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CONSISTENT POLICY RULES AND THE BENEFITS OF MARKET POWER

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ABSTRACT

A simple method of obtaining subgame-perfect feedback policy rules in a rational expectations environment is applied to the problems of a durable-goods monopolist and of a monopolist facing a dynamic competitive fringe. The resulting equilibrium trajectories illustrate a sufficient condition for potential market power to be advantageous. Numerous examples suggest that, in situations where this sufficient condition is not satisfied, it is possible to find parameterizations of taste and technology such that market power is disadvantageous.

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INTRODUCTION

In a rational expectations environment, if agents with market power (hereafter called "leaders") are unable to make binding commitments regarding their future actions, the potential for market power may be disadvantageous. Whether market power is disadvantageous depends, in most situations, on specific tastes and technology and not simply on the nature of the relationship between agents. However, there are some cases where a sufficient condition for market power to be advantageous holds generically (for all parameterizations of tastes and technology). At the other extreme, in some circumstances, leaders are compelled by the logic of their position to behave as if they were myopic. In these circumstances, market power is particularly likely to be disadvantageous.

The problems of a monopolist selling a durable good and a monopolist facing a dynamic competitive fringe illustrate these points. Both of these problems are of intrinsic interest and have been extensively studied. The section below on the durable goods monopolist generalizes Kahn's (1986) results. Kahn showed that a durable goods monopolist facing linear demand and quadratic production costs would not immediatly dissipate monopoly profits, contrary to the Coase Conjecture. Rather, the existing stock of the good under a monopolist is less than the socially optimal (competitive) level but approaches that level asymptotically. We show that this holds for general cost and demand functions and that it implies that potential market power cannot be disadvantageous in this case. We also suggest that if goods are not infinitely durable, Kahn's result on the asymptotic level of the stock is unlikely to hold.

The next section adapts Berck and Perloff's (1985) model of dynamic limit pricing. They study the monopolist's optimal open-loop policy, whereas we consider the (time-consistent) subgame-perfect policy. In addition, they assume that the monopolist has constant costs of production, whereas we allow for convex costs. The size of the competitive fringe is larger under monopoly than under perfect competition which implies that market power may be disadvantageous. This can occur if costs are strictly convex, but not if costs are constant. This section provides an example where the leader behaves myopically, which contrasts to the case of the durable goods monopolist.

If leaders were able to make commitments, they would be able to duplicate the competitive trajectory, so market power could not be disadvantageous. If they are unable to make commitments, the competitive trajectory may no longer be feasible, so there is no presumption that market power is advantageous. Suppose that the environment in which the game is played can be described by a state variable (hereafter called "state"). Under the competitive regime, let the value of the state at stage i be z_i. Even if the trajectory $\{z_i\}$ is feasible under the noncompetitive regime, potential market power may be disadvantageous. If, however, for all i the (intraperiod) benefit of moving the state from z_i to z_{i+1} is no less for the leader in period i than it would be for his competitive counterpart, then market power must be advantageous. This is a very restrictive sufficient condition, but it is often easy to check. This paper mentions examples of several types of markets where the sufficient condition does not hold generically; in each of these examples, it is possible to find instances where market power is disadvantageous.

Maskin and Newbery (1978) use a two-period model which supports this intuition. In both periods, a monopsonistic importer is able to impose a tariff against a competitive supplier of nonrenewable resource; the Rest of World

(ROW) demand function is given and decreases in price. The state in this model is the remaining stock of the resource. Let the level of the stock at the beginning of the second period be z_2 under competition. If, in the second period under monopsony, the level of the stock was also z_2, then the market price at that time would be lower than under competition due to the monopsonist's ability to restrict demand. The intertemporal arbitrage condition implies that price in the first period must, in this case, also be lower under monopsony than under competition. Given the hypothesis that under both regimes the stock in the second period is z_2, the downward sloping ROW demand curve implies that the monopsonist must consume less in the first period than his competitive counterpart. It is easy to imagine cases where the first period monopsonist would have to completely abstain from consumption in order for the second period stock to be z_2. In these cases, forcing the state to track the competitive trajectory is more costly for the monopsonist than for his competitive counterpart in the first period: The sufficient condition for market power to be advantageous does not hold.

Given the same level of stock in the second (last) period, the monopsonistic importer does better than his competitive counterpart. However, the knowledge that in the second period the leader will impose a tariff may make it more costly for the first period leader to leave his successor a desirable level of stock. Future policies determine the difficulty of controlling the state which, in turn, determines the leader's future payoff. If future policies make the cost of controlling the state sufficiently large (the benefits sufficiently small), market power harms the leader.

In extreme cases, the current leader loses all ability to affect the state his successor inherits. In these cases, the current leader maximizes the current flow of welfare. This behavior appears to be myopic but, in fact, is forced on the leader by the assumption of rational expectations and the requirement of subgame perfection. Myopic behavior may or may not arise in the limiting case where each leader's tenure becomes arbitrarily short. A modification of the Maskin-Newbery model shows that myopia can arise in quite general models. Suppose, for example, that second period ROW demand is zero. In that case, the seller in the first period has no incentive to conserve the resource, since the monopsonist will be able to expropriate whatever remains in the second period. Given this knowledge, the monopsonist in the first period cannot affect his successor's welfare and therefore ignores it in choosing his tariff.

All of our results are conditioned on the particular subgame-perfect equilibrium that we select. If agents have access to sufficiently complex strategies, a great variety of equilibria, with very different characteristics, may emerge. It then becomes difficult to say anything about most problems that involve strategic behavior. The reason for this multiplicity of equilibria is related to the Folk Theorem(s) of supergames (Fundenberg and Maskin, 1986). These theorems give conditions under which any individually rational outcome constitutes a perfect equilibrium. The theorems do not apply directly to the problems considered here where the set of feasible outcomes at a point in time depends on previous actions. However, the logic remains roughly the same. Examples of where this logic has been used to construct multiple equilibrium in dynamic, structurally dependent games include Oudiz and Sachs (1985) for the linear-quadratic game and Haurie and Pohjola (1987) for a game of class conflict.

We exclude the possibility of punishment, or trigger strategies, used in the Folk Theorems mentioned above. We consider only the equilibrium that results from solving a finite horizon problem and letting the horizon go to infinity. We assume tnat, given stationary tastes and technology, this results in stationary strategies which are differentiable in the state. The assumption of stationarity is not important, but the assumption of differentiability is crucial since it rules out trigger strategies. The resulting decision rule is designated the feedback policy to emphasize that it depends on the current state but not directly on previous actions. We assume, in addition, that for each of the constituent games there is a unique solution. This rules out a possibility discussed by Friedman (1983).

Our choice among the probably infinitely many subgame-perfect equilibria may strike some readers as arbitrary. Kahn (1986) and Stokey (1981) both adopt the same definition of equilibrium. Ausubel and Deneckere (1986) obtain very different results for the durable goods problem by allowing trigger strategies. There seems to be no definitive economic reason for ruling out such strategies. However, it is reasonable to suppose that agents would adjust their expectations and actions by a small amount, given a small deviation from equilibrium on the part of some other agent.

The next two sections consider the problem of the durable-goods monopolist and of the monopolist facing a dynamic competitive fringe. The conclusion summarizes the results and suggests other circumstances where similar results apply.

THE DURABLE GOODS MONOPOLIST

Kahn (1986) showed that, if a durable goods monopolist faces linear demand and incurs quadratic production costs, the feedback policy results in a lower level of stock (i.e., cumulative sales) than the socially optimal level and that the stock under the monopolist asymptotically approaches the socially optimal steady state. These results also hold for general demand and (convex) cost functions and imply that market power cannot be disadvantageous. If, however, the good is not infinitely durable, it is unlikely that the asymptotic stock under the monopolist equals the socially optimal steady state.

For the infinitely durable case, the state variable is the outstanding stock of the good (Kahn 1986, Theorem 3.1). Let Q be the stock; demand for rental of the good is $f(Q)$, where $f' < 0$ for $Q < \overline{Q}$, $f(\overline{Q}) = 0$. The market is saturated at $\overline{Q} < \infty$; for smaller stock levels, demand is downward sloping. Whether the producer is a monopolist or competitive, his remaining payoff (value function) must be nonincreasing in the state. A larger current stock of the good cannot increase the price received for future sales whatever the trajectory of these sales; a larger current stock will strictly decrease future prices if the stock is such that demand for rental of the good is positive.

We begin with the case of 0 depreciation. As in Kahn (1986), the equilibrium is obtained by starting with a finite stage, finite horizon problem to which standard dynamic programming methods are applied. We let the horizon become infinite to obtain stationary policy rules; however, as is apparent from the derivation, the assumed stationarity of the problem is not essential. Next, we let the length of the stage go to zero to obtain the continuous time limit. Demand and production are defined as flows; this procedure makes it easy to take the continuous time limit.

The length of a period is ε. At an instant before $t + i\varepsilon$, $i \geq 0$, the level of cumulative sales is $Q_{t+(i-1)\varepsilon}$. The monopolist at time $t + i\varepsilon$ produces $M_{t+i\varepsilon}\,\varepsilon$ at cost $c(M_{t+i\varepsilon})\,\varepsilon$. The production is sold so that the stock available at the beginning of the period is $Q_{t+i\varepsilon} = Q_{t+(i-1)\varepsilon} + M_{t+i\varepsilon}\,\varepsilon$; there is no depreciation. The flow of demand for the services of the stock is $f(Q)$, $f' \leq 0$, and the instantaneous interest rate (common to all agents) is r. Given competitive buyers with rational expectations and no uncertainty, the market-clearing price of a unit of the good at t is P_t, which satisfies

$$P_t = f(Q_t)\,\varepsilon + e^{-r\varepsilon}\,P_{t+\varepsilon}. \tag{1}$$

The value of the seller's payoff at t is

$$\sum_{i=0}^{\infty} e^{-ri\varepsilon}[P_{t+i\varepsilon}\,M_{t+i\varepsilon} - c(M_{t+i\varepsilon})]\,\varepsilon. \tag{2}$$

The seller at t chooses M_t and understands how $M_{t+i\varepsilon}$, $i \geq 1$, will be chosen. If the stock is $Q_{t+i\varepsilon}$ at $t + i\varepsilon$, it follows from induction and the stationarity of the problem that $P_{t+i\varepsilon} = P(Q_{t+i\varepsilon})$; the function $P(\ )$ is endogenous to the problem but taken as given by the monopolist. These facts imply the following dynamic programming problem

$$J(Q_{t-\varepsilon}) = \max_{M_t}\{[P_t\,M_t - c(M_t)]\,\varepsilon + e^{-r\varepsilon}\,J(Q_t)\}$$

where $J(\ )$ is the monopolistic value function.

For future comparison, we note that the effect of the current control on the current flow of welfare and on the future state is $O(\varepsilon)$. Substituting for Q_t and P_t gives

$$J(Q_{t-\varepsilon}) = \max_{M_t}[\{f(Q_{t-\varepsilon} + M_t\ \varepsilon)\ \varepsilon + e^{-r\varepsilon} P[Q_{t-\varepsilon} + M_t\ \varepsilon + M(Q_{t-\varepsilon} + M_t\ \varepsilon)\ \varepsilon]\}\ M_t - c(M_t)]\ \varepsilon + e^{-r\varepsilon} J(Q_{t-\varepsilon} + M_t\ \varepsilon). \tag{3}$$

The dependence of the next period control on the value of the next period state is shown by replacing $M_{t+\varepsilon}$ in (3) with the function $M(Q_{t-\varepsilon} + M_t\ \varepsilon)$. The assumption that the functions P( ) and M( ) are differentiable eliminates trigger strategies.

The first-order condition to (3) is

$$\{f(Q_t)\ \varepsilon + e^{-r\varepsilon} P_{t+\varepsilon} + f'(Q_t)\ M_t\ \varepsilon^2 + e^{-r\varepsilon} P'(Q_{t+\varepsilon})\ [\varepsilon + M'(Q_t)\ \varepsilon^2]\ M_t - c'(M_t) + e^{-r\varepsilon} J'(Q_t)\}\ \varepsilon = 0.$$

Since this equality must hold for all ε, the expression in braces must vanish at the optimum. Given the continuity assumptions, the first-order condition becomes

$$e^{-r\varepsilon} P_{t+\varepsilon} - c'(M_t) + e^{-r\varepsilon} J'(Q_t) + O(\varepsilon) = 0$$

where $O(\varepsilon) \to 0$ as $\varepsilon \to 0$. As $\varepsilon \to 0$, this gives

$$P_t - c'(M_t) + J'(Q_t) = 0. \tag{4}$$

This equality is the first-order condition to the continuous time dynamic programming problem

$$r\ J(Q_t) = \max_{M_t} P(Q_t)\ M_t - c(M_t) + J'(Q_t)\ M_t. \tag{5}$$

Equation (5) can also be obtained directly by expanding (3) around $\varepsilon = 0$ and $Q = Q_{t-\varepsilon}$, dividing by ε, and letting $\varepsilon \to 0$ (see the next section). The function P( ) which is endogenous to the problem but which the monopolist takes as given must satisfy

$$\dot{P} = r\ P - f(Q) = P'(Q)\ M \tag{6}$$

where the first equality follows from (1) and the second is a definition.

If f is linear and c quadratic, then P( ) is linear and J( ) quadratic. Kahn's formulae can be obtained directly from (4) to (6). The current approach simplifies and generalizes the analysis. Equation (5) is associated with the following control problem

$$\max_{Q} \int_0^\infty e^{-rt}[P(Q)\ \dot{Q} - c(\dot{Q})]\ dt$$

for which the Euler equation is

$$0 = r\ P - r\ c'(\dot{Q}) + c''(\dot{Q})\ \ddot{Q} = \dot{P} + f(Q) - r\ c'(\dot{Q}) + c''(\dot{Q})\ \ddot{Q}. \tag{7a}$$

The solution to the social planner's problem, Q*, satisfies

$$0 = f(Q^*) - r\ c'(\dot{Q}^*) + c''(\dot{Q}^*)\ \ddot{Q}^*. \tag{7b}$$

Integrating (7b) using the transversality condition gives the well-known requirement that, at the competitive equilibrium, the marginal cost of production equals the discounted flow of rents which equals the competitive selling price. Integrating (7a) gives

$$c'(\dot{Q}_t) = r \int_0^\infty e^{-rs} P_{t+s}\, ds$$

so at the monopolistic equilibrium the marginal cost of production equals the discounted flow of future prices multiplied by r to obtain a flow. The only steady state of (7a) and (7b) satisfies $f(\dot{Q}) = c'(0) = f(Q^*)$. Given the monotonicity of f, this implies:

Lemma 1: The stock of the durable good produced by the monopolist asymptotically approaches the socially optimal level.

We next show that, for $t > 0$, $Q^* > Q$ outside the steady state. Consider two second-order differential equations, $\ddot{Q}_i = g_i(Q_i, \dot{Q}_i)$ $i = 1, 2$, and define t_j as an instant such that $\dot{Q}_1(t_j) = \dot{Q}_2(t_j)$, $j = 1, 2, \ldots.$ We have the following:

Lemma 2: Suppose that (i) g_i has continuous first derivatives and (ii) $Q_1(0) = Q_2(0)$ and $\lim_{t\to\infty} Q_2 \geq \lim_{t\to\infty} Q_1$. The hypothesis $\ddot{Q}_2(t_j) > \ddot{Q}_1(t_j) \Rightarrow Q_2(t_j) > Q_1(t_j)$ is necessary and sufficient for $Q_2(t) > Q_1(t)$ over $(0, \infty)$.

This lemma is a restatement of Proposition 1 of Karp (1984). Finally, we note it must be the case that $\dot{P} \leq 0$ [from (6)].

The assumptions already made ensure that the first condition of Lemma 2 holds where $g_i(\ )$ is given by (7); Lemma 1 and the given initial condition ensure that the second condition of Lemma 2 holds, where Q is identified with Q_1 and Q^* with Q_2. The inequality $\dot{P} < 0$ and inspection of (7a) and (7b) establishes that the hypothesis of Lemma 2 is satisfied. This implies:

<u>Proposition 1</u>: Except at the initial point and the steady state, the stock of the durable good is smaller under the monopolist than under the social planner. For a given level of stock, the price of new sales is higher for the monopolist.

Proposition 1 and Lemma 1 imply:

<u>Corollary 1</u>: The monopolist does better than the producer under the social planner--market power is not disadvantageous.

The proof of this corollary, given in the Appendix, uses the fact that, at any instant (stage), given the same state as his competitive counterpart, the monopolist could produce at the competitive rate. This would leave his successor on the competitive trajectory and, from Proposition 1, the current monopolist would receive a higher price than would his competitive counterpart. This is an example where the policies of the current monopolist's successors make it less painful for the current monopolist to bequeath them a good state.

Lemma 1 and Proposition 1 imply that, in the case of increasing marginal costs of production, the Coase Conjecture is correct only asymptotically. It is doubtful whether the conjecture remains even asymptotically true if the stock depreciates. This case is difficult to analyze since the relevant information set (the state) becomes the entire history of production rather than simply the current level of the stock. In the absence of a state variable, the dynamic-programming argument used earlier cannot be applied. We, therefore, consider a simpler model in which the current monopolist takes his successor's levels of output rather than their policy rules as given. The resulting equilibrium is open loop time consistent but not subgame perfect. In the case of 0 depreciation, the trajectory differs from the subgame-perfect trajectory considered above, but the two asymptotically approach the same level which is the steady state under the social planner. However, in the case of positive depreciation, the asymptotic stock under the open-loop time-consistent and social-planner regimes differ; this suggests that, with positive depreciation, the feedback (subgame-perfect) trajectory may also fail to approach the social planner's steady state.

We modify the previous problem by assuming that a unit of stock depreciates at a constant rate, δ, so that the stock at time t is

$$Q_t = \sum_{i=0}^{\infty} M_{t-i\varepsilon}\, e^{-\delta i \varepsilon}\, \varepsilon, \tag{8}$$

and the market-clearing price at t is

$$P_t = \sum_{i=0}^{\infty} f(Q_{t+i\varepsilon})\, e^{-(r+\delta) i \varepsilon}\, \varepsilon. \tag{9}$$

At time t, the value of the monopolist's payoff is

$$\sum_{i=0}^{\infty} e^{-ri\varepsilon}[P_{t+i\varepsilon} M_{t+i\varepsilon} - c(M_{t+i\varepsilon})]\, \varepsilon. \tag{10}$$

The monopolist maximizes (10) by choice of M_t, taking $M_{t+i\varepsilon}$, $i = \pm 1, \pm 2$ ...., as given. The model can easily accommodate a more general decay function, and durability can be a choice variable. Abel (1983) considered such a model, but in his paper the monopolist at t = 0 was able to choose the entire future sequence of output and durability (a time-inconsistent policy).

Substituting (8) and (9) into (10), setting the derivative with respect to M_t of the resulting expression equal to 0, letting $\varepsilon \to 0$, and simplifying gives the equilibrium condition

$$\int_0^\infty e^{-r\tau} M_{t+\tau}\left[\int_0^\infty f'(Q_{t+\tau+s})\, e^{-\delta(\tau+s)}\, e^{-(r+\delta)s}\, ds\right] d\tau + \int_0^\infty e^{-(r+\delta)s} f(Q_{t+s})\, ds$$

$$- c'(M_t) = 0. \tag{11}$$

At the steady state, this reduces to

$$\frac{f'(M/\delta)\ M}{(r + 2\ \delta)\ (r + \delta)} + \frac{f(M/\delta)}{r + \delta} - c'(M) = 0. \tag{12}$$

The steady-state condition of the social planner [which can be obtained by specializing equation (5a) of Abel 1983] is

$$\frac{f(M/\delta)}{r + \delta} - c'(M) = 0. \tag{13}$$

Equations (12) and (13) establish that, for positive rates of depreciation, the requirement of consistency does not eliminate monopoly power asymptotically. It remains an open question whether the stronger requirement of a feedback (subgame-perfect) equilibrium would asymptotically eliminate market power.

The open-loop time-consistent problem suggests why depreciation may prevent the monopolist from dissipating all rents asymptotically even under the requirement of subgame perfection. In the absence of depreciation, maintenance of a steady state requires that production cease ($M \equiv \dot{Q} = 0$). In order for subsequent producers to be unwilling to produce, it must be the case that marginal revenue equals marginal cost at zero production. With depreciation, a steady state requires positive production. At a positive level of production (and sales), marginal revenue does not equal price so the steady-state monopolist and social-planner equilibrium conditions differ.

The only case where the feedback consistent and open-loop consistent policy can be compared is for $\delta = 0$. Getting $\delta = 0$ in (11) and differentiating with respect to t gives the equilibrium condition

$$\int_0^\infty f'(Q_{t+s})\,(\dot{Q}_t - \dot{Q}_{t+s})\,e^{-rs}\,ds + \dot{P} + f(Q) - r\,c'(\dot{Q}) + c''(\dot{Q})\,\ddot{Q} = 0. \qquad (14)$$

The function P(Q) in (14) is not the same as the function P in (7a), although both satisfy (6). Comparison of (7a) and (14) demonstrate that the trajectories under the open-loop and feedback time-consistent programs are different, but that their steady states are the same. Lemma 2 cannot be used to compare the trajectories outside the steady state.

This digression suggests how the ability to control technological variables, such as durability, may preserve monopoly power where it would otherwise be eroded. Bulow (1982) made this point in the context of a two-period model.

A LIMIT PRICING MODEL

A monopolist may attempt to reduce entry of a dynamic competitive fringe by threatening to reduce price in the future. If this threat has the desired effect, the monopolist in the future faces less competition than would otherwise be the case and would like to charge a higher price than originally announced. This is the dynamic inconsistency of the optimal open-loop program. Under the time-consistent feedback policy, the monopolist no longer practices limit pricing but sets marginal revenue equal to marginal cost in each period; he behaves myopically, in contrast to the durable-goods monopolist.

The reason for the difference is that, in the durable-goods problem, the current monopolist's ability to affect the state his successors inherit is $O(\varepsilon)$ which is the same order as his current flow of welfare; in the limit-pricing model considered here, the effect of the current decision on the current flow of welfare is $O(\varepsilon)$ but the effect on the future state is $o(\varepsilon)$. Therefore, as $\varepsilon \to 0$, the current monopolist cannot do better than by behaving myopically.

A second difference between the two problems is that here monopoly power can be disadvantageous. In the limit pricing model, the state is larger under monopoly than under the competitive regime. If production by the incumbent (the potential monopolist) involves increasing marginal costs, the incumbent receives quasi-rents (producer surplus) which is distinct from monopoly profits. These quasi-rents decrease with the size of the competitive fringe. Given the myopic behavior alluded to above, the monopoly rents may be quickly dissipated. The potential to exercise monopoly power involves a gain in monopoly rents but a potential loss in producer surplus. If the monopoly rents are small and the loss in producer surplus large, monopoly power is disadvantageous. If the incumbent produces at constant costs, the producer surplus is zero and monopoly power cannot be disadvantageous.

The current model is adapted from Berck and Perloff (1985) who study the optimal open-loop (time-inconsistent) policy for the case in which the monopolist/incumbent has constant costs. We retain their assumption that the competitive fringe has constant costs. In each period there is a pool of potential entrants, each of whom can produce one unit (a flow) at cost c. Given periods of length ε and price (as a flow) P, the present value of producing a unit each period in the future is

$$y_t = \sum_{i=0}^{\infty} (P_{t+i\varepsilon} - c)\, e^{-ri\varepsilon}\, \varepsilon = (P_t - c)\, \varepsilon + e^{-r\varepsilon}\, y_{t+\varepsilon}. \tag{15}$$

It will be apparent that in equilibrium an agent that has entered will continue to produce, so y_t gives the present value at t of entering. Suppose also that the cost of entering is uniformly distributed over the pool (which may be of infinite size) and that agents enter if they make nonnegative profits. Let $Q_{t-\varepsilon}$ be the size of the fringe in the previous period, and suppose that entry occurs at the beginning of the period. Then, the size of the fringe in the current period is

$$Q_t = Q_{t-\varepsilon} + k_t y \varepsilon \tag{16}$$

where k is constant. The linearity of (16) derives from the assumption that entry costs are uniformly distributed over the pool; this assumption is not essential to the argument.

If the incumbent's restricted profit (as a flow) is $\pi(P_t, Q_t)$, his payoff at t is

$$\sum_{i=0}^{\infty} e^{-ri\varepsilon}\, \pi(P_{t+i\varepsilon}, Q_{t+i\varepsilon})\, \varepsilon. \tag{17}$$

This includes the special case where the incumbent produces at constant cost, as well as the situation where he has access to a different technology than the entrants and produces at increasing costs.

Using dynamic programming with a finite horizon, it is evident that the state variable at t for this model is $Q_{t-\varepsilon}$. To motivate the chief result of this section, consider the case where potential entrants at t cannot become active until $t + \varepsilon$. At t, the size of the competitive fringe operating in that period has already been determined; the current state is Q_t rather than $Q_{t-\varepsilon}$. Current decisions about entry depend only on future prices. Therefore, the current monopolist has no direct influence on the state his successors inherit; since he takes their policy rules as given, the only way he could influence their actions, and thus indirectly affect the state they inherit, is by directly affecting the state. Therefore, the current monopolist cannot affect his successors' welfare and so behaves myopically, i.e., maximizes the current flow of rent. This argument holds for the discrete stage finite horizon model; by definition, the infinite horizon model is obtained by considering the limiting case of the finite horizon model.

The previous argument relied on the assumption that today's potential entrants cannot become active until tomorrow. In view of the assumed differentiability of all functions, the qualitative result (myopia) also holds in the limit as $\varepsilon \to 0$ when we begin with a model in which today's potential entrants can become active immediately. The reason is that, under the feedback equilibrium, the monopolist's problem is simply a dynamic-programming problem. In general, if one obtains a continuous time control problem by passing to the limit in a discrete time problem, the result does not depend on whether one begins with a forward or backward difference equation.

To verify this, we return to the original problem in which the state at t is $Q_{t-\varepsilon}$. Applying the standard inductive argument, it is clear that $y_{t+\varepsilon}$ depends only on Q_t. As the number of periods remaining becomes infinite and under the assumption that stationary rules are obtained, we can write $y_{t+\varepsilon} = y(Q_t)$ where (once again) the function y( ) is assumed differentiable. Substituting (15) into (16) gives Q_t implicitly as

$$Q_t = Q_{t-\varepsilon} + k[(P_t - c)\,\varepsilon + e^{-r\varepsilon}\,y(Q_t)]\,\varepsilon. \tag{16'}$$

Implicit differentiation gives

$$\frac{d\,Q_t}{d\,P_t}\left[1 - e^{-r\varepsilon}\,k\,\frac{d\,y(Q_t)}{d\,Q}\,\varepsilon\right] = k\,\varepsilon^2 \tag{18}$$

so that

$$\frac{d\,Q_t}{d\,P_t} \sim o(\varepsilon). \tag{19}$$

The stationary dynamic-programming problem is

$$J(Q_{t-\varepsilon}) = \max_{P_t}[\pi(P_t,\,Q_t)\,\varepsilon + e^{-r\varepsilon}\,J(Q_t)].$$

Expand the right side around $\varepsilon = 0$ and $Q = Q_{t-\varepsilon}$ and define $\Delta Q \equiv Q_t - Q_{t-\varepsilon}$; then rearrange and divide by ε to obtain

$$r\,J(Q_{t-\varepsilon}) = \max_{P_t}\left[\pi(P_t,\,Q_{t-\varepsilon}) + J_Q(Q_{t-\varepsilon})\,\frac{\Delta Q}{\varepsilon} + \frac{o(\varepsilon)}{\varepsilon}\right]. \tag{20}$$

Using the definition of ΔQ and (19), the first-order condition to (20) is

$$\frac{\partial\,\pi(P_t,\,Q_{t-\varepsilon})}{\partial\,P_t} + J_Q(Q_{t-\varepsilon})\,\frac{o(\varepsilon)}{\varepsilon} = 0.$$

As $\varepsilon \rightarrow 0$, the current monopolist maximizes the current flow of rent by setting current marginal profits equal to 0. His ability to affect the welfare of his successors vanishes relative to his ability to affect his own welfare.

Under both the competitive and monopoly regimes, market price asymptotically approaches c. Away from the steady state, for a given size of the fringe, price is higher under a monopolistic incumbent than under a competitive incumbent. The monopolistic incumbent encourages more rapid entry than would his competitive counterpart.

The steady state under the monopolistic and competitive regimes are independent of the interest rate, r, and the adjustment parameter, k. If the incumbent's marginal cost is increasing, his steady-state flow of welfare is higher under competitive behavior than if he follows the feedback consistent (myopic) policy. The reason is that, under the latter, he is unable to act on the knowledge that in the long run his residual demand is perfectly elastic at c. Figure 1 illustrates this. The incumbent's short-run residual demand curve (which takes the fringe size as fixed) in the steady state is shown as P^c under the competitive regime and P^m under the monopolistic regime. The loss due to monopolistic behavior in the flow of welfare at the steady state is the triangle bde. If k is large, the respective steady states are approached quickly and, if r is small, the payoff in the neighborhood of the steady state is a large part of the total payoff to an incumbent beginning at a position away from the steady state. Therefore, for large k and small r, an incumbent with convex costs may clearly prefer the competitive regime. This regime is unobtainable if he has potential market power and must use a feedback (consistent) policy.

If the incumbent's marginal cost is constant, producers surplus is zero. In this case the potential for market power must be beneficial.

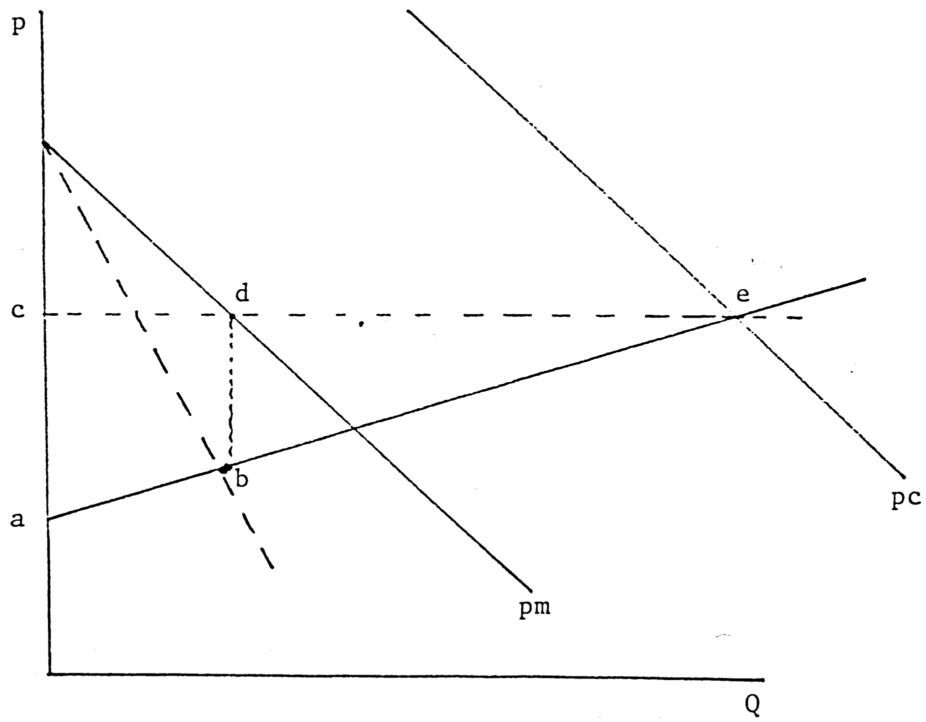

Figure 1

CONCLUSION

Two types of problems illustrated circumstances under which potential market power is disadvantageous. In both problems the leader's value function is monotonic in the state. Given the same initial condition, at every point in time, the leader prefers the level of the state under the feedback equilibrium to the level under the competitive equilibrium in the case of the durable-goods monopolist. The opposite holds for the monopolist who faces a dynamic competitive fringe. In the former case, potential market power must be advantageous; in the latter case, market power is often disadvantageous.

There have recently been a number of papers (in addition to Maskin and Newbery, 1978) that point out the potential loss in welfare due to market power. Karp (1988) shows that a monopsonistic importer of a competitively produced good which requires a quasi-fixed input (i.e., one which involves nonlinear adjustment costs) may be harmed by potential market power. Due to his inability to restrain his successors' tariffs, the importer discourages investment and this causes the state (the level of the quasi-fixed input) to be lower than it would otherwise have been.

Farrell and Gallini (1987) consider a two-period problem in which a seller faces consumers who incur start-up costs for consumption. They show that the seller may prefer competition in the second period to monopoly power in both periods; a slight extension of their arguments shows that the seller may prefer competition in both periods to monopoly in both periods. The monopolist's inability to credibly promise a low price in the second period decreases the demand for the good in the first period.

In an interesting variation of these ideas, Kehoe (1986) points out that international fiscal policy coordination may harm the countries involved. Policy coordination in this model corresponds to monopoly power in the previous models, and lack of such coordination corresponds to competition. In his two-period model, the state is the level of investment. Because of the timing of decisions, policy coordination discourages investment.

These problems illustrate a very intuitive point: The ability to extract short-term benefits does not necessarily imply that long-term benefits are also achieved. The exercise of market power in the future may make it difficult, and in certain cases impossible, to leave one's successors in a good position. Under these circumstances, market power can be disadvantageous. The apparent myopia of the monopolist facing a dynamic competitive fringe is an artifice of the continuous time setting. The important point is that if the current leader's ability to affect the state his successors inherit is of a smaller order of magnitude than is his ability to affect his current welfare, then he approximates myopic behavior as his tenure is made small.[1]

A simple method of characterizing the feedback equilibrium was applied to two problems. In the case of the durable goods monopolist, this generalized and simplified earlier results; in the case of the monopolist facing a dynamic competitive fringe, new results were obtained. The same method can be applied to other situations where agents have rational expectations.

The feedback consistent equilibria used here and in most other papers mentioned seems plausible but is only one of the many possible subgame-perfect equilibria. One way to view this equilibrium is as a threat point which sustains a more favorable outcome. This interpretation is problematic since it requires that agents other than the leader have a degree of strategic sophistication that one does not normally associate with competitive agents.

An additional problem with this interpretation concerns the motivation of other agents for agreeing to an alternative to the feedback trajectory. Consider two possible alternatives: the optimal (for the leader) open-loop (time-inconsistent) trajectory and the competitive trajectory. Suppose that it were possible at time 0 for all agents to sign contracts enforcing one or another of these trajectories and that the alternative to signing was the feedback trajectory. For concreteness, we consider two situations for which the feedback trajectories are qualitatively the same: the monopsonist importer facing competitive producers who incur adjustment costs, alluded to above, and the monopolist facing a competitive fringe studied in this paper.

In the first case under the optimal open-loop trajectory, the monopsonist begins with a high tariff and promises to reduce the tariff in the future. The optimal open-loop trajectory of the monopolist facing a competitive fringe, on the other hand, uses threats: The monopolist threatens to reduce the price in the future, i.e., to practice limit pricing (Berck and Perloff 1985). The requirement of consistency prevents the leader in the first case from making these promises credible and, in the second case, from making the threats credible. In the first case the competitive producers prefer the leader's optimal open-loop trajectory to the feedback trajectory and would be willing to sign a contract enforcing it (making the promises credible). In the second case the agents in the pool of potential entrants have no incentive to assist the leader in making his threats credible and would refuse to sign the contract.

The situation is similar if the alternative to the feedback trajectory is the competitive equilibrium. Producers with adjustment costs prefer to face a zero tariff in each period, whereas the potential entrants in the model of the competitive fringe would just as soon have the incumbent follow the feedback trajectory since that increases the price they receive.

The point of this digression is that problems for which the feedback trajectories are qualitatively similar may possess important differences which become apparent only when one compares their respective optimal open-loop trajectories. An example of such a difference is the possibility that the open-loop trajectory may rely on either promises or threats. It is reasonable to suppose that competitive agents would collaborate with a leader to develop institutions capable of sustaining promises but would not collaborate in the support of threats.

APPENDIX

Proof of Corollary 1

Proof: Given the continuity assumptions, the continuous-time payoffs can be approximated to any degree of accuracy by discrete-stage approximations. We prove the corollary for the discrete-stage approximation using induction. Let the value functions of the monopolist and competitive producer be J(Q) and J*(Q), respectively. These are both nonincreasing in the state. At time 0, the value of the state is the same under both regimes. Designate the competitive trajectory as $\{Q^*_{i\varepsilon}\}$, and suppose that, for some j, $J(Q^*_{(j+1)\varepsilon}) \geq J^*(Q^*_{(j+1)\varepsilon})$. Then it must be the case that $J(Q^*_{j\varepsilon}) > J^*(Q^*_{j\varepsilon})$. At the jth stage, the monopolist could match the competitive level of production; in view of Proposition 1 he receives a higher price than his competitive counterpart and in view of the inductive hypothesis the future returns of being in the same state in the next stage are not less for the monopolist than for the competitive seller. To begin the inductive chain, note that both regimes converge to the same steady state where both J and J* equal 0.

Footnote

[1]In Karp (1984) a monopsonistic importer of a nonrenewable resource which is extracted at increasing costs also behaves myopically. However, this results from the way the equilibrium is defined: A policymaker's tenure lasts as long as it takes to consume a given amount of the resource. By definition, the current policymaker cannot affect the state his successors inherit. This does not correspond to either the feedback or open-loop consistent equilibria discussed here.

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