Potential Competition May Reduce Welfare

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There is a widespread belief that increasing competition will increase welfare. In general, of course, policies aimed at increasing competition will make some individuals better off and some individuals (in particular, the owners of the initial firms) less well off. The standard welfare argument is that the gainers could more than compensate the losers.

The object of this paper is to question that presumption by presenting a more general theory of market interaction in which, under quite plausible assumptions, restrictions on firm behavior which are intended to increase competition lead, in fact, to everyone being worse off.

I. The Basic Argument

Consider a market in which, at present, there is a single firm. The firm, however, is constantly subjected to competitive pressures from entry: potential rivals can engage in *R&D* activity which will result in their having a lower cost or a better product. This potential competition forces the existing firm to undertake research at a sufficient rate to deter the entry of the rival. This view of competition is more akin to the kind of competition that Schumpeter discussed than that which is conventionally presented as "pure competition."

My argument that increasing competition may lead to a Pareto inferior equilibrium is based on three critical observations: first, the amount of research in a market economy *may be* excessive. There is not a close correspondence between the returns which firms appropriate, and the social returns to *R&D*. On the one hand, it is widely recognized that there are important spillovers from any *R&D*, whether successful or not; not all increments in knowledge are patentable, and, even when a patent is feasible, other firms may be able to patent around the invention. Concern about the difficulties of appropriating returns has lead to the widespread view that there may be an underinvestment in *R&D*. At the same time, in deciding to engage in *R&D*, firms ignore the deleterious effect that a successful research program will have on the value of the capital stock of other firms. In addition, the reward provided by the patent system does not correspond directly to the *marginal* return to the particular inventor's activities, namely, the increase in the present discounted value of net benefits resulting from the fact that the invention occurred earlier than it would otherwise have occurred. The *expected* return to the inventor is the total value of the invention times the probability that he will obtain the patent (be the first to make the discovery). Under not implausible conditions, the expected private returns may thus exceed the social returns.

Secondly, the presence of potential competition alters the behavior of the existing monopolist. He will take actions to pre-empt, deter, or delay entry. These actions may lead to higher prices and lower profits, thus making both producers and consumers worse off. As discussed below, policy actions aimed at restricting some category of entry deterrent activities may lead to an increase in other entry deterring activities; again the net effect may be a reduction in profits *and* in consumers' welfare.

Finally, if the costs of production are lowered by experience (the "learning-by-doing" hypothesis), then a monopolist will

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produce beyond the point where marginal revenue equals current marginal cost of production; the firm takes into account that increasing production this period lowers production costs in subsequent periods. (See my paper with A. B. Atkinson.) Indeed, A. Michael Spence has established that, for a finite period of production and a zero interest rate, the effective marginal cost of production is exactly the marginal cost of production at the terminal period. Even if entry results in increased industry output, output per firm may be lower. If a significant part of learning is firm specific, this will increase the "effective marginal cost" of the monopolist, so that, during the period prior to entry, his output will be lower and prices higher.

More generally, markets in which there is a monopolist faced with potential entry will differ from those in which the monopolist is not faced with entry in (a) the allocation of resources to *R&D*, and consequently the date (rate) of *invention*; (b) the timing of the *introduction* of new techniques (the date of *innovation*); (c) the behavior (with respect to output, investment, and pricing) prior to the invention; and (d) the behavior after the invention. Both the pure monopoly and the monopoly faced with potential entry act in ways which are not socially optimal, but there is no presumption that one is better than the other.

The presumption that competitive markets lead to efficient resource allocations is based on the belief that there is a close congruence between private and social profits. In sectors of the economy where technological change is (or could be) important, this may not be the case, not only because of the appropriability problems which have long been recognized, but because in such markets, price will not equal marginal costs of production (otherwise the revenue required to pay for the *R&D* cannot be raised). Hence (even marginal) actions by one firm may have a significant effect on the sales (hence, profitability) of other firms. It is only under extreme and unrealistic assumptions of the Arrow-Debreu model that these externalities (sometimes referred to as pecuniary externalities) can be ignored.

II. The Natural Resource Market: An Example

Consider an intertemporal market for an exhaustible natural resource. Assume a perfect substitute for it has just been discovered which can be produced at constant costs $\bar{p}$. We contrast the situation where the substitute is controlled by the monopolist (a pure monopoly) with one in which the substitute is competitively produced. In the latter case, the substitute will be produced when the price of the natural resource rises to $\bar{p}$. The monopolist thus faces an elastic demand for the resource at the price $\bar{p}$; the presence of the competitors *raises* his marginal revenue at all dates. The presence of potential competition thus induces him, in the short run, to raise his price, although in the long run, price is lowered. For large values of the initial stock and interest rates, it can be shown that the first effect dominates the second so consumers are worse off.

There are further effects prior to the innovation. The monopolist facing the threat of entry knows that the marginal revenue, at the date of *invention*, will be higher as a result of the potential competition. This induces him to sell less prior to the invention: even before the invention occurs, the threat of potential competition raises prices.

So far, we have assumed that the date of invention is exogenous (although the date of innovation depended both on the actions prior to and after the invention). But the monopolist knows that the strongest deterrent to entry is having a large stock of natural resource; for the entrant knows that the larger the stock of the natural resource at the date of invention, the lower will prices be. Thus, the monopolist *raises* his price to reduce sales of his resource as an effective entry deterring tactic. (See my paper with Gilbert and Dasgupta.) Again, the threat of entry has resulted in consumers being worse off.

If we allow the monopolist to engage in *R&D* activity, and if there is competition for the patent for the substitute but all competitors have the same cost function, it is easy to show that the existing monopolist will *pre-empt* the competitors. But he will not charge as high a price in the period prior to the invention as when he does not engage in *R&D*. Though the monopoly is thus maintained, welfare *may* be increased. (See my papers with Dasgupta, 1980a, Gilbert and Dasgupta; and the paper by Gilbert and Newbery.) These arguments extend to more general situations with durable capital as I illustrate in the next section.

III. A Simple Model

Assume that on the date T a new firm enters a market which was previously controlled by a monopolist. (The monopolist may have a patent on a particular process for producing widgets; the new firm has just discovered an alternative way of producing the same commodity.) There is now a duopoly, and we can consider a variety of different concepts for describing the equilibrium which will emerge. For our present purposes, however, we need only note two important properties of the equilibrium. First, the profits of each of the duopolists will be a function of the *state* variables $S(T)$ describing the original firm at date T. We denote the present discounted value of the profits of the entrant (viewed as of date T) as $V^e(S(T))$ and the present discounted value of the original firm's profits by $V^m(S(T))$.

The determination of what are relevant state variables may be a fairly subtle matter. Capital goods would not be state variables, if there were perfect rental markets for them. On the other hand, long-lived durable goods which have no use other than the present one (or for which transportation costs to any other site are prohibitive) are clearly "state variables." The relevant state variables may include not only capital goods but also previously signed contracts. In the case of the learning model described briefly above, the state variable is the state of knowledge at date T. In the natural resource model, it is the stock of resource remaining at T.

Secondly, the sum of the profits are lower than what the monopolist would have enjoyed had he obtained the patent at date T. Denoting the present discounted value of these profits by $\hat{V}^m$,

$$\hat{V}^m(S(T)) \geqslant V^e(S(T)) + V^m(S(T)) \tag{1}$$

The duopoly equilibrium will not in general maximize joint profits.

Finally, denote by $\tilde{V}^m(S(T), T)$ the maximized present discounted value of the original monopolist's profits during the period $(0, T)$, given that he is constrained to have $S(T)$ at date T.

For most of the analysis, we will be concerned with situations where the date of entry of a competitor is endogenous. Assume that the entrant enters immediately after discovering an invention, which, say, lowers the cost of producing the given commodity. The present discounted value of *R&D* expenditure required to obtain the invention at date T is $R(T)$. The date of discovery, T, can be brought forward by allocating more resources to *R&D*, $R' < 0$.

I compare three market structures: 1) free entry into the *R&D* activity, but the monopolist is prohibited from engaging in *R&D* to maintain his monopoly position; 2) there is a monopolist with the same *R&D* technology facing no competition (the pure monopolist); and 3) the monopolist can engage in *R&D*, but faces competition.

A. *Pure Monopoly*

The pure monopoly problem is easiest to formulate. He simply

$$\max_{\{T^m, S\}} \tilde{V}^m(S(T^m), T^m) + \hat{V}^m(S(T^m))e^{-rT^m} - R(T^m) \tag{2}$$

yielding the first-order conditions

$$\tilde{V}^m_S + \hat{V}^m_S e^{-rT^m} = 0 \tag{3a}$$

$$\tilde{V}^m_T - r\hat{V}^m e^{-rT^m} = R' \tag{3b}$$

The firm balances off the increase in the present discounted value of profits from having, say, a larger stock of capital at date T with the cost in the obvious manner.

Similarly, it balances the gain from postponing the induced obsolence of its old capital stock with the direct gains from bringing forward the date at which the cheaper technology is introduced, and the costs of doing so.

B. *Monopoly with Threat of Entry*

The monopolist facing potential entrants (but restricted from engaging in *R&D* himself) has a somewhat different problem. He maximizes

$$\tilde{V}(S(T),T)+V^{m}(S(T))e^{-rT} \tag{4}$$

subject to

$$V^{e}(S(T))e^{-rT}=R(T) \tag{5}$$

The constraint (5) reflects his belief that the *R&D* market is sufficiently competitive to drive profits to zero. Whether or when a rival enters (or engages in *R&D* in hope of discovery which will allow him to enter) depends on his beliefs about the profitability of entering. These in turn depend on the entrant's beliefs about "state" variables describing the monopolist at the date of entry. What is critical, in this view, is that actions prior to entry affect entry only to the extent that they effect potential entrants' beliefs about these state variables. High current profits or high current prices have an effect on entry only to the extent that (a) they provide *information* to possible entrants concerning the value of the relevant state variables; and (b) they affect those state variables themselves. Thus, firms with low costs may attempt to identify themselves to potential entrants by charging low prices; there may exist, as a result, a "screening equilibrium" in which all firms except the highest cost firm charge prices below the pure monopoly price, and, in more dynamic settings, may even engage in predatory pricing (charging prices below marginal costs).

Formally, the first-order conditions for the problem (4) may be written (letting μ be the Lagrange multiplier associated with the constraint (5))

$$\tilde{V}_S^{m}+V_S^{m}e^{-rT}-\mu V_S^{e}e^{-rT}=0 \tag{6a}$$

$$\tilde{V}_T^{m}-rV^{m}e^{-rT}+\mu(rR+R')=0 \tag{6b}$$

C. *Comparison of Monopoly with and without Entry Competition*

We now need to contrast (3) and (6). They differ in three ways:

(a) In general, $V_S^m \neq \hat{V}_S^m$. The marginal return (*after* the entry date) to capital (or some other state variable) will be different as a result of competition. In general, one might have thought it would be lower, but the natural resource model discussed briefly earlier shows that it may be higher. If competition does lower the marginal return to capital, this will lower the level of investment, and thus tend to raise prices prior to entry.

(b) In general, $T \neq T^m$. Competition will result in earlier innovation. The earlier innovation increases the rate of obsolence of capital goods installed prior to the invention, and thus lowers the level of investment, and increases the price prior to T.

My paper with Gilbert refers to these two effects as *entry accommodation*. In more general models, other entry accommodating effects may be identified. Assume the firm is uncertain about the date of entry. Since after entry, it will face more competition, it may reduce its output, though industry output may rise. It thus wants a technology with greater flexibility. The more flexible technology may have a higher average cost, and even a higher marginal cost at the point where the firm operates prior to entry. Thus prices are higher prior to entry.

(c) There is, in addition, in the presence of competition, an *entry deterrence effect* of a change in S. This leads to an increase in those state variables which discourage entry, a decrease in those which encourage entry. The effect on prices and output prior to the invention are ambiguous. For instance, assume that the durability of the capital stock is one of the variables which firms can change. Since greater durability lowers the return of the entrant, the initial firm will be induced to use machines which are more durable than he would have used in the absence of competition; since this increases his costs of production he may produce less and charge higher prices. In contrast, in the standard model (see Spence) where the only state variable is "capacity," entry deterrence leads to increased capacity and thus, presumably, to lower prices prior to entry. Similarly, in a learning-by-doing model where the state variable is the marginal cost of production at T (or equivalently, the cumulative output up to T), then lowering that will deter entry; and to lower the marginal cost of production at T, the monopolist must lower prices prior to entry. The attempt to deter entry raises welfare prior to the innovation.

Note that in many of the instances cited, the entry accommodation effects and the entry deterrence effects work in opposite directions. Thus the net effect of potential competition is in general ambiguous, and a detailed examination of the particular situation at hand is required.

D. *Pareto-Inferior Competition*

My analysis has identified two periods with differing welfare effects: Even if after the innovation T consumers are better off with competition prior to the date of innovation, consumers may be worse off in markets with potential competition, both because of the entry deterring and entry accommodation effects. In a variety of circumstances I have been able to establish that consumers are unambiguously worse off. Moreover, the monopolist is worse off, and, since *R&D* competition drives profits of entrants to zero, they are indifferent: *potential competition may be Pareto inferior.*

To see that consumers may be worse off, consider a case where T is exogenous; there is only the first entry accommodation effect. Let $\tilde{U}(S,T)$ be the present discounted value of utility up to date T, and $U^e(S)e^{-rT}$ and $U^m(S)e^{-rT}$ be the present discounted value after date T with and without competition. Let W represent the present discounted value of welfare, i.e.,

$$(7)\quad W^i=\tilde{U}(S^i,T)+U^i(S^i)e^{-rT}\quad i=e,m$$

where (W^e,S^e) and (W^m,S^m) represent the values of welfare and the state variables in the equilibrium with and without potential competition. It is immediate that $W^e\to W^m$ and $S^e\to S^m$ as $T\to\infty$. Let $\lambda=e^{-rT}$. Using (3a) and (6a) (with $\mu=0$), we observe that at $\lambda=0$

$$(8)\quad \frac{d(W^e-W^m)}{d\lambda}=U(S^e)-U(S^m)+\tilde{U}_S(S,T)[dS^e/d\lambda-dS^m/d\lambda]$$
$$=\tilde{U}_S\left[\frac{U(S^e)-U(S^m)}{\tilde{U}_S}-\frac{V_S^m-\hat{V}_S^m}{\tilde{V}_{SS}^m}\right]$$

Assume for instance that the present monopolist can produce by means of machines which are infinitely durable and which have operating costs of m_1 per unit. Each machine produces one unit and costs c_1 dollars. Let $p(Q)$ be the inverse demand function, Q_1 the output prior to entry, Q_2 the output of the entrant (under our assumptions, once he enters, his output remains unchanged), and $\bar{Q}=Q_1+Q_2$. I assume that consumers have a separable utility function with constant marginal utility of income, $u(Q)-I$, where I represents the individual's consumption of other goods, so $p=u'(Q)$. The entrants marginal cost is m_2 and his machine costs c_2, with $m_2+rc_2>m_1>m_2$. Then, at $\lambda=0$, it can be shown that

$$(9)\quad rd(W^e-W^m)/d\lambda=\left[u(\bar{Q}^e)-u(\bar{Q}^m)-\frac{(1-\alpha)p(\bar{Q}^e)\varepsilon(\bar{Q})\bar{Q}^e}{\varepsilon(Q_1^e)(2+\nu(Q_1))}\left(\frac{1-\alpha}{2+\nu(\bar{Q}^e)\alpha}-\alpha\right)\right]$$

where $\varepsilon=p/p'Q$, $\alpha=Q_2^e/\bar{Q}^e$, and $\nu=p''Q/p'$. The first term is positive, the second term may be negative. The second term depends on p''(i.e., u'''). There are no natural restrictions on p''. Moreover $u(\bar{Q}^e)-u(\bar{Q}^m)<p(\bar{Q}^m)(\bar{Q}^e-\bar{Q}^m)$. Since $p(\bar{Q}^e)\bar{Q}^e/p(\bar{Q}^m)(\bar{Q}^e-\bar{Q}^m)$ can be very large, it is clearly

possible to make the second term dominate the first, so that (at least for small λ), $W^m > W^e$: consumers are better off with pure monopoly than with potential competition. My paper with Gilbert constructed other examples where competition is Pareto inferior when the date of innovation is endogenous.

E. *Pre-Emption*

If we now allow the monopolist to engage in research, he can either not do it (thus solving problem (5)-(6)) or he can pre-empt his rivals, i.e.,

$$\text{(10)} \quad \max \tilde{V}(S,T)+e^{-rT}\hat{V}^m(S)-R(T)$$

subject to the constraint that

$$\text{(11)} \qquad V^e(S)e^{-rT} \leqslant R(T)$$

Using (1), the latter strategy dominates the former (see my paper with Dasgupta, 1980a, and Gilbert and Newbery). The first-order conditions are now

$$\text{(12a)} \quad \tilde{V}_S+e^{-rT}\hat{V}_S^m-\mu e^{-rT}V_S^e=0$$

$$\text{(12b)} \quad \tilde{V}_T-r\hat{V}^m(S)e^{-rT} - R'+\mu(rR+R')=0$$

Again, the effect on welfare of the pre-emption strategy is ambiguous: There is some presumption, if $\hat{V}_S^m > V_S^m$, (competition reduces the marginal return to capital) that when the monopolist is allowed to pre-empt his rival, he increases his investment prior to the invention. This also serves to deter entry. Thus, prices in the initial period may be lowered, but in later periods, prices may be raised.

IV. Concluding Remarks

There are two general implications of these results. First, real competitive markets are very different from the kind of idealized competitive markets modeled in the Arrow-Debreu world. The results reported here describe one attempt to provide a better basis for understanding competition in market economies. The result that increases in competition may lower welfare does not require perverse assumptions, and indeed is more general than the special models presented here; the result obtains in a variety of situations where markets are incomplete, information is imperfect and costly, and where research and development expenditures and learning are important.

Second, my results suggest that unless antitrust policy is based more directly on a more complete analysis of the functioning of competition in imperfectly competitive environments (and markets in which *R&D* are important are inherently imperfectly competitive), the pursuit of well-intentioned policies may well result in Pareto-inferior equilibria with consumers as well as producers being worse off.

Our task now is to delineate more precisely the conditions under which various policies are likely to lead to welfare improvements.

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