subtracted. The nongeneric cases can be treated in a completely analogous way, but the case differentiation is more tedious.

Proposition 1. The set of Nash equilibria in pure strategies of the sealed-bid first-price auction is not empty.

Proof. If for all B_i it holds that $\pi_i + \max_j \alpha_{ji} \le 0$, then

$$\mathbf{p} = (p_1, \ldots, p_n) = (0, 0, \ldots, 0)$$

is a Nash equilibrium. Otherwise, choose B_i, B_k such that $\pi_i + \alpha_{ki} > \pi_j + \alpha_{fj}$ for all $j \ne i$, and for all $f \ne \delta$. Let $\mathbf{p} = (p_1, \ldots, p_n)$ be a strategy profile as follows:

$$p_i = \pi_i + \alpha_{ki} - \epsilon; \quad p_k = \pi_i + \alpha_{ki} - 2\epsilon; \quad p_j < p_k, \quad \forall j \ne i, k.$$

We claim that the profile $\mathbf{p}$ constitutes a Nash equilibrium of the auction game. If $\mathbf{p}$ is played, the payoff of B_i is given by $\pi_i - p_i = -\alpha_{ki} + \epsilon$, and B_i obtains the good. It is

clear that B_i does not gain by increasing p_i. If B_i lowers his bid below p_k, then B_k obtains the good and B_i's payoff is $-\alpha_{ki} < -\alpha_{ki} + \epsilon$. If B_i announces $p_i = p_k$, then his payoff is given by $\frac{1}{2}(\pi_i - (\pi_i + \alpha_{ki} - 2\epsilon)) + \frac{1}{2}(-\alpha_{ki}) = -\alpha_{ki} + \epsilon$. Hence, $p_i = \pi_i + \alpha_{ki} - \epsilon$ is optimal for B_i if all other players play according to profile $\mathbf{p}$. We now look at B_k. If $\mathbf{p}$ is played, her payoff is $-\alpha_{ik}$. If B_k lowers her bid, her payoff does not change, and B_i still wins. Assume now that B_k bids $p_k = p_i = \pi_i + \alpha_{ki} - \epsilon$. Then B_k's payoff is given by $\frac{1}{2}(\pi_k - (\pi_i + \alpha_{ki} - \epsilon)) + \frac{1}{2}(-\alpha_{ik})$. By the selection of B_i and B_k we know that $\pi_i + \alpha_{ki} > \pi_k + \alpha_{ik}$, and hence that $\pi_k - (\pi_i + \alpha_{ki}) < -\alpha_{ik}$. Hence, $p_k = p_i$ cannot be optimal for B_k. The same holds for bids of B_k above p_i. We now look at $B_j \neq B_i, B_k$. If $\mathbf{p}$ is played, the payoff of B_j is given by $-\alpha_{ij}$. If B_j lowers her bid, her payoff does not change. The same argument as for B_k shows that an increase in the bid cannot be advantageous for B_j.   Q.E.D.

There are, in general, many Nash equilibria in pure strategies. However, most of them employ weakly dominated strategies. It is easy to show that (i) any strategy of B_i, p_i, such that $p_i \geq \pi_i + \max_j \alpha_{ji}$, is weakly dominated by the strategy

$$\bar{p}_i = \pi_i + \max_j \alpha_{ji} - \epsilon$$

and (ii) strategies $p_i \leq \bar{p}_i$ are not dominated.

Let $\mathbf{p} = (p_1, p_2, \ldots, p_n)$ be a vector of bids. We denote by $U_i(\mathbf{p})$ the utility of bidder B_i when $\mathbf{p}$ is played.

Proposition 2. Let $n = 2$, and assume without loss of generality that

$$\pi_2 + \alpha_{12} > \pi_1 + \alpha_{21}.$$

In all Nash equilibria of the auction game, buyer B_2 obtains the objects, and she pays at least $\bar{p}_2 = \pi_1 + \alpha_{21}$.

Proof. Let $\mathbf{p} = (p_1, p_2)$ be a Nash equilibrium. Assume first that $p_1 > p_2$. Then $U_2(\mathbf{p}) = -\alpha_{12}$. It must be the case that $p_1 \leq \pi_1 + \alpha_{21}$. Hence, $U_1(\mathbf{p}) \geq -\alpha_{21}$. (Otherwise, B_1 could bid zero and improve his payoff.) By bidding $p_1 + \epsilon$, B_2 could improve her payoff to $\pi_2 - (p_1 + \epsilon) \geq \pi_2 - (\pi_1 + \alpha_{21} + \epsilon) > -\alpha_{12}$. This is a contradiction to the assumption that $\mathbf{p}$ is an equilibrium. A similar argument applies to the case where $p_1 = p_2$.

We have shown that $p_2 > p_1$. Assume now that $p_2 < \pi_1 + \alpha_{21}$. Clearly, the best response of B_1 is in this case either $p_1 = p_2$ or $p_1 = p_2 + \epsilon$, yielding a contradiction. Q.E.D.

Note that in the case of Proposition 2, there exists a unique Nash equilibrium in undominated strategies: $\bar{p}_1 = \pi_1 + \alpha_{21} - \epsilon; \bar{p}_2 = \pi_2 + \alpha_{21}$.

The next example shows that when there are at least three bidders, the structure of the externality matrix does not uniquely determine the bidder who will obtain the object in equilibrium, although we maintain throughout the article the assumption of generic parameters. We exhibit two Nash equilibria in undominated strategies whose underlying logic is different. The winners, and the price they are paying, are also different. The reason for the multiplicity of equilibria is as follows: Because of the externalities, the price a bidder is ready to pay depends on his belief about who will get the object if he himself does not get it. This belief is endogenously determined in equilibrium, and several consistent sets of beliefs can be constructed when there are at least three bidders.

Note that winner indeterminacy cannot occur in generic auctions without externalities: although the winning price may vary, the winner in all equilibria is the buyer B_i (unique for generic settings) such that $i = \operatorname{argmax}_j \pi_j$.

Example 1 (winner indeterminacy). Let $\pi_1 = \pi_2 = \pi_3 = \pi$. Let

$$\alpha_{12} = \alpha_{21} = \alpha; \qquad \alpha_{32} = \alpha_{31} = \beta; \qquad \alpha_{13} = \alpha_{23} = \gamma.$$

Assume that $\alpha > \gamma > \beta$. (The symmetry of B_1 and B_2 is chosen only to simplify the argument. The same kind of result holds in a neighborhood of the parameter values, hence also for generic games.) Let $\bar{\mathbf{p}} = (\bar{p}_1, \bar{p}_2, \bar{p}_3) = (\pi + \alpha - \epsilon, \pi + \alpha - \epsilon, \pi + \gamma - \epsilon)$, and let $\hat{\mathbf{p}} = (\hat{p}_1, \hat{p}_2, \hat{p}_3) = (\pi + \beta, \pi + \beta, \pi + \beta + \epsilon)$. It is readily verified that both profiles $\bar{\mathbf{p}}$ and $\hat{\mathbf{p}}$ are Nash equilibria in undominated strategies. If $\bar{\mathbf{p}}$ is played, then either B_1 or B_2 obtains the object. These players, who are very afraid of each other, engage in a "race" and end up paying a high price. If $\hat{\mathbf{p}}$ is played, B_1 and B_2 "coordinate" to avoid the expensive race and allow B_3 to obtain the object. Note that if $\hat{\mathbf{p}}$ is played, the seller obtains the price $\pi + \beta + \epsilon$, which is only the "third-best" price. *Q.E.D.*

4. The trappings of auctions

■ In this section we show that both potential winners and potential losers may be better off by not participating in the auction at all. We consider an extended game, denoted by Γ, where the buyers have first the opportunity to decide whether or not they want to participate in the auction. Those decisions are made simultaneously. In the second stage of Γ, the auction takes place with the bidders that decided to participate. The payoffs to all agents are determined by the result of the second stage. Hence, buyers who decide not to enter the market cannot simply avoid the effect of the negative externalities. Note that without externalities it is always optimal to participate in the auction, and this independently of what other agents are doing.

In the next two propositions we shall identify, in the simplest possible settings, the reasons for the nonparticipation effects. First, a potential loser may, simply by being present in the auction stage, frighten another bidder who ends up winning. If that potential loser simply retreats, then she is not frightening any more, and the good will go to a third buyer. This may, overall, be a better outcome for the bidder who stayed out. Second, a potential winner may have to pay a huge price to win and thereby keep the good from falling into the hands of a dangerous competitor. But if the potential winner stays out, the competitor's interest may diminish as well, and the good may end up in the hands of a third buyer. Again, this may be a better outcome for the potential winner who retreated from the market.

We focus on three-person situations because they are the minimal ones needed to display these effects. It is clear that similar effects may occur in situations with more bidders—the underlying logic will be exactly the same. Finally, to separate the participation issues from the winner indeterminacy issue (see Example 1), we look at situations where winner indeterminacy does not occur.

Proposition 3 (where the winner should stay out). Let Γ be a game with three buyers where the following conditions hold:

$$\pi_1 = \pi_2 = \pi_3 = \pi, \tag{3}$$

$$\alpha_{31} > \alpha_{13} > \alpha_{ij}, \ \forall \{i, j\} \neq \{1, 3\}, \tag{4}$$

$$\alpha_{21} > \max\{\alpha_{12}, \alpha_{32}\}, \text{ and} \tag{5}$$

$$\alpha_{32} > \alpha_{23}. \tag{6}$$

Then the following statements hold:

(i) In all Nash equilibria of the auction where all buyers participate, B_1 obtains the object and pays at least $\pi + \alpha_{13}$.

(ii) There is no subgame-perfect Nash equilibrium of Γ where all buyers participate in the auction. The pattern of behavior where B_1 stays out and the other buyers participate is part of a subgame-perfect Nash equilibrium.

Proof. (i) Assume that all buyers participate in the auction, and let **p** be an equilibrium vector of bids. We first show that B_2 cannot obtain the good in equilibrium. Assume, on the contrary, that B_2 obtains the object when **p** is bid. Hence no bid is higher than p_2. Assume, for example, that $p_2 > p_1 > p_3$. The proof for all other cases is completely analogous. It must be the case that $p_2 \leq \pi + \max\{\alpha_{12}, \alpha_{32}\}$. Otherwise,

$$U_2(\mathbf{p}) = \pi - p_2 < -\max\{\alpha_{12}, \alpha_{32}\}.$$

By deviating and bidding zero, B_2 is sure to obtain at least $-\max\{\alpha_{12}, \alpha_{32}\}$, yielding a contradiction to the assumption that **p** is an equilibrium. We have $U_1(\mathbf{p}) = -\alpha_{21}$. By bidding $\overline{p}_1 = p_2 + \epsilon$, B_1 obtains at least $-\max\{\alpha_{12}, \alpha_{32}\} - \epsilon$. Because of condition (5) this yields a contradiction to the assumption that **p** constitutes an equilibrium. This completes the proof that B_2 cannot obtain the object in equilibrium.

We now show that B_3 cannot get the object in equilibrium. Assume, for example, that $p_3 > p_1 > p_2$. Hence $U_1(\mathbf{p}) = -\alpha_{31}$. It must be the case that $p_3 < \pi + \alpha_{13}$ (see condition (4)). Hence, by bidding $\overline{p}_1 = p_3 + \epsilon$, B_1 can obtain the good and get utility of $\pi - (p_3 + \epsilon) > -\alpha_{13} - \epsilon$. Because of condition (4), we again obtain a contradiction to the assumption that **p** is an equilibrium.

We now complete the proof of point (i) by showing that $p_1 \geq \pi + \alpha_{13}$. Assume, on the contrary, that $p_1 = \pi + \alpha_{13} - \mu\epsilon$, where $\mu \geq 1$. Because B_1 always obtains the good in equilibrium, we have $U_3(\mathbf{p}) = -\alpha_{13}$. If $\mu > 1$, then B_3 can improve her payoff by bidding $\pi + \alpha_{13} - (\mu - 1)\epsilon$, and obtaining the good. This is a contradiction to the assumption that **p** is an equilibrium. If $p_1 = \pi + \alpha_{13} - \epsilon$, then the best response of B_3 is $p_3 = p_1$. In this case we have $U_1(\mathbf{p}) = \frac{1}{2}(-\alpha_{31}) + \frac{1}{2}(-\alpha_{13} + \epsilon)$. Because of condition (4), it is better for B_1 to deviate and bid $\pi + \alpha_{13}$, yielding a contradiction to the assumption that **p** is an equilibrium.

(ii) Let σ be a subgame-perfect Nash equilibrium of Γ. It is clear that, for the auction stage, σ prescribes to those buyers who have chosen to participate in an equilibrium behavior for that auction. Hence, if all buyers participate, we know by point (i) that B_1's utility when σ is played cannot exceed $-\alpha_{13}$. But if the other buyers are participating, then B_1 is better off by staying out. In this case, the bidders in the auction stage are B_2 and B_3 and, because of condition (6) and Proposition 2, in all equilibria of the auction B_2 obtains the object. Hence, if he stays out, B_1 has a payoff of $-\alpha_{21} > -\alpha_{13}$ (see condition (4)), and it cannot be optimal for this buyer to participate if the other buyers are also participating.

It is readily verified that the pattern of behavior in which B_1 stays out and B_2 and B_3 participate and bid according to an equilibrium of that two-buyer auction constitutes the play-path of a subgame-perfect Nash equilibrium of Γ.   *Q.E.D.*

Proposition 4 (where a loser should stay out). Let Γ be a game with three buyers where the following conditions hold:

$$\pi_1 = \pi_2 = \pi_3 = \pi, \tag{7}$$

$$\alpha_{31} > \alpha_{13} > \alpha_{ij}, \ \forall \{i, j\} \neq \{1, 3\}, \tag{8}$$

$$\alpha_{23} > \max\{\alpha_{12}, \alpha_{32}\}, \ \text{and} \tag{9}$$

$$\alpha_{12} > \alpha_{21}. \tag{10}$$

Then the following statements hold:

(i)   In all Nash equilibria of the auction where all buyers participate, B_1 obtains the object and pays at least $\pi + \alpha_{13}$.

(ii) There is no subgame-perfect Nash equilibrium of Γ where all buyers participate in the auction. The pattern of behavior where B_3 stays out and the other buyers participate is part of a subgame-perfect Nash equilibrium.

Proof. The proof of point (i) is completely analogous to the one in the previous proposition, hence it is omitted here.

(ii) Let σ be a subgame-perfect Nash equilibrium of Γ. For the auction stage, σ prescribes to those buyers who have chosen to participate an equilibrium behavior for that auction. Hence, if all buyers participate, we know by point (i) that B_3's utility when σ is played cannot exceed $-\alpha_{13}$. But if the other buyers are participating, then B_3 is better off by staying out. Then, in the auction stage, the bidders are B_1 and B_2. Because of condition (10) and Proposition 2, in all equilibria of the auction B_2 obtains the object. Hence, B_3 if he stays out obtains a payoff $-\alpha_{23} > -\alpha_{13}$ (see condition (8)). Clearly, it cannot be optimal for this buyer to participate if the other buyers are also participating.

It is readily verified that the pattern of behavior in which B_3 stays out and B_1 and B_2 participate and bid according to an equilibrium of that two-buyer auction constitutes the play-path of a subgame-perfect Nash equilibrium of Γ.   *Q.E.D.*

Assuming that bidders use undominated strategies in the auction stage, the game Γ has two subgame-perfect Nash equilibria in pure strategies for the parameters of Proposition 4. The participating sets of buyers are $\{B_1, B_2\}$ (winner is B_2) and $\{B_1, B_3\}$ (winner is B_1), respectively. We do not know of a general intuitive argument for refining the set of subgame-perfect Nash equilibria in order to achieve uniqueness. Recall that winner indeterminacy, and hence multiplicity of equilibria, already appears in the one-stage auction game (see Example 1).

Proposition 4 seems to formalize *The Economist*'s explanation of BSN's behavior quoted in the Introduction: BSN was thinking that it was going to lose the battle over Perrier to the Agnellis. By retreating from the race, BSN allowed Nestlé, which it feared less, to finally acquire Perrier. BSN committed to nonparticipation by selling its minority holding of Perrier shares to Nestlé.

A crucial part in the strategic considerations of whether or not to participate in a contest is played by the credibility of commitments not to participate. Note that in Propositions 3 and 4 it is not optimal for B_1 and B_3, respectively, to participate in the auction and bid, say, zero. They must credibly commit not to participate at all.

The question is, then, how does one commit not to participate? The feasibility of such a commitment seems reasonable, for example, in instances where bidders have to pay a form of entry fee to participate in the auction. Many tenders ask potential bidders to acquire the tender's prospect, and to deposit a security bond. This must be done by a deadline usually specified to the day, hour, and minute. By not undertaking the aforementioned actions, one commits not to participate. (If bidders have to pay an entry fee to participate in the auction, then the analog subgame-perfect equilibria may employ

mixed strategies at the entry level. Then, whatever equilibrium is played, nonpartici-
pation may occur with positive probability. Our results describe then the limit behavior
as the fees tend to zero.) In other cases, the final bidders are chosen from among the
participants in a kind of preauction. "Bidding" in that preauction sometimes has the
character of lobbying (e.g., the award of the Olympic Games to a city). Again, by
avoiding the lobbying, one could commit not to participate in the auction among the
finalists. For our analysis to hold in the above-mentioned situations, it must be the case
that the list of participants in the final auction is common knowledge.

Commitment may also be achieved by more sophisticated means, according to the
nature of the respective institution. For example, U.S. sports teams could commit not
to participate in the bidding for a player by acquiring another player in the same
position (i.e., a quarterback), or by approaching beforehand the budgetary limit for
acquisitions imposed by the league's rules. We are not aware whether these specific
actions have been strategically used in practice—it is quite difficult for an outsider to
attribute such moves, if undertaken, to an exact motive. Due to the complexity of actual
institutions, none of the above-mentioned possibilities for commitment is perfect.

In the context of nonparticipation effects, it is also instructive to revisit Example
1, which displayed an auction where the winner in equilibrium is not uniquely deter-
mined by the valuations and externalities. For that example, we observe that in a
subgame-perfect Nash equilibrium of Γ, it cannot be the case that all buyers participate
and then continue by playing in the auction stage the equilibrium that involves a "race"
between two buyers.

Example 1 (revisited). Let $\pi_1 = \pi_2 = \pi_3 = \pi$. Let $\alpha_{12} = \alpha_{21} = \alpha$; $\alpha_{32} = \alpha_{31} = \beta$;
$\alpha_{13} = \alpha_{23} = \gamma$. We assume that $\alpha > \gamma > \beta$.

Let

$$\bar{\mathbf{p}} = (\bar{p}_1, \bar{p}_2, \bar{p}_3) = (\pi + \alpha - \epsilon, \pi + \alpha - \epsilon, \pi + \gamma - \epsilon),$$

and let

$$\hat{\mathbf{p}} = (\hat{p}_1, \hat{p}_2, \hat{p}_3) = (\pi + \beta, \pi + \beta, \pi + \beta + \epsilon).$$

Both profiles $\bar{\mathbf{p}}$ and $\hat{\mathbf{p}}$ are Nash equilibria in undominated strategies. But in the extended
entry game, the sequence of actions in which all agents enter and then bid according
to $\bar{\mathbf{p}}$ cannot be part of a subgame-perfect Nash equilibrium. For example, B_1 can deviate
and improve his payoff by not entering. (In this case B_3 obtains the object and B_i's
payoff is $-\beta > -\alpha + \epsilon$.) The sequence of actions in which all agents enter and then
bid according to $\hat{\mathbf{p}}$ constitutes the play-path of a subgame-perfect Nash equilibrium.
Only prices approximately equal to $\pi + \beta$ will be observed in subgame-perfect Nash
equilibria of the extended entry game. *Q.E.D.*

5. Oligopoly and innovation

■ We now consider the appearance of a cost-reducing innovation in an oligopolistic
market. The main role is played by the asymmetric externalities, and by the presence
of at least three firms. We assume that the innovation is protected by a patent, and
acquisition of the patent confers exclusive rights to use the new technology.

We illustrate below a situation in which there is no subgame-perfect Nash equi-
librium of the entry game followed by the auction, where all firms participate in the
auction. The logic of the result is as follows: The innovation is valuable to only one
firm. If this firm acquires the innovation it creates negative externalities to the other

firms. Hence, those firms will be prepared to pay a positive amount of money for the innovation even though it is of no use to them. However, each of the firms that has no direct interest in the innovation prefers that the other similar firm pay the high price required to keep the innovation out of the hands of the dangerous firm.

Consider the following scenario: Three Cournot oligopolists produce a homogeneous good with constant marginal costs denoted by c_1, c_2, and c_3, respectively. Inverse demand is given by $P = A - Q$, where Q denotes the total quantity supplied. The "status quo" profit of firm i is given by

$$\Pi_i = (A + c_j + c_k - 3c_i)^2/16, \tag{11}$$

where $i \neq j \neq k$.

A technical innovation reduces marginal costs. Denote by $\bar{c}_i$ the marginal costs of firm i if it acquires the innovation, and denote by Π_j^i the profit of firm j if firm i, $i \neq j$, acquires the innovation. Then

$$\Pi_j^i = (A + \bar{c}_i + c_k - 3c_j)^2/16. \tag{12}$$

The profit of firm i if it acquires the innovation is given by

$$\Pi_i^i = (A + c_j + c_k - 3\bar{c}_i)^2/16. \tag{13}$$

As already noted (see (1) and (2)), we can plug this situation into our framework by setting $\pi_i = \Pi_i^i - \Pi_i$, for all i such that $1 \leq i \leq 3$; $\alpha_{ij} = \Pi_j - \Pi_j^i$, for all i, j such that $1 \leq i,j \leq 3$ and $i \neq j$. To keep the exposition as simple as possible we look at a situation in which the innovation has an impact (and hence a positive direct value) only for one firm, say firm 3. Firms 1 and 2 are assumed to be symmetric. The idea might be that firm 3 is *a priori* less efficient than the other two firms that already possess a superior technology. We have then

$$c_1 = c_2 = \bar{c}_1 = \bar{c}_2 = c \tag{14}$$

and

$$\bar{c}_3 < c_3. \tag{15}$$

It will be clear that our result is robust with respect to small variations in the parameter values. The assumptions needed to ensure that all firms produce positive amounts before and after the innovation is introduced are

$$A + 2c - 3c_3 > 0 \tag{16}$$

and

$$A + c_3 - 2c > 0. \tag{17}$$

Given our assumptions, we obtain that all relevant parameters are zero, except those corresponding to firm 3's having the good, namely

$$\alpha_{31} = \alpha_{32} = (c_3 - \bar{c}_3)(2A - 4c + c_3 + \bar{c}_3)/16 \tag{18}$$

and

$$\pi_3 = 3(c_3 - \bar{c}_3)(2A + 4c - 3c_3 - 3\bar{c}_3)/16. \tag{19}$$

Proposition 5. If $c^* = 2A/5 + 8c/5 - c_3 < c_3$, then for all $\bar{c}_3 \in [c^*, c_3)$ there is no subgame-perfect Nash equilibrium of the respective game Γ where all firms participate in the bidding stage.

Proof. We first show that if both $\alpha_{31} > \pi_3$ and $\alpha_{32} > \pi_3$, then there is no subgame-perfect Nash equilibrium of Γ where all firms participate in the bidding stage. If this condition is satisfied, and if all firms participate in the auction stage, then either firm 1 or firm 2 will acquire the object. The price must be $\pi_3 + \epsilon$, hence the winner has utility of $-(\pi_3 + \epsilon)$. Assume, for example, that when all firms participate, an equilibrium is played such that firm 1 is the winner. Then this firm would be better off by staying out of the bidding stage altogether. In this case the winner will be firm 2 (see Proposition 2), and firm 1 ends up with utility $0 > -(\pi_3 + \epsilon)$. A similar argument applies to the case where firm 2 wins the auction if all firms participate. Hence, there is no subgame-perfect Nash equilibrium of Γ where all firms participate in the bidding stage.

   The proof of the proposition is concluded by observing that if c^* satisfies the required condition, then for all $\bar{c}_3 \in [c^*, c_3)$, it holds that $\alpha_{31} > \pi_3$ and $\alpha_{32} > \pi_3$. *Q.E.D.*

   It is interesting to note that the condition $c^* < c_3$ together with the condition $A + 2c - 3c_3 > 0$ necessarily imply that $c < c_3$. Hence, the nonparticipation effect can emerge only if firm 3, the only firm that directly values the patent, is *a priori* less efficient than the other two firms.

   Note also that firm 3 will get the patent only if the innovation is relatively drastic, i.e., only if $\bar{c}_3 < c^* < c_3$. Only in this case is the value to firm 3 higher than the price that firms 1 and 2 are willing to pay for blocking firm 3. In our view, this last observation nicely explains cases of moderate improvements where the innovation is not acquired by the firms that (directly) value it most, but rather ends up as a sleeping patent (see Gilbert (1981) and Pakes (1986)). Clearly, in such a case consumer welfare is negatively affected.

6. Instability and coalitions

■   A main feature of the institution we analyzed so far was the absence of communication between buyers, i.e., there was no "market for the externality." This makes sense, for example, in cases where cartel laws would normally prevent collusion. However, it may be expected that if contracts and side payments between buyers are allowed, a "stable" solution may be achievable, in the sense that individuals and coalitions will have no incentive to deviate.

   As an illustration, consider the following story (*The Economist,* 1992b). South Korea plans to build a high-speed train network between Seoul and Pusan. The contract is worth several billions of dollars. The firms competing to obtain the South Korean contract are: a Japanese consortium headed by Mitsubishi Corporation; Germany's Siemens, builder of the Inter City Express; and GEC-Alsthom, a joint venture between the French Alcatel Alsthom and Britain's General Electric Company, builders of the Train à Grande Vitesse. These three firms are the only ones possessing the technology needed for bullet trains. South Korea insists that the contract winner will transfer as much technology as possible to local firms, which will build most of the trains under license. Hence, the winning company will help create a fourth, low-cost competitor in the market for fast trains! The identity of the winner matters a lot because the European companies would transfer state-of-the-art technology to Korea, whereas the Japanese technology is old-fashioned—an updated version of that initially

used in Japan in the 1960s. On the other hand, the Europeans fear that if the project goes to the Japanese, it will yield the latter the "push" it needs to start developing a superior technology.

The German and French governments tried to persuade Siemens and GEC-Alsthom to form a joint venture. Such an agreement would be advantageous for both parties because it would lessen the competition in the bidding stage and, via side payments, allow both Siemens and GEC-Alsthom to enjoy some of the profits. Both firms refused to cooperate and continued separately to try to obtain the contract. It now seems that GEC-Alsthom will win.

In general, there is a wealth of conceivable coalitional agreements in our framework: Some potential buyers agree not to buy; a coalition of buyers "bribe" the seller for not selling; a buyer is "bribed" not to buy; losers are compensated by the winner, and so forth.

Our main finding in this section is that in all interesting cases, no cooperative agreement is stable because there are always coalitions that, by deviating from the agreement, could do better for all their members, and this independently of what other agents are doing. In other words, we shall show that a core-related set, the α-core, is empty, unless a buyer exists whose valuation (excluding the effect of the externalities) is much higher than all other valuations and external effects.

The main thing to note is that the α-core is the least-sharp core concept: Deviators assume that the complement will choose the worst possible response from the point of view of the deviators. If the α-core is empty, then any other core set will be empty as well. For a discussion of the α-core, see Shapley and Shubik (1969) and Scarf (1971).

For a payoff vector to be in the α-core, two conditions are necessary: first, the vector must arise from some joint selection of strategies by all the players (feasibility), and second, independently of what the complementary coalition chooses to do, no coalition can do better for all its members by selecting an alternative set of strategies (no blocking). Note that assumptions about deviators' expectations are necessary in a framework with externalities because, contrary to a usual exchange market, what a coalition can achieve depends on the actions of others.

Shapley and Shubik (1969) have shown that the α-core may be empty in the "garbage game" that involves negative externalities. An important assumption in their model is that garbage may be dumped. The dumping assumption is not realistic in our model, so we shall assume that the seller cannot unilaterally "dump" the indivisible object to one of the buyers.

We now characterize the α-core in our framework. First, let $\mathcal{B}$ denote the set of buyers (with cardinality n), and let $\mathcal{B}^{-i}$ denote the set $\mathcal{B} \setminus \{B_i\}$.

Proposition 6. Let $\{S, \mathcal{B}, (\pi_i)_{1 \leq i \leq n}, (\alpha_{ij})_{1 \leq i,j \leq n}\}$ be a market with externalities such that $\max_i \pi_i > 0$. The α-core of the market is not empty if and only if there exists a buyer B_i such that

$$\pi_i \geq 2 \cdot \sum_{i \neq j} \alpha_{ij} \tag{20}$$

and

$$\forall T \subset \mathcal{B}^{-i}, \forall B_j \in T, \ \pi_i \geq \pi_j + \alpha_{ij} + \sum_{\substack{B_k \in T \\ B_k \neq B_j}} (\alpha_{ik} - \alpha_{jk}). \tag{21}$$

Proof. Assume first that the α-core is not empty, and let $\mathbf{x} = (x^S, x^{B_1}, x^{B_2}, \ldots, x^{B_n})$ be a payoff vector in the core. There are several cases, corresponding to different trades that may yield a feasible payoff vector:

Case 1. The indivisible good remains in the possession of the seller.

There are two subcases:

Subcase 1a. Money does not change hands.

Then $\mathbf{x}$ is the zero vector. This corresponds to the case where all buyers agree not to buy, but no monetary transfers are made between buyers. Assume without loss of generality that $\pi_n > 0$. The payoff vector $\mathbf{x}$ is blocked by the coalition $\{S, B_n\}$. The seller sells to B_n at a price $0 < p < \pi_n$, and both members of this coalition obtain strictly positive payoffs.

Subcase 1b. Money changes hands.

Then $\mathbf{x}$ represents a vector of net transfers to the agents. The transfers may be either positive or negative. It must hold that $x^S + \sum_{i=1}^n x^{B_i} = 0$. It must also hold that $x^S \geq 0$, otherwise S alone blocks the outcome. Assume first that $x^S > 0$ (hence $\sum_{i=1}^n x^{B_i} < 0$). This corresponds to the case where the seller is bribed not to sell. Assume, for example, that $x^{B_1} < 0$. Then $\mathbf{x}$ is blocked by the coalition of all buyers with payoff vector $\mathbf{y} = (y^{B_1}, y^{B_2}, \ldots, y^{B_n}) = (-(n-1)\cdot\delta, x^{B_2} + \delta, \ldots, x^{B_n} + \delta)$, where $\delta > 0$ and $-(n-1)\cdot\delta > x^{B_1}$. The vector $\mathbf{y}$ represents an agreement where some buyers are bribed not to buy, but, in total, they are paid less than it was agreed to bribe the seller not to sell. Note that here we use the nondumping assumption.

Assume now that $x^S = 0$ (hence $\sum_{i=1}^n x^{B_n} = 0$). If $x^{B_i} = 0$, $1 \leq i \leq n$, we are in Subcase 1a. Otherwise, assume without loss of generality that $x^{B_1} < 0$. Because we are in the case where the seller keeps the good and has a zero payoff, the negative payoff of B_1 must be to a transfer to other buyers. Then $\mathbf{x}$ is blocked by coalition $\{S, B_1\}$, where B_1 makes a slightly smaller but still positive transfer to the seller (bribing her not to sell).

Case 2. The indivisible object changes hands

Assume without loss of generality that B_1 obtains the object. An outcome where B_1 buys the good and makes some transfer payments to the other buyers is blocked by the coalition $\{S, B_1\}$. Hence, if $p > 0$ is the price paid to the seller, $\mathbf{x}$ must be of the form $(p, \pi_1 - p, -\alpha_{12}, -\alpha_{13}, \ldots, -\alpha_{1n})$. If $p > \pi_1$, then this outcome is blocked by the coalition of all buyers with payoff vector

$$\mathbf{y} = (y^{B_1}, y^{B_2}, \ldots, y^{B_n}) = (-\rho, \rho/(n-1), \ldots, \rho(n-1)),$$

where $0 < \rho < p - \pi_1$. Note that here we use the nondumping assumption.

So far, we have shown that a stable payoff vector $\mathbf{x}$ cannot have any form other than $(p, -\alpha_{i1}, \ldots, -\alpha_{ii-1}, \pi_i - p, -\alpha_{ii+1}, \ldots, -\alpha_{in})$, where $p \leq \pi_i$. For such $\mathbf{x}$ to be stable it must also hold that (a) $p \geq \sum_{j \neq i} \alpha_{ij}$ and (b) $\pi_i - p \geq \sum_{j \neq i} \alpha_{ij}$. If (a) is not satisfied, the coalition $\{S, \mathcal{B}^{-i}\}$ blocks the outcome. The buyers in $\mathcal{B}^{-i}$ bribe S not to sell. They can pay her, jointly, more than p and still be better off. If (b) is not satisfied, the coalition $\mathcal{B}$ blocks the outcome. The buyers in $\mathcal{B}^{-i}$ bribe B_i not to buy. They can pay him more than $\pi_i - p$ and still be better off. Conditions (a) and (b) together yield condition (20). Condition (21) must hold because otherwise $\mathbf{x}$ is blocked by a coalition of buyers (not including B_i) and the seller. The indivisible good is allocated to one of the buyers in that coalition, and transfer payments are made to the seller and the other buyers in that coalition.

For the converse part, it is now readily verified that if a buyer B_i exists such that conditions (20) and (21) hold, then any allocation resulting from a transaction between S and B_i at a price p such that

$$\max_{\substack{T \subset B^{-i} \\ B_j \in T}} \left\{ \pi_j + \alpha_{ij} + \sum_{\substack{B_k \in T \\ B_k \neq B_j}} (\alpha_{ik} - \alpha_{jk}), \, 2 \cdot \sum_{i \neq j} \alpha_{ij} \right\} \leq p \leq \pi_i$$

must be in the α-core.   Q.E.D.

Roughly speaking, Proposition 6 states that outcomes in the α-core can result only from a transaction between the seller and a buyer whose valuation (without taking into account the external effects) is so high that all other valuations and externalities become irrelevant. It is rather surprising that only this kind of transaction survives the coalitional constraints imposed by a core concept, given the wealth of possible coalitional agreements when externalities are present.

Note that if the conditions for the nonemptiness of the α-core hold, then the equilibria of the entry game followed by an auction have a very simple form: the buyer with highest valuation π_i has a dominant strategy (to enter, independently of the decisions of other agents) and, given that this buyer uses her dominant strategy, all other buyers are indifferent between entering or not.

7. Conclusion

■ We studied auctions for an asset whose acquisition generates directed negative external effects for the nonacquirers. Besides private valuations, bids also reflect preemptive incentives stemming from the desire to minimize the negative externalities. We have shown that subgame-perfect Nash equilibria of a two-stage game, the first stage of which represents the decision to participate in the second-stage auction, may involve some players choosing not to participate in the auction. (We assume that externalities cannot be avoided simply by nonparticipation.) Both potential winners and potential losers may be better off by not participating if their own participation has, through a dramatic increase in equilibrium bidding, an undesirable influence on the identity of the final purchaser and on the price paid to the seller. Finally, we have shown that unless a buyer exists whose valuation is much higher than the aggregate externality imposed, all cooperative agreements (which may include side payments) are unstable: there are always coalitions that, by deviating from the agreement, obtain higher payoffs for their members.

References

The Economist. "BSN and the Agnellis: Friend or Foe?" February 29, 1992a, p. 77.
———. "Faster Than a Speeding Bullet." April 4, 1992b, pp. 87–88.
FUNK, P. "The Persistence of Monopoly and the Direction of Technological Change." Working Paper, Department of Economics, University of Bonn, 1992.
GILBERT, R.J. "Patents, Sleeping Patents and Entry Deterrence." In S. Salop, ed., *Strategy Predation and Antitrust Analysis.* Washington, D.C.: Federal Trade Commission, 1981.
——— AND NEWBERY, D.M.G. "Preemptive Patenting and the Persistence of Monopoly." *American Economic Review,* Vol. 72 (1982), pp. 514–526.
JEHIEL, P. AND MOLDOVANU, B. "Negative Externalities May Cause Delay in Negotiations." *Econometrica,* Vol. 63 (1995), pp. 1321–1327.
KAMIEN, M.I. AND TAUMAN, Y. "Fees versus Royalties and the Private Value of a Patent." *Quarterly Journal of Economics,* Vol. 101 (1986), pp. 471–493.
KATZ, M.L. AND SHAPIRO, C. "How to License Intangible Property." *Quarterly Journal of Economics,* Vol. 101 (1986), pp. 567–589.
KRISHNA, K. "Auctions with Endogenous Valuations: The Persistence of Monopoly Revisited." *American Economic Review,* Vol. 83 (1993), pp. 147–160.
MCAFEE, R.P. AND MCMILLAN, J. "Auctions and Bidding." *Journal of Economic Literature,* Vol. 25 (1987), pp. 699–738.

MILGROM, P.R. "Auction Theory." In T.F. Bewley, ed., *Advances in Economic Theory*. Cambridge: Cambridge University Press, 1987.

―――― AND WEBER, R.J. "A Theory of Auctions and Competitive Bidding." *Econometrica*, Vol. 50 (1982), pp. 1089–1122.

PAKES, A.S. "Patents as Options: Some Estimates of the Value of Holding European Patent Stocks." *Econometrica*, Vol. 54 (1986), pp. 755–784.

ROCKETT, K.E. "Choosing the Competition and Patent Licensing." *RAND Journal of Economics*, Vol. 21 (1990), pp. 161–172.

SCARF, H.E. "On the Existence of a Cooperative Solution for a General Class of N-Person Games." *Journal of Economic Theory*, Vol. 3 (1971), pp. 169–181.

SHAPLEY, L. AND SHUBIK, M. "On the Core of an Economic System with Externalities." *American Economic Review*, Vol. 59 (1969), pp. 678–684.

TIROLE, J. "The Theory of Industrial Organization." Cambridge, Mass.: MIT Press, 1988.