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A welfare analysis of barriers to entry

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It is widely believed that welfare would be improved by encouraging entry in circumstances where "barriers to entry" (in the sense of Bain) exist. Two models are developed herein which demonstrate that this view is incautious. Economies of scale and product differentiation are both held to be barriers to entry in the Bain scheme of analysis. I show that there are plausible parameter configurations for both economies of scale and goodwill (which is a variant of product differentiation) under which welfare would be improved by increasing, rather than decreasing, the protection of incumbents from the competition of entrants. Greater attention to detail in the analysis of industry circumstances and greater caution in reaching "obvious" welfare conclusions are needed.

1. Introduction: the problem

■ **Background.** Barriers to entry are considered an important structural characteristic of an industry. The competitiveness and the performance of an industry are generally assumed to be strongly influenced by its entry conditions. Bain's pioneering work (1956) specified three sources of entry barriers: absolute cost advantages of incumbent firms, economies of scale, and product differentiation advantages of incumbent firms. Stigler (1968) later proposed a definition: "a barrier to entry may be defined as a cost of producing (at some or every rate of output) which must be borne by a firm which seeks to enter an industry but is not borne by firms already in the industry" (p. 67). This definition by and large corresponds to the use of the term in the industrial organization literature. But we should be aware that economists normally implicitly assume that barriers to entry are a distortion of the competitive process. They inhibit the proper working of the principle of the "invisible hand," and thus imply inefficiencies.

I propose to make this welfare implication of barriers to entry explicit. Without this revision in the definition we are in the danger of drawing inappropriate policy conclusions. Since we cannot show as a theorem that barriers to entry, as defined by Stigler, lead to inefficiencies under all circumstances, we have to choose between two ways of handling the concept. Either we stick to the Stigler definition and are careful not to draw any welfare and policy conclusions from it or we revise the definition and re-

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quire the existence of certain inefficiencies as an attribute of entry barriers. The latter approach seems to be more advisable, since the inefficiency connotation of the concept is by now deeply ingrained in the use of the term by policy-oriented economists and policy makers.

Taking this approach, we can use the term barriers to entry in the following way. What could an "ideal" government do about any given situation? If a distortion is involved, the best state of affairs, which conceivably could be achieved by appropriate social organization, has not been achieved by the market forces. Thus an omniscient, omnipotent, and benevolent government could improve the situation, where we must make sure that omniscient does not mean knowledge of technologies not yet available to society. As was pointed out by Demsetz (1969) and others, such government does not exist. This was Demsetz' criticism of the nirvana approach in economics. And indeed, if we ask, whether the government should actually interfere, all the limitations of "real" governments have to be taken into account. Nevertheless, it makes sense theoretically to ask what an "ideal" government could do. The principle of the invisible hand clearly implied more than the proposition that markets do marginally better than incompetent and corrupt government agencies. Economists praising the virtues of the market have always said that markets do incomparably better than such "real" governments. But then, as a first step, it is appropriate to compare actual market performance with some "ideal" performance. One meaning of the concept of an invisible hand is that it does the job of an omniscient, omnipotent, and benevolent government.

Barriers to entry presumably lead to suboptimal entry of resources into an industry. This condition is obviously also fulfilled if activities in an industry create positive externalities, from which others benefit without paying for the service. But this distortion of entry is, of course, not covered by Stigler's definition. There is no distinction in the costs of an incumbent firm and an entering firm, which can be causally linked to positive externalities. This observation is straightforward. But it is not always easy to see immediately whether a distortion is of the externality kind or the barriers-to-entry kind. We have occasion to come back to this distinction in Section 3 on product differentiation. In a forthcoming book on barriers to entry I treat other examples in which the distinction between externalities and barriers to entry is important and not straightforward.

☐ **Definition.** We then define barriers to entry in the following way, building on Stigler's definition: a barrier to entry is a cost of producing which must be borne by a firm which seeks to enter an industry but is not borne by firms already in the industry and which implies a distortion in the allocation of resources from the social point of view.

For an alternative way of defining the same concept, we may start from the welfare point of view and distinguish between two opposing causes of a distortion. Entry into an activity may be socially suboptimal because the activity is not sufficiently protected. This is the case of positive externalities. Or it is suboptimal because incumbent firms are protected from entry, i.e., incumbent firms are overly protected. This is the case of barriers to entry. They thus can be defined to be socially undesirable limitations of entry, which are attributable to the protection of resource owners already in the industry.

An "ideal" government, by reducing this protection or by regulating the behavior of incumbent firms, could improve the allocation of resources. In the following two sections I discuss two models. They are examples of two of Bain's three sources of entry barriers: economies of scale and product differentiation advantages. If one puts the entry conditions in these two models into an explicit welfare context, it turns out that Bain's theory of barriers to entry sources is not generally applicable. In both models we do not generally find barriers to entry according to our definition. In the economies of scale case we can obtain plausible parameter constellations such that from a social welfare viewpoint there are in equilibrium too many suppliers in the industry. In the product differentiation model we get the result that there is suboptimal entry of high quality suppliers, but the distortion is of the externality kind. Moreover, the product differentiation is not a cause, but rather a partial cure, of the distortion. In both models government action, if it could at all improve things, would tend to increase rather than lower the protection of incumbent firms.

2. Economies of scale: a Cournot model

■ **The issues.** Assume that economies of scale are such that an entrant would be forced to supply a substantial fraction of industry output if he wants to be competitive in terms of costs. He will reckon that the ensuing expansion of output depresses price. It may therefore not be profitable to enter the industry, even if the incumbent firms make a profit above the normal return on capital at the preentry prices. This is the core of Bain's argument why economies of scale are a source of entry barriers.

Several questions arise. Would it be socially advantageous that an additional firm enters the industry? If not, in which sense can we speak of a barrier to entry? What is the characteristic of incumbent firms which distinguishes them from entrants and which therefore allows them to obtain profits above average? Before developing a model in some detail, we can immediately clarify one point. The difference between incumbent firms and entrants is that incumbent firms own plant and equipment specific to this industry and thereby are committed to continue operations in this industry, whereas this is not the case for a potential entrant. It is thus not just simple economies of scale which may cause a barrier to entry, but rather economies of scale in combination with irreversible capital commitments. This modification in describing the source of entry barriers may seem somewhat pedantic, since the added condition of irreversible capital commitment will almost always be fulfilled. But it is worth pointing it out, because the precise nature of a policy remedy will depend on the precise nature of the barrier to entry. This can be shown by an example to be discussed now.

Very substantial economies of scale may imply a natural monopoly situation. Demsetz (1968) proposed a competitive solution to the natural monopoly problem. Bidders would compete for the monopoly franchise in terms of the price at which they are prepared to sell the product. The bidder promising the lowest price obtains the franchise. A similar, somewhat more involved scheme is available for a bidding competition of a multiproduct natural monopoly (von Weizsacker, forthcoming). It would lead to Ramsey prices. Williamson (1976) has written a convincing critique of the Demsetz proposal. In many real-

world situations it will not work. As Williamson points out, the causes of the difficulties described by him all depend on the fact that for technological reasons the monopolist has to invest activity-specific capital and that it is therefore necessary to offer the franchise for an extended period of time. The Demsetz proposal or a generalized Demsetz proposal would not encounter these difficulties if activity-specific investments would not be necessary. Obviously, activity-specific investments include investments in human capital, such as learning-by-doing effects.

☐ **A simple model.** I now develop a very simple model of an industry with economies of scale. I assume that the demand function for the homogeneous product of the industry is constant through time and is given by

$$x = A - p,$$

where x is demand, p is price, and A is a constant. The cost structure for each supplier in the industry can be characterized by the following cost function:

$$C = k + az + \tfrac{1}{2}bz^2,$$

where z is the individual supplier's output and k, a, b are nonnegative constants. The average cost-minimizing level of output, as the reader can easily verify, is given by

$$z = \sqrt{\frac{2k}{b}}.$$

The minimum average cost is

$$\frac{C}{z} = a + \sqrt{2kb}.$$

An optimum finite firm size, which is implied by a positive b, can be explained along the lines of the rising administrative costs of coordinating more and more people. This is the theory of optimum firm size as developed by E. A. G. Robinson (1931) and applied to explain firm growth by Penrose (1959). Modern management techniques, including the decentralizing of decisions within the firm, have obvious implications for the optimum firm size, and, thus, the analysis of market structure. On this theme see Chandler's historical account (1977) and Williamson's transaction cost based analysis (1975). For me it is important to realize that the modern industrial organization literature implicitly or explicitly assumes that firms beyond the optimum size do not suffer great cost disadvantages. Marris and Mueller (1980) in their recent survey draw this conclusion. Since large firms can make use of the advantages of decentralization within the firm, this hypothesis is plausible.

If the cost-minimizing output is substantial relative to total industry demand, we have the situation envisaged by Bain. If b is zero, the cost minimization occurs at $z = \infty$. We assume that part of the costs are due to industry specific capital investments, which implies that incumbent firms have a commitment to the industry as discussed above.

I now compare a Cournot-monopoly or oligopoly equilibrium with the optimal allocation of resources. First, I treat n, the number of firms in the industry as given. It is well known that in the optimum marginal cost and price must be equal. The marginal cost of a supplier is given by

$$MC = a + bz.$$

Assuming that each supplier has the same marginal cost and hence the same output, total output x is equal to

$$x = nz.$$

Therefore,

$$MC = a + b \frac{x}{n}.$$

Using the $p = MC$-condition and the demand function, we obtain

$$p = A - x = a + b \frac{x}{n},$$

from which follows

$$x = \frac{n}{b + n} (A - a), \qquad p = \frac{b}{b + n} (A - a) + a, \qquad z = \frac{A - a}{b + n}.$$

The Cournot equilibrium for given n can be characterized as follows. The individual supplier maximizes his profit π under the assumption that his actions do not influence the output level of his competitors. His profit is

$$\pi = pz - k - az - \frac{b}{2} z^2.$$

Obviously, keeping output of others the same implies

$$\frac{dp}{dz} = -1$$

and therefore profit maximization leads to

$$\frac{d\pi}{dz} = p - a - (b + 1)z = 0$$

or

$$z = \frac{p - a}{b + 1}.$$

Thus

$$x = nz = n \frac{p - a}{b + 1} = n \frac{A - x - a}{b + 1}$$

or

$$x = \frac{n}{b + 1 + n} (A - a), \qquad p = \frac{b + 1}{b + 1 + n} (A - a) + a, \qquad z = \frac{A - a}{b + 1 + n}.$$

For given n, output is smaller and price is higher than in the social optimum. This is straightforward. The interesting question is to compare the optimal and the equilibrium number of suppliers. To simplify the notation I introduce the following convention. By

$$F(n) \approx w$$

with w a real number and n an integer number I mean: n is such that for a real valued v, solving the equation $F(v) = w$, we have $|n - v| < 1$. We say n is a neighbor of v.

Market surplus S is equal to consumer surplus plus market profit. S can thus be expressed as gross consumer utility from this good (obtained by integrating the demand function) minus social cost of production. We have for $z = x/n$

$$S = Ax - \frac{1}{2}x^2 - n\left(k + az + \frac{b}{2}z^2\right) = (A - a)x - \frac{1}{2}\left(1 + \frac{b}{n}\right)x^2 - nk.$$

Using the formula for the optimum x for given n, we can write

$$S = (A - a)^2 \frac{n}{b + n} - \frac{1}{2}\frac{n + b}{n}\left(\frac{n(A - a)}{b + n}\right)^2 - nk$$

$$= \frac{1}{2}(A - a)^2 \frac{n}{b + n} - nk.$$

S would be a single peaked function of n, if n were a continuous variable. But this implies that the optimal integer value of n must be a neighbor of the value at which the first derivative of S with respect to n vanishes. Differentiation implies

$$\frac{dS}{dn} = \frac{1}{2}(A - a)^2 \frac{b}{(b + n)^2} - k = 0,$$

from which it follows that the optimal integer fulfills

$$(b + n)^2 \approx \frac{(A - a)^2}{k}\frac{b}{2}.$$

I now investigate the equilibrium number of suppliers. I define it as the largest number of suppliers such that a Cournot equilibrium is still profitable. In other words, entry occurs up to the maximum point where profits are still compatible with a Cournot equilibrium of suppliers. The profit an oligopolist earns in a Cournot equilibrium is

$$\pi = (p - a)z - \frac{b}{2}z^2 - k$$

$$= \frac{b + 1}{b + 1 + n}(A - a)\frac{A - a}{b + 1 + n} - \frac{b}{2}\frac{(A - a)^2}{(b + 1 + n)^2} - k$$

$$= \frac{b + 2}{2}\left(\frac{A - a}{b + 1 + n}\right)^2 - k.$$

The highest value of n such that π remains positive thus fulfills the condition

$$(b + 1 + n)^2 \approx \frac{(A - a)^2}{k}\frac{b + 2}{2}.$$

Let n^* be the optimal n and let $\bar{n}$ be the Cournot equilibrium n. It is not difficult to see that n^* and $\bar{n}$ can be different.

Thus, for example, we compute for $(A - a)^2/k = 20$ and $b = .05$ that n^* is equal to 1 and $\bar{n}$ is equal to 3. Here the optimum number of firms is lower than the equilibrium number of firms. If in addition $A - a$ is equal to 10, the optimal level of output is equal to

$$x^* = \frac{n^*}{b + n^*} (A - a) = \frac{10}{1.05} .$$

The Cournot-equilibrium level of output is

$$\bar{x} = \frac{\bar{n}}{b + 1 + \bar{n}} (A - a) = \frac{3}{4.05} 10 < \frac{1}{1.05} 10.$$

We have too small an output from too many firms. Note that this numerical example is not untypical. Indeed, a comparison of the equations for n^* and $\bar{n}$ convinces us that $\bar{n}$ will be larger than n^* whenever b is sufficiently small and A is sufficiently large. It is obvious that for $b = 0$ we always have a natural monopoly situation with n^* at most equal to one (if not zero). On the other hand, a sufficiently strong demand (a sufficiently large value of A) would support several suppliers in a Cournot-equilibrium.

In which sense should we speak of a barrier to entry if n^* is smaller than $\bar{n}$? Society certainly does not want entry of additional firms. It does want more supply, but from fewer firms. An ''ideal'' government could improve the situation by ordering lower prices. If firms could not charge more than the price which corresponds to the optimal output level, then in our numerical example only a single firm would be able to cover costs. Thus, in a sense we could speak of distortions of entry due to too much protection of incumbent firms and we could speak of barriers to entry. In principle, an ''ideal'' competition policy could improve the allocation of resources.

The result depends, of course, on the particular assumptions made about the technology, demand, and the behavior of suppliers. One might criticize the Cournot behavioral assumption. Which kind of behavior could stabilize n below the Cournot-equilibrium $\bar{n}$? A potential entrant, who after entry would be the $\bar{n}$th supplier, must expect a more competitive behavior than corresponds to the Cournot model. But why should he? It is not in the self-interest of the incumbent firms to compete so strongly after entry has occurred. Spence (1977) argued that the buildup of excess capacity could be used as an entry deterrent, because it may make it rational to use that preexisting capacity after entry in such a way that the entrant faces losses. This interesting idea of distortions and waste implied by the tendency to preempt potential entrants has gained wide acceptance. Without discussing it in detail, I want to make three critical remarks: (1) The model just presented makes it less certain that expenditures to deter entry are wasteful. They could be socially productive in comparison with the equilibrium which would prevail without them. (2) Entry deterrence by the buildup of capital only works if the rate of interest is sufficiently high. Indeed, if the rate of interest were zero, entry cannot be deterred by precommitment into industry-specific capital. If, despite precommitment, entry occurs, the rational policy of the incumbent is to reduce capacity gradually. In the end a normal Cournot duopoly prevails. This, by assumption, is profitable for the entrant. Since it lasts indefinitely and since the rate of interest is zero, this gain will outweigh the initial loss inflicted by the preemptive strategy. A more detailed analysis of the time structure of entry deterrence is needed. Note that here the rate of interest is in terms of units such that the size of the market remains constant. In those terms the interest rate may easily be zero or negative. (3) As we shall see shortly, it will be difficult to deter entry in industries whose market grows relative to the minimum optimum scale of firms.

☐ **Growing markets.** I now turn to the discussion of growing markets. In the model which we have discussed, it remains true that economies of scale imply higher profitability of incumbent firms. If the equilibrium number $\bar{n}$ of suppliers is small, say 1 or 2 or 3, profits on invested capital can be substantially higher than the opportunity cost of capital. But we should note that this link between economies of scale and high profitability hinges on the time invariance of the model parameters. Economists have a tendency to start with models— and frequently to stick to models—which have this property of stationarity. This is the reason the link between substantial economies of scale and high profitability is so frequently taken for granted.

If the equilibrium number of suppliers does not remain constant, we have two major cases: the market shrinks relative to the minimum efficient size of firms or the market grows relative to the minimum efficient size of firms. I mainly consider the case of expanding demand. As demand expands continually, the profitability of entry increases. Entry prevention thus becomes more difficult. If the cost structure is such that expansion of firm size beyond the optimum raises average cost, entry cannot be prevented. Too much internal growth of incumbent firms puts them into a cost disadvantage compared with entrants who enter at optimum size and who therefore cannot be discouraged to enter. But, if, owing to market growth, it is futile to prevent entry, it will occur at a time such that incumbent firms can expect only average returns on their investments. The reason is easy to understand.

The timing of entry will be determined by the competition among potential entrants for the next open place in the industry. That competition is a competition of the first-come-first-served-kind. The potential entrant prepared to enter first will win this competition. But then, if the potential entrants are about equal in their capability, the entry will occur at the moment at which the discounted private net benefit of entry is equal to zero. Reckoned from the moment of this entry, the expected rate of profit of incumbents will also not be above the opportunity cost of capital unless the incumbents have advantages which do not stem from the economies of scale. Thus, in an industry in which the market grows faster than the efficient size of firms, oligopolistic structure due to large minimum efficient firm size is not a protection of high profits. What we shall find are periods of rising (accounting) profitability attributable to market growth without immediate entry interchanging with moments of sudden profitability collapses caused by the recent entry of a newcomer.

From a theoretical viewpoint this different profitability picture holds whenever the persistent rate of growth of the market deviates from zero in an ever so slight degree (in the positive direction), since this will already induce the rate for the next position. This discontinuity at the point zero (in terms of growth rates) should not disturb us. In the real world with the uncertainties about the future, potential entrants cannot know with certainty whether in the future there will be space for an additional supplier. The higher the observed rate of growth, the more certain they can be about this fact. Thus, at low growth rates entry may occur much later than predicted by the zero-net-benefit condition discussed above in the context of a deterministic model. Since the signals about growth are fuzzy, there is also more opportunity for incumbents to mislead potential entrants and thereby prevent or postpone entry. At high growth rates the obvious cannot be concealed, and we thus would expect the zero-net-benefit

condition to predict the timing of entry better here, even in the presence of substantial risk and uncertainty.

High profitability is a common occurrence in rapidly growing industries. Our analysis should warn us against a misspecification of this high profitability as being due to a barrier to entry connected with economies of scale. There exist obvious other reasons for a positive relation between profitability and market growth.

Obviously, a steady reduction in demand relative to efficient firm size is not a favorable precondition for high average industry profits. Without discussing a theoretical model, I simply point to the common experience that shrinking industries tend not to be very profitable. We are therefore left with the conclusion that the model of the stationary market is a rather special case, so that theorems developed within that model are of somewhat limited explicative value of the real world. The model could perhaps be defended if one could show that the subjective beliefs and conceptions of the agents concerned are very much guided by conscious and unconscious assumptions of stationarity. This would then allow for the possibility that the model explains well how people interact, because they work on the assumptions of the stationary model, and the system then works like a self-fulfilling prophecy.

It remains generally true that economies of scale create distorted incentives for entry. I now want to investigate this issue of entry distortion in a growing industry, where, as we have seen, there is no longer a reason to expect profits above average to be protected by economies of scale. The actual entrant, as was already said, can expect a return on his investment, which corresponds to the opportunity cost of capital, i.e., the normal rate of return. His entry— if compared with a situation where he is absent from the market—creates external benefits to the consumers, because prices will be lower. On the other hand, his competitors lose from the entry. If over his whole lifetime in the industry the loss to his competitors is larger than the gain to the consumers, then his entry was premature. It created a net social loss: his net gain is zero in equilibrium, and the net gain of others is negative. This method of analysis allows us to avoid the intricacies of a truly dynamic model. The dynamic analysis is made for us by the entrants, and we take advantage of it by considering an equilibrium situation which ensues from this dynamic analysis. It is the equilibrium which implies, of course, the condition of the zero net gain of the entrant. We now simply look at the effects of the presence of the additional supplier at each moment of time. If we can say something which uniformly applies to each moment, it must—by summation—also apply to the total lifetime of the entrant.

Before going into the formalism of the analysis, let us note that the net benefit of entry to others would be zero if two conditions hold: (1) the output of the other suppliers remains unaffected and (2) the supply of the new entrant is small in relation to the market. Then total market output will be raised by a small dx and thereby cause a price change dp. We know by the first condition that the costs of suppliers remain the same, and thus the loss to the suppliers is equal to $-xdp$ (with $dp < 0$). It is also known from demand theory that the gain to consumers of this price reduction is equal to $-xdp$. Thus, the net benefit is zero. If the net benefit (always reckoned without the net benefit to the entrant himself) is different from zero, it must result from the effect of

entry on the quantity supplied by others and/or from the fact that the entrant's supply is too large to be treated as "infinitesimal." A more than "infinitesimal" effect of entry on the price, called Δp, implies a benefit to the consumers which is larger than $-x\Delta p$ and thus the price reduction as such helps consumers more than it hurts competitors. (See Figure 1.) On the other hand, if in the new equilibrium output of the competitors is smaller than without entry, the suppliers incur an additional loss, if price is above marginal cost, and hence output reductions imply more revenue loss than cost reductions. Which of the two effects is greater has to be investigated in a specific model.

Let x be the output supplied by the competitors and let y be the output supplied by the entrant. Let $p(x + y)$ be the market price, as determined by demand. Let $C(x)$ be the costs of the other suppliers and let $U(x + y)$ be the consumer utility of the good (in money equivalent terms). We assume Cournot-oligopoly behavior. Thus, the other suppliers treat the new supplier's output y as given in making their decision about their output. Given y, a certain output x will correspond to the Cournot-oligopoly behavior. We thus can treat x as a function $x(y)$ of y. The value $y = 0$ corresponds to the absence of the new supplier. Later, we shall determine the size of y also in the framework of a Cournot model. Let x_0 and p_0 be the values of x and p corresponding to $y = 0$. By Δv I generally mean the difference in the value of any variable v in the situation with the new supplier (supplying y) and without him (i.e., $y = 0$).

The total net benefit of consumers is

$$U(x + y) - p(x + y)(x + y),$$

where, of course, $U'(x + y) = p(x + y)$. The total profit of other suppliers is

$$p(x + y)x - C(x).$$

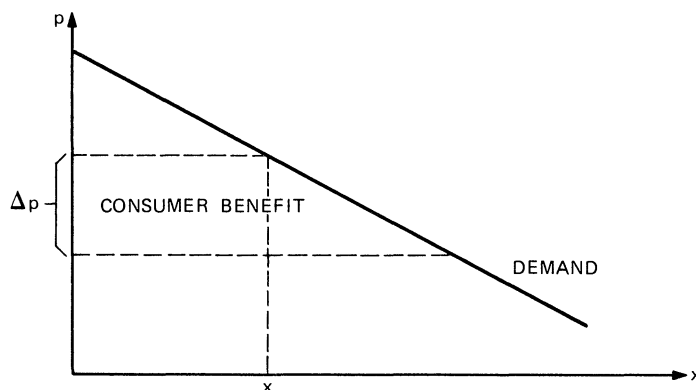Hence, market surplus (net of the net benefit of the new supplier) W is

$$W = p(x + y)x - C(x) + U(x + y) - p(x + y)(x + y)$$
$$= U(x + y) - C(x) - p(x + y)y.$$

Remembering that $\Delta y = y$, we then have

$$\Delta W = \Delta U - \Delta C - (p_0 + \Delta p)y.$$

FIGURE 1

I now use the assumptions of the model discussed earlier. The model used before had a demand function with a slope equal to -1. As market size and perhaps costs change through time, we have to adapt our units in such a way as to maintain this slope of the demand curve. Quantities (and thereby price) are expressed in terms of the following unit: one unit is the additional amount of demand leading to a unit reduction of price. The parameters, A, k, a, b, then will have to be adapted to this unit, and thus will change through time. The fact that we have a growing market in terms of the efficient size of firms means that $A - a$ will grow relative to k and/or b. For our exercise it is not necessary to specify the precise form this growth takes.

The demand function and the cost function are

$$x + y = A - p$$

and

$$C(x) = nk + ax + n \frac{b}{2}\left(\frac{x}{n}\right)^2,$$

respectively. Since the utility function is obtained from the demand function by integration, we have

$$U(x + y) = A(x + y) - \frac{(x + y)^2}{2}.$$

We therefore get

$$\Delta U = A(\Delta x + y) - x_0(\Delta x + y) - \frac{(\Delta x + y)^2}{2},$$

$$\Delta C = a\Delta x + \frac{b}{n}\left(x_0 \Delta x + \frac{(\Delta x)^2}{2}\right),$$

$$\Delta p = -(y + \Delta x).$$

This implies, using $p_0 = A - x_0$, that

$$\Delta W = (A - a)\Delta x - x_0 \frac{n + b}{n} \Delta x - \frac{1}{2} \frac{n + b}{n} (\Delta x)^2 + \frac{y^2}{2}.$$

Using the formula for x in the Cournot equilibrium, we obtain

$$x_0 = \frac{n}{b + 1 + n}(A - a), \qquad x_0 + \Delta x + y = \frac{n + 1}{b + 2 + n}(A - a),$$

$$y = \frac{1}{b + 2 + n}(A - a).$$

We thus can express all four terms of ΔW in terms of y by using the following relations

$$x_0 + \Delta x + y = (n + 1)y, \qquad x_0 = n \frac{b + 2 + n}{b + 1 + n} y$$

$$\Delta x = -\frac{n}{b + 1 + n} y, \qquad A - a = (b + 2 + n)y.$$

Therefore,

$$\Delta W = \frac{y^2}{2} \left\{ -2(b + 2 + n) \frac{n}{b + 1 + n} \right.$$

$$\left. + 2n \frac{n + b}{b + 1 + n} \frac{b + 2 + n}{b + 1 + n} - \frac{n(n + b)}{(b + 1 + n)^2} + 1 \right\}$$

$$= \frac{y^2}{2} \left\{ -2n \frac{b + 2 + n}{(b + 1 + n)^2} - \frac{n(n + b)}{(b + 1 + n)^2} + 1 \right\}$$

$$= \frac{y^2}{2} \left\{ 1 - \frac{3n}{b + 1 + n} - \frac{n}{(b + 1 + n)^2} \right\} .$$

For later reference we show that ΔW is negative for $(b + 1)^2 = 4n^2 + 1$, where, of course, n is a positive integer. Indeed, we then have

$$\Delta W = \frac{y^2}{2} \frac{1}{(b + 1 + n)^2} \{4n^2 + 1 + n^2 + 2n \sqrt{4n^2 + 1} - 3n^2 - 3n \sqrt{4n^2 + 1} - n\}$$

$$= \frac{y^2}{2(b + 1 + n)^2} \{2n^2 - n \sqrt{4n^2 + 1} + 1 - n\}$$

$$< \frac{y^2}{2(b + 1 + n)^2} \{2n^2 - n \sqrt{4n^2}\} = 0.$$

☐ **Ramifications.** We now have to interpret this result in terms of familiar concepts relating to the cost function and the demand function. First notice that ΔW is always negative, if b is equal to zero, i.e., if average cost never rises as firm output increases. If b is positive, there exists a unique firm size which minimizes average costs. We may characterize the cost structure by determining the percentage difference in average cost at the optimum size and at twice the optimum size.

We define γ by the equation

$$1 + \gamma = \frac{\text{average cost at twice optimum size}}{\text{average cost at optimum size}} ,$$

and then obtain from the formula for the optimum size

$$z^* = \sqrt{\frac{2k}{b}}$$

$$\frac{C(z^*)}{z^*} = a + \sqrt{2kb}, \qquad \frac{C(2z^*)}{2z^*} = \frac{k + a(2z^*) + 4k}{2\sqrt{\frac{2k}{b}}} = a + \sqrt{2kb} + \frac{\sqrt{kb}}{2\sqrt{2}} .$$

We then obtain

$$\gamma = \frac{1}{4} \frac{\sqrt{2kb}}{a + \sqrt{2kb}} ,$$

where γ is the cost disadvantage of the larger size firm. Then we can compute the elasticity of demand at the Cournot equilibrium point. We get

$$\epsilon = \frac{dx}{dp}\frac{p}{x} = -\frac{p}{x} = -\left[\frac{b+1}{n} + \frac{a}{A-a}\frac{b+1+n}{n}\right].$$

Furthermore, we are able to say something about the relation between k and n in equilibrium. We know that in a growing industry the equilibrium n will be at least as large as in a stationary industry, given the present market size. But then we know from the equilibrium condition for stationary industries that the equilibrium n for growing industries fulfills the inequality

$$(b+1+n)^2 \geq \frac{(A-a)^2}{k}\frac{b+2}{2},$$

or

$$\sqrt{2kb} \geq \frac{A-a}{b+1+n}\sqrt{b^2+2b}$$

$$= \frac{A-a}{b+1+n}\sqrt{(b+1)^2-1}.$$

If we now put $(b+1)^2 = 4n^2 + 1$, we know that ΔW is negative, and by substituting on the right-hand side, we get

$$\sqrt{2kb} \geq \frac{A-a}{b+1+n}\sqrt{(b+1)^2-1} = \frac{A-a}{b+1+n}2n.$$

We also can write

$$a = \frac{1-4\gamma}{4\gamma}\sqrt{2kb}.$$

Thus, remembering that $b + 1 = \sqrt{4n^2+1} > 2n$, we can write for $|\epsilon|$,

$$|\epsilon| = \frac{b+1}{n} + \frac{a}{A-a}\frac{b+1+n}{n}$$

$$\geq 2 + \frac{1-4\gamma}{4\gamma}\sqrt{2kb}\frac{b+1+n}{n(A-a)} \geq 2 + \frac{1-4\gamma}{4\gamma}2.$$

As we now reduce the value of b for given n, clearly ΔW remains negative, whereas the elasticity of demand goes down in absolute value. Thus, for any demand elasticity less than $2 + 2(1 - 4\gamma/4\gamma)$ we also have ΔW negative. This gives us the following results:

γ	ΔW negative for $|\epsilon|$ not greater than
25%	2
20%	2.5
15%	3.33
10%	5
5%	10.

Typically, industry demand elasticities in oligopolistic industries are low, and cost disadvantages of firms twice the size of optimal size firms are also insubstantial. This implies that in most cases where the conditions of our model are

fulfilled ΔW is negative, i.e., that entry of competitors into growing oligopolistic industries is premature if compared with the social optimum. Obviously, the model's assumptions are restrictive: the suppliers offer a completely homogeneous good, the market is faced with a linear demand function, and the firms have quadratic cost functions. These are about the most straightforward assumptions one can make. Any more complex or more general models have not been investigated with respect to the question considered here. In the context of the special model addressed here, however, there exists no presumption that entry into a growing industry with substantial economies of scale occurs too late.

We should note that the exercise which we just have completed is a typical second-best exercise. We assumed that we cannot change the output and pricing behavior of incumbent firms, and then ask ourselves whether entry conditions are optimal or not. We conclude that in this second-best sense entry is too rapid rather than too slow.

If competition policy has to play a role here, it will be a rather unorthodox one. If an entry fee is charged, entry may slow down, and thereby improve resource allocation. Clearly, it is difficult to describe this industry as one in which incumbents are excessively protected from entry. Therefore, it does not make very much sense to speak of entry barriers in this context.

3. Product differentiation: goodwill

■ **The extrapolation principle.** In this section I shall concentrate on the particular form of product differentiation known as goodwill. Goodwill is the phenomenon that consumers through experience or other kind of information form a good opinion about the quality of the product or products of a supplier. Goodwill concerning quality of products can be of particular importance in markets where it is not easy for consumers to ascertain the quality of a product before they buy it. We should note at the outset that it creates the incentive to offer good quality, even in circumstances where consumers have a substantial informational deficit concerning quality.

Goodwill is based on a mode of behavior which I call the extrapolation principle. By this I mean the phenomenon that people extrapolate the behavior of others from past observations, and that this extrapolation is self-stabilizing because it provides an incentive for those others to live up to these expectations. This principle drastically reduces the cost of transmitting (and therefore, in a sense, producing) information—in this case information about the likely future behavior of others. Extrapolation substantially reduces the depreciation rate of the stock of relevant information. It thus makes the generation of information much cheaper in a society. A progressive, rapidly changing society with a great need for the dispersion of new information will need the extrapolation principle to keep information costs at manageable levels.

Turning back to goodwill as a consequence of the extrapolation principle, we see that it is a good, but not perfect, substitute of direct knowledge of quality. It is not a perfect substitute because sometimes extrapolative expectations are disappointed. A good quality supplier may become a bad quality supplier or *vice versa*. To the extent that the supplier himself has difficulty ascertaining the product quality, the goodwill mechanism will not resolve the problem.

Moreover, if effective product quality depends on the user's own behavior, he cannot expect an implied guarantee of the quality from the supplier via the goodwill mechanism. The goodwill mechanism is particularly important in these circumstances, however, since moral hazard makes a contractual guarantee of the product quality impossible. Goodwill still works as an incentive for suppliers to make an effort for good quality.

Goodwill is also only an imperfect substitute for direct knowledge of quality, because a new supplier first has to establish a quality reputation. If he offers good quality from the beginning, his products will first have to be sold at a discount compared with products of equal quality of long-established suppliers. Goodwill is a valuable asset precisely because it takes time to acquire it.

☐ **A simple model.** I now discuss a very simple model of goodwill. It is a rational expectations model in the sense that the subjective probability distribution of quality for products of unknown quality corresponds to the true frequency distribution of qualities for these products of unknown quality. This rational expectations assumption can be justified, because I look at a steady-state equilibrium, so that experience from the past guides the consumers' expectations in the right direction.

Obviously, this steady-state assumption is not realistic, and indeed is very special. In a rapidly changing environment other assumptions may be more appropriate. In such circumstances the lemons problem may remain much more serious than is suggested by our model. A turnover in the population of consumers and the imperfect transfer of knowledge among them may distort expectations so that they never settle down at the rational expectations equilibrium. Under such circumstances there is scope for phenomena, which we may characterize as barriers to entry and which are not present in the model to be discussed. On the other hand, we should note that other more extended forms of the extrapolation principle can play a role in these situations. Goodwill can be carried over from one product to another. Wherever an important consumer information problem arises, there is a business opportunity for a firm that has or acquires a reputation only to sell high quality products. But before we can fully understand these more complex situations, we should try to understand the simple cases, which admittedly are not completely realistic.

First, I derive a phenomenon, which I call quasi risk aversion. Let z be a quality parameter of the good which we consider. Obviously, any monotonic transformation $\zeta(z)$ of z could again be used as a parameterization of quality. Let us assume that market prices $p(z)$ exist for goods of known quality z. We then are able to choose the quality parameter in such a way that $p(z)$ becomes linear,

$$p(z) = p(z_0) + \alpha(z - z_0).$$

We call α the quality premium. Let us choose z_0 in such a way that the consumer whom we consider prefers quality z_0 over other known qualities, if he is confronted with the price schedule $p(z)$. We assume that he is at present only interested in buying one unit of the good. His net utility from buying the good may be expressed by the function

$$U(z) = V(z) - p(z).$$

He maximizes $U(z)$ among known qualities by choosing z_0 such that

$$V(z_0) - p(z_0) \geq V(z) - p(z_0) - \alpha(z - z_0)$$

$$V(z_0) \geq V(z) - \alpha(z - z_0).$$

Note that $U(z)$ is of the same dimension as $p(z)$ and hence can be measured in dollars. Assuming that the good in question is a small item, and hence that $U(z)$ is small in relation to the buyer's total budget or wealth, we are allowed to ignore risk aversion, and thus we can assume that under conditions of risk about quality the consumer is interested in maximizing the expected net monetary value when buying a certain good. Given a certain probability distribution of z attached to a good of uncertain quality, the consumer thus values this good as the expected value of $U(z)$ which he can expect from this good. If $f(z)$ is a density function representing the probability distribution, the net value of the good thus is equal to

$$\int f(z)V(z)dz - \hat{p}$$

(the integral sign is meant to mean integration over the relevant range of z), where $\hat{p}$ is the good's price. At which price $\hat{p}$ will the consumer be indifferent between buying a good of known quality z_0 (his preferred quality) and buying the good of unknown quality, if we assume that the expected value of its quality is equal to z_0? For this indifference we get the equation

$$\int f(z)V(z)dz - \hat{p} = V(z_0) - p(z_0).$$

Because of the assumption that

$$\int f(z)z\,dz = z_0$$

and because of

$$V(z) - \alpha(z - z_0) \leq V(z_0)$$

we can write

$$\int f(z)V(z)dz = \int f(z)(V(z_0) - \alpha(z - z_0))dz \leq \int f(z)V(z_0)dz = V(z_0).$$

It therefore follows that $\hat{p} \leq p(z_0)$.

　　At equal prices and equal expected values of quality, the consumer prefers the certain quality, if it is the quality level which he prefers over other certain qualities. This we call quasi risk aversion. It is a property which can be derived; it does not have to be assumed.

　　Consider now the supply side. Suppliers have a given finite lifetime T. The quality of a product can be ascertained by consumers S periods after purchase. The costs of production are capital costs and current expenditure. Current expenditures per unit of output are equal to h and do not depend on quality. Capital expenditures k have to be incurred at the time of entry, and they are proportional to the product quality. Without loss of generality we can write

$$k = z.$$

This assumption, as will be seen below, is not inconsistent with a linear price schedule $p(z)$. For simplicity of presentation, we assume a rate of interest equal

to zero. (There exists no difficulty in introducing a rate of interest different from zero.)

The assumption about a fixed finite lifetime is obviously made for the purpose of simplification. The same is true about the assumption that the quality effort occurs in the form of an initial investment. If the quality effort were a current expenditure, we would first have to show why suppliers keep their chosen level of quality constant. This can be done in a somewhat changed model, in which the time of "death" of the firm is stochastic and exponentially distributed. The incentive to maintain quality can be derived from the consumers' preference for quality certainty (quasi risk aversion). The changed model, although without fundamental problems, is substantially more complicated. The reason is that we have to solve certain problems of existence of equilibrium which are by now familiar to theorists working in the economies of information area. To keep things simple I make the assumptions just described.

A firm which entered the industry less than S years ago produces a product whose quality is unknown to the market. (We ignore the possibility to inquire about the firm's capital intensity of production to draw conclusions about its product quality.) Thus, all products of "young" firms (i.e., firms less than S years old) sell at a uniform price $\hat{p}$, where $\hat{p}$ is a variable to be determined. After S periods, the quality of the firm's product can be extrapolated from the now known quality z of its initial product, and the product sells at a price $p(z)$, where the equilibrium price schedule $p(z)$ has to be determined. Each firm can only produce one unit of output per period. In equilibrium total cost through the firm's lifetime and total revenue must be equal. For each z we therefore obtain the equation

$$S\hat{p} + (T - S)p(z) = z + Th.$$

The left-hand side is the cumulated revenue over the T periods; the right-hand side is total cost, where $k = z$ is the capital expenditure and Th is the cumulated current expenditure. Rewriting this equation as

$$p(z) = \frac{z + Th - S\hat{p}}{T - S}$$

shows that $p(z)$ is a linear price schedule.

Given the quality premium per unit of quality

$$\frac{1}{T - S},$$

we know that each consumer has a definite first choice of quality, if qualities are known and if he decides to buy a product in this market at all. As we are primarily interested in a simple example, I make a further simplification by assuming that all consumers are characterized by the same degree of quasi risk aversion. I assume that consumer i wants to maximize the net benefit function,

$$V_i(z) - p(z) = a_i + b_i z - cz^2 - p(z),$$

where a_i and b_i are consumer-specific parameters and c is a universal parameter expressing the degree of quasi risk aversion.

If he buys a product of known quality, then optimizing the quality parameter implies

$$\frac{dV_i(z)}{dz} - \frac{dp}{dz} = b_i - 2cz - \frac{1}{T - S} = 0$$

or

$$z = \frac{b_i - \dfrac{1}{T - S}}{2c}.$$

Let us call this value z_i. We are interested in whether consumer i is prepared to buy a product of quality z_i, or whether he prefers to buy a product of unknown quality or not to buy at all. We thus want to compute the equivalence price $\hat{p}_i$ of the product of unknown quality which makes the consumer i indifferent between buying the product of unknown quality and buying the product of quality z_i. Let $\bar{z}$ be the expected value of the product of unknown quality and let $p(\bar{z})$ be defined by

$$p(\bar{z}) = \frac{\bar{z} + Th - S\hat{p}}{T - S}.$$

The equivalence price $\hat{p}_i$ can be computed by the equation

$$\int f(z) V_i(z) dz - \hat{p}_i = V_i(z_i) - p(z_i)$$

or

$$\hat{p}_i = \int f(z) V_i(z) dz - [V_i(z_i) - p(z_i)]$$

$$= \int f(z)(a_i + b_i z - c z^2) dz - [V_i(z_i) - p(z_i)]$$

$$= a_i + b_i \bar{z} - c \bar{z}^2 - c \int f(z)(z^2 - \bar{z}^2) dz - [V_i(z_i) - p(z_i)]$$

$$= V_i(\bar{z}) - c \text{ var } (z) - [V_i(z_i) - p(z_i)]$$

$$= p(\bar{z}) - c \text{ var } (z) + [V_i(\bar{z}) - p(\bar{z})] - [V_i(z_i) - p(z_i)],$$

where var (z) is the variance of z. But, because $V_i(z) - p(z)$ is being maximized at z_i, we have

$$V_i(\bar{z}) - p(\bar{z}) = V_i(z_i) - p(z_i) - c(z_i - \bar{z})^2$$

and thus we obtain

$$\hat{p}_i = p(\bar{z}) - c \text{ var } (z) - c(z_i - \bar{z})^2.$$

The farther z_i is from $\bar{z}$, the lower is the equivalence price $\hat{p}_i$.

☐ **Equilibrium.** We are then in a position to characterize the equilibrium in this market. Consumers with a preferred quality near the average expected quality are more easily induced to buy the product of unknown quality than consumers with a preferred quality far away from the average expected quality. But this induces suppliers to produce those qualities which are far away from the average preferred quality. The qualities actually produced and therefore the density function $f(z)$ are biased towards the extremes as compared with the distribution of preferred qualities among consumers. The consumers with close to average preferences will in equilibrium buy the product of unknown quality. Its equilibrium price $\hat{p}$ will be equal to the equivalence price of the consumer who is the marginal buyer of the product of unknown quality. This marginal buyer will be determined by the relative quantities of supply of

products with known and with unknown quality, which itself will be determined by the ratio S/T.

For the particular case that the frequency distribution of the z_i is symmetric and that all consumers want to buy the product in the relevant price range (so that we can ignore the option of not buying the product at all), we can find an explicit solution for the market equilibrium. Let $g(z)$ be the frequency distribution of consumers characterized by their preferred qualities at the per unit quality premium $1/T - S$. By assumption $g(z)$ is symmetric, and the expected value $\bar{z}$ is also the median. We thus have $g(\bar{z} + w) = g(\bar{z} - w)$ for all w. We define $\hat{w}$ by the equation

$$(T - S) \int_{\bar{z}-\hat{w}}^{\bar{z}+\hat{w}} g(z)dz = S\left[\int_{-\infty}^{\bar{z}-\hat{w}} g(z)dz + \int_{\bar{z}+\hat{w}}^{\infty} g(z)dz \right] = S2 \int_{\bar{z}+\hat{w}}^{\infty} g(z)dz.$$

The points $\bar{z} - \hat{w}$ and $\bar{z} + \hat{w}$ are the locations of the marginal buyers of products of unknown quality. Under the specific assumption which we made, these marginal buyers can be determined beforehand. We then know that the ruling price $\hat{p}$ of the product with unknown quality must be equal to the equivalence price of the marginal buyer with preferred quality $\bar{z} + \hat{w}$ or $\bar{z} - \hat{w}$. The frequency distribution of the products being produced, $f(z)$, then can be computed to be

$$f(z) = 0, \quad \text{if} \quad |\bar{z} - z| \le \hat{w}$$

$$f(z) = \frac{T}{T - S} g(z), \quad \text{if} \quad |\bar{z} - z| > \hat{w}.$$

For this distribution we can compute the variance, which we call

$$\sigma^2\left(\frac{S}{T}\right)$$

to indicate that it depends on $\hat{w}$, hence on S/T. It rises with rising S/T. We can then write

$$\hat{p} = p(\bar{z}) - c\sigma^2\left(\frac{S}{T}\right) - c\hat{w}^2,$$

where

$$p(\bar{z}) = \frac{\bar{z} + Th - S\hat{p}}{T - S}.$$

These two linear equations can be transformed into the solutions

$$p(\bar{z}) = \frac{\bar{z}}{T} + h + \frac{S}{T} c\left(\sigma^2\left(\frac{S}{T}\right) + \hat{w}^2\left(\frac{S}{T}\right) \right)$$

$$\hat{p} = \frac{\bar{z}}{T} + h - \frac{T - S}{T} c\left(\sigma^2\left(\frac{S}{T}\right) + \hat{w}^2\left(\frac{S}{T}\right) \right),$$

which implies

$$p(\bar{z}) - \hat{p} = c\left(\sigma^2\left(\frac{S}{T}\right) + \hat{w}^2\left(\frac{S}{T}\right) \right),$$

indicating the size of the equilibrium quasi risk discount, i.e., the equilibrium difference in price between a product of average quality and a product of unknown quality with the same expected value in quality.

We are now in a position to discuss the allocational distortions implied by the difficulty to ascertain quality. Obviously, the extrapolation of quality assessments helps to mitigate the distortions. The proportion S/T indicates the severity of the quality assessment problem which remains after use has been made of the extrapolation principle. First, we observe that the market quality premium of $1/T - S$ per quality unit is higher than the social cost premium of quality, which is equal to $1/T$. Thus, the equilibrium quality obtained by consumers, who buy products with characteristics inferred from quality extrapolation, is lower than it ideally would be, because of the higher quality premium. This is clearly the most important conclusion. The quality premium tends to infinity as the extrapolation principle becomes less and less important, i.e., as S approaches T. The quality premium approaches the social cost premium of quality from above as the extrapolation principle provides a more and more complete solution to the quality assessment problem, i.e., as S approaches zero.

If the quality assessment problem exists and is only partially solved by the goodwill mechanism, then products of known and of unknown quality become joint products. A supplier first goes through a period when his product quality is not known; in a second period he provides products of a quality known by extrapolation. This joint product property implies a second, more subtle distortion in the allocation mechanism: the quality mix produced has a greater variance than would correspond to the ideal mix, given consumer preferences. Producers of intermediate qualities find no market (or an unnaturally small market), because consumers with intermediate quality preferences are those who most easily take advantage of the discounts with which products of unknown quality are offered.

☐ **Ramifications.** The invisible hand does not work properly in the model discussed. The incentives to provide high quality products are reduced as compared with the ideal allocation of resources. A higher quality premium is required for the production of high quality, and thus demand for quality is lower than in the ideal state. If there existed a way for the invisible hand to subsidize high quality producers and to tax low quality producers, the allocation of resources would be improved. Entry is distorted, favoring low quality entrants and hindering high quality entrants.

Are barriers to entry involved? Are owners of a goodwill position unduly favored as compared with producers of the same quality, but without being known for the quality of their products? This is clearly not the case. The goodwill premium received by high quality producers already in the market for more than S years is the very incentive which induces new entrants to produce high quality products. The entry distortion is an externality. The producers of high but unknown quality provide a positive externality, which in equilibrium will be compensated by a higher quality premium for products with known quality. It is not useful to say that entrants are at a disadvantage as compared with established firms, since they enter precisely because of the later advantages of an established firm. The earlier output of unknown quality and the later output of known quality are joint products, and the bookkeeping losses incurred in the earlier period are really investments to be recovered in the later period. On the other hand, it is reasonable to talk of a disadvantage of high quality producers *vis-à-vis* low quality producers, but this disadvantage does not make

goodwill a barrier to entry. On the contrary, without the goodwill mechanism this disadvantage would even be larger.

Today we have an advantage which Bain did not have, when he wrote his book on entry barriers. The economics of information as pioneered by Stigler (1961), Akerlof (1970), Spence (1974), and others allows us to approach the product differentiation issue in a new way. From the point of view of the theory of the lemons problem it is a mixup of cause and partial cure of an illness if one considers goodwill a barrier to entry. But this cannot be the end of the story. Goodwill is only a partial cure of the problem. Suppliers can try to invest resources into making the quality of their products known earlier or, if it is not so high, later. Substantial distortions can ensue from these signalling activities. To the extent that a market has a quality assessment problem, it is not inconceivable that intervention of an "ideal" government could improve things. Such intervention would consist of limitations on incumbent firms' freedom of action, i.e., of regulating their behavior. In this sense barriers to entry can arise out of the lemons problem. But these would be secondary barriers created as an answer to the original distortion, an externality. Goodwill as such is not a barrier to entry.

Another potential cause of entry barriers in this context could be the economies of scale properties of goodwill. A firm may acquire a good reputation while still small, and may then use this reputation to grow much larger. The setup cost of establishing a reputation may therefore not be in proportion to the eventual size of the firm. To the extent that economies of scale are a source of entry barriers, goodwill could cause an entry barrier in the form of economies of scale in acquiring goodwill. But as was shown in Section 2, economies of scale are not always a source for barriers to entry. In the model above we excluded economies of scale by allowing a maximum output of 1.

4. Conclusion

■ The examples show that the entry barriers identified by Bain are not always entry barriers as defined here. It appears to be necessary to take a very careful look at the particular circumstances before one can conclude whether or not purported barriers to entry constrain competition in any given industry. The theoretical guideline for such an analysis will have to be whether a distortion in the allocation of resources is involved and whether the situation could conceivably be improved if an "ideal" government would regulate the behavior of incumbent firms. Greater care in the use of the term, barriers to entry, seems to be required.

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