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# SUBSIDIZING THE COMPETITION

by

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## Abstract

This paper examines puzzling behavior in industries in which one firm is able to obtain a price premium and/or a dominant market share for a product which is identical to that of its rivals. It is shown that when there is learning by doing, economies of scale, network externalities, or reputational effects, the dominant firm's position may be enhanced by the presence of many weak competitors rather than a few strong ones. The dominant firm may therefore subsidize entry by giving away technical information, setting low licensing fees, or creating its own in-house competition.

## 1. Introduction[1]

A focal interest of modern game theory and industrial organization is to explain how monopolists inhibit potential competitors. Economists have however been pre-occupied with the dominant firm's strategy for obstructing the first entrant, with little consideration for its strategy with respect to subsequent potential entrants. This paper addresses the issue of how a dominant firm should behave when its market power has already been somewhat dissipated. Given that some competitors have already entered its market, does the dominant firm still have the same interest in barriers to entry? How does the dominant firm's position change as the number of entrants changes? The firm's strategy space includes more than setting price and quantity, since by sharing technology it can influence the number of competitors who enter.

Under a standard Cournot-competition model of oligopoly, the firm prefers to minimize the number of its competitors, since the fewer the market participants, the more closely the industry resembles a monopoly. However, this result seems to be in conflict

[1]I wish to thank, without implicating, Nancy Gallini, Arthur Hosios, Frank Mathewson, Ralph Winter, participants at a University of Toronto workshop, and especially Yehuda Kotowitz, who offered many insightful suggestions.

with the persistent observation that firms commonly license their proprietary technologies for very low fees, thus increasing industry size with only nominal direct compensation (Rostoker, 1983). Similarly, firms with leading positions in their industries often make in-house generic or "OEM" (original equipment manufacturer) products which compete (along with products made by other firms) against their own brandname good. The firm that competes against itself in this way not only cannibalizes the market for its high-end product, but also risks damaging its reputation if consumers discover the dual pricing strategy. What would motivate a firm to compete against itself with OEM products, or to license its technology at low cost to a potential competitor? These practices clearly increase the number of competitors faced by the firm and presumably decrease the market share of all competitors. As I show in this paper, however, when current production confers a positive externality on future profits through, for example, learning by doing or the development of a reputation, firms may sometimes wish to encourage -- and thus fragment -- their competition: that is to say, they may prefer to have many weak competitors rather than a few strong ones.

The issues addressed in this paper are nicely illuminated by the puzzling phenomenon of premium retention by pioneering drugs. After Merck's introduction of the diuretic Diuril in 1958, other firms found it easy to invent around the patent and within two years at least ten firms were marketing equivalent products and many additional firms entered soon after. But in 1971, Diuril still had a 33% share of the market, despite charging a price four times higher than major competitors and spending less per sales dollar on marketing. Warner-Lambert had similar success with its unpatented anti-anginal drug Peritrate introduced in 1952. Warner-Lambert attracted nearly 100 competitors, charged a price over five times higher than major competitors, spent less on marketing per sales dollar, and yet in 1972 still commanded a 30% share of the anti-anginal market.[2]

[2]Bond and Lean 1977 and 1979.

How could this apparent market failure have endured on such a grand scale for so long? One possibility is that there were *too many* competitors, each of which was correspondingly weak. Physicians were perhaps reluctant to try other drugs which had not been subject to as extensive testing in the marketplace and which had not had the opportunity to develop strong reputations.[3] In a market in which reputation is important and information is expensive, the dominant brand may be advantaged if its competition is fragmented. Analysis of U.S. pharmaceutical prices after patent expiry by Caves, Whinston and Hurwitz (1991) found exactly this effect: a regression of the prices of branded drugs on the number of generic entrants had a negative coefficient but the number of generics squared had a positive coefficient. Their cross-sectional analysis showed that the price decreased the most for around 20 generic entrants, and began *increasing* after that. The implication is that while firms would prefer to have no competitors at all, if they have some, they may want even more.

Firms encourage the entry of extra competitors with surprising frequency. The first type of such competition comes from leading firms in a market themselves. In the pharmaceutical industry, brand name leaders, upon expiry of their patent, often introduce one or more "in-house" generic drugs which compete against the brand name item on the same footing as other generics. For example, just as SmithKline's patent on its popular anti-ulcer drug Tagamet expired in 1994, it introduced a generic copy to compete against the other generics which had been approved by the FDA.[4] A similar strategy is used by leading firms in the computer industry: IBM has been constantly present in the computer OEM market, manufacturing machines under other brandnames which compete with its own products. It is also common to observe manufacturers permitting "parallel imports" of their goods to compete with goods sold by authorized dealers, thus cannibalizing their

[3]This effect would of course be strengthened when physicians have no personal incentive to prescribe cheaper drugs.
[4]*New York Time*s, May 11 1994, p. D5.

own market. These goods are frequently of slightly lower quality or do not carry the manufacturer's warranty. Such parallel imports also harm manufacturer-retailer relationships and generally discourage retailers from making relationship-specific investments. However, such low-priced imports may provide tighter price competition for their chief competitors. For example, in the mid-1980s, European luxury car manufacturers sold tens of thousands of cars in the U.S. through the parallel market just as the Japanese automobile manufacturers were attempting to gain a foothold in the U.S. luxury car market.[5]

A second way that incumbents encourage extra competitors is by licensing their technology at low cost, thereby subsidizing the costs of entry. One of the empirical puzzles that has been addressed in the economics of licensing is "why royalty rates are observed to be so low."[6] For example, Rostoker's 1983 survey into licensing practices in the United States found that many licenses had royalty fees as low as 0.1% of sales. The insight of this paper suggests that low royalty rates may sometimes be a subsidy to encourage entry. A particularly large-scale case of such a technical subsidy occurred in the early 1980s when IBM was planning to enter the personal computer (PC) market. A number of firms -- Apple, Tandy, and Commodore, for example -- had already established reputations for their PCs, which made them major competitors to IBM. However, IBM left its operating system in the hands of Microsoft and then *published* the complete technical specifications of its PC.[7] This open architecture facilitated competition to such an extent that a vast number of new competitors entered the clone PC market, and initially at least were more successful at competing against each other than against IBM. The strategic position of IBM's established competitors was particularly weakened by the clones. IBM apparently believed that its reputation and economies of scale would permit it

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[5]Holusha, 1985.
[6]Rockett, 1990, p.162.
[7]Heller,1994, pp.58-60.

to have a dominant position in this market despite having a technically undifferentiated product, and indeed it initially captured 80% of the corporate PC market.

Usually accommodation of entry is seen as a kind of passive resistance, an idea which is captured in the characterization of the accommodating firm as a puppy dog or fat cat in Fudenberg and Tirole (1984). This paper shows that sometimes "accommodation" can be aggressive. There are other economic models which may explain welcoming the competition, in other circumstances. Farrell and Gallini (1988) argue that second-sourcing can be an effective commitment to prevent opportunistic exploitation of buyers. Their idea is that when buyers must make some seller-specific investment, they become to some extent "locked in" to the seller, who may then be able to extract economic rents; as a result, buyers may be unwilling to enter into such contracts without some mechanism to prevent *ex post* seller opportunism. One effective mechanism to prevent such opportunism is for the seller to license its technology to another firm. Economides (1995) shows that technologies may also be given away to create an industry standard. If a market has very strong network externalities, then a firm may be able to profit by transferring its technology to competitors who increase the size of the network. My paper differs in its conditions from those in that Farrell and Gallini require that the buyer be locked-in because of some seller-specific investment, while Economides requires network externalities. Thus those papers would not explain the examples of pharmaceutical pricing and in-house generics discussed above.

This paper is also related to the economic literature on the strategic uses of licensing. Gallini (1984) and Gallini and Winter (1985) show that licensing may be used strategically to deter competitors from investing in R&D: my paper shows that licensing can be used strategically to affect the more fundamental decision of entry. Rockett (1990) showed that an incumbent firm facing patent expiry might choose to license its technology to a competitor perceived to be "weak" in order to deter entry by a stronger competitor. Eswaran (1994) generalized her result to show that an incumbent in a market threatened by entry can exploit its first-mover advantage by licensing its technology not to a potential entrant but to firms that would have remained outside the industry. The intuition for this is that in a Cournot competition framework, the incumbent can gain a larger share of a smaller industry profit by licensing extra firms for a royalty. For some parameter values, this will be profit-increasing for the incumbent. In contrast to those models, I show that it may be profitable for the incumbent to license "extra" firms even without any kind of payment from licensees. These additional firms are used like "fighting brands" to weaken other entrants.

Raising rivals' costs is the essential strategy behind subsidizing the competition in my analysis, as in Salop and Scheffman (1983), who suggest that dominant firms may establish mandatory product standards, set up exclusive dealing contracts, or increase industry wage levels (as in Williamson 1968), to the detriment of fringe firms. The key requirement for such strategies to be profitable is that they in some way enhance the cost advantage of the dominant firm. Here the method of enhancing the incumbent's advantage is to induce extra entrants into the market. I also show that the advantage need not be limited to costs.

Section 2 presents a simple model of a monopolistically competitive Cournot industry with learning by doing, in which additional firms may decrease the entrants' rate of learning and hence extend the incumbent's cost advantage. Section 3 uses a linear model and numerical simulations to demonstrate how the dominant firm can increase its profits by increasing the number of its competitors. In Section 4, I show that this analysis can be extended: while the model focuses on learning-by-doing, it may also be applied to cases with reputation, network externalities, or economies of scale in production. I then show in the context of a sequential game that the possibility of subsidizing entrants may allow the first firm into a market to exclude entrants entirely. Section 6 concludes.

## 2. The model

Learning by doing is the process through which production costs are reduced through production experience. It is well known that learning by doing introduces an intertemporal dimension to a firm's output and pricing decisions, encouraging low pricing early in the product lifecycle. This paper shows that it may also introduce an intertemporal dimension to the firm's strategy for industry structure, since subsidizing entrants' fixed costs may be used strategically to *increase* the competition's marginal costs when there is proprietary learning by doing. The model used to show this is a monopolistically competitive industry, as in Spence (1981). While Spence allowed the possibility that firms might enter at different times, he assumed no strategic action by the incumbent. This section extends his analysis to allow for this strategic behavior.

There are two time periods of interest, period 1 when some firms enter an industry and compete with the incumbent, and period 2, when they continue to compete, having gained some experience. The larger the number of entrants, the less each produces and learns in the first period, and hence the higher each one's costs are in the second period. In some cases, this learning effect will outweigh the effect of additional competition because of more firms. When this is the case, the incumbent firm may obtain a strategic advantage by subsidizing the entry of additional firms.

Industry demand in both periods is characterized by

(1) $$p = p\left(q_{It} + nq_{Et}\right)$$

where $q_{It}$ is the output of the incumbent in period $t$, $q_{Et}$ is the output of each entrant, and $n$ is the number of symmetric entrants. At the start of period 1, the incumbent firm has been operating alone in the industry for some period of time, perhaps because it had patent protection. The patent protection is about to end. The incumbent has zero fixed costs and has reached the end of its learning curve and now has "best practice" marginal cost of $c$. All entrants face some fixed costs and have constant marginal cost of production $C_1 \geq c$ in the first period and $C_2 = C_2\left(q_{E1}\right) \geq c$ where $\frac{\partial C_2}{\partial q_{E1}} < 0$ so that the more each entrant produces in the first period, the lower its costs in the second period. I assume zero spillovers in learning so that each entrant's second period costs are a function of its own first period production only.

The number of entrants is determined endogenously by solving for the sum of their first and second period profits as a function of *n* and setting this equal to fixed costs. Because firms are forward-looking, the problem is solved recursively, starting with the second period Nash equilibrium as a function of $q_{E1}$ and *n*.

In the second period the incumbent maximizes over quantity

(2) $$\max_{q_{I2}} \left[ p\left(q_{I2} + nq_{E2}\right) - c \right] q_{I2},$$

and each entrant solves the maximization

(3) $$\max_{q_{E2}} \left[ p\left(q_{I2} + q_{E2} + [n-1] q_{\bar{E}2}\right) - C_2\left(q_{E1}\right) \right] q_{E2},$$

where $q_{\bar{E}2}$ indicates the production of other entrants. The Cournot-Nash equilibrium quantities produced in the second period are functions of $n$, $C_2$, and $c$:

(4) $$q_{I2} = q_{I2}\left(n, C_2, c\right)$$

and

(5) $$q_{E2} = q_{E2}\left(n, C_2, c\right).$$

The price is derived by substituting (4) and (5) into (1) to obtain

(6) $$p_2 = p_2\left(n, C_2, c\right)$$

For the incumbent, second-period profits are therefore

(7) $$\pi_{I2} = \pi_{I2}\left(n, C_2, c\right)$$

and for each entrant, second-period profits are

(8) $$\pi_{E2} = \pi_{E2}\left(n, C_2, c\right).$$

With suitable conditions on the demand function, partial derivatives will have the usual signs:

$$\frac{\partial \pi_{I2}}{\partial n} < 0,\ \frac{\partial \pi_{I2}}{\partial C_2} > 0,\ \frac{\partial \pi_{I2}}{\partial c} < 0,\ \frac{\partial \pi_{E2}}{\partial n} < 0,\ \frac{\partial \pi_{E2}}{\partial C_2} > 0, \text{ and } \frac{\partial \pi_{E2}}{\partial c} > 0.$$

Notice that $C_2$ is a function of $q_{E1}$, which is in turn dependent on *n*. If there is no learning by doing so that $\frac{\partial C_2}{\partial q_{E1}} = 0$, then both periods 1 and 2 will be the same: the dominant firm will wish for the minimum number of competitors since $\frac{\partial \pi_{It}}{\partial n} < 0$. However, when there is learning by doing, current production reduces future costs so that $\frac{\partial C_2}{\partial q_{E1}} < 0$.

During the first period, entrants must account for the effect of first period production on second period profits. Each entrant therefore solves

(9) $$\max_{q_{E1}} \left[ p\left(q_{I1} + [n-1]q_{\bar{E}1} + q_{E1}\right) - C_1 \right] q_{E1} + \pi_{E2}\left(q_{E1}\right)$$

while the incumbent solves the one period problem

(10) $$\max_{q_{I1}} \left[ p\left(nq_{E1} + q_{I1}\right) - c \right] q_{I1}.$$

Since $\frac{\partial \pi_{E2}}{\partial q_{E1}} > 0$, the second term in (9) will cause the entering firms to produce more than if there were no learning by doing. By producing more than is myopically optimal in the first period, costs are reduced in the second period.

We can now identify two effects of the number of competitors on incumbent profits. First, there is the standard direct effect on the profits of both periods: $\frac{\partial \pi_{I1}}{\partial n} < 0$ and $\frac{\partial \pi_{I2}}{\partial n} < 0$. These effects are simply the well known ones: the larger the number of competitors, the greater the total industry production and the lower the margin of price over costs. However, there is also a second, indirect effect: $\frac{\partial \pi_{I2}}{\partial C_2} \frac{\partial C_2}{\partial q_{E1}} \frac{\partial q_{E1}}{\partial n} > 0$. This expresses the result that the higher the number of entrants in the first period, the less each one learns, and so the higher its costs are in the second period. This will have a positive effect on the dominant firm's second period profits. When the indirect, dynamic effects outweigh the direct effects, then the incumbent may wish to increase the number of entrants, by for example subsidizing their costs of entry. However, it is not possible in this very general form to qualify which effects -- direct or indirect -- will be larger. Thus we show in the following section an example with specific functional forms, in which simulations reveal that the dominant firm can profit from increasing the number of its competitors.

## 3. A Numerical Simulation

In order to provide more structure to the model, I employ in this section a linear demand and linear learning technology. Despite these restrictions, it should be remembered that the results are not specific to the linear model but can be generalized. I then present the results of numerical simulation to show that the effect of the number of entrants on incumbent profits is ambiguous. There are some ranges of parameter values in which an increase in the number of entrants enhances incumbent profits, and sometimes even industry profits.

Demand in each period is now specified by the simple linear equation

$$p(q_{It} + nq_{Et}) = a - b[q_{It} + nq_{Et}] \tag{11}$$

and the functional form for the effect of learning by doing is given the linear form :

$$C_2 = C - \alpha q_{E1} \geq c. \tag{12}$$[8]

This specification of the model makes it possible to derive some closed form results. The total effect of increasing the number of entrants on the sum of incumbent profits from periods 1 and 2 is given by:

$$\frac{d\Pi_I}{dn} = -\left\{q_{E1} + n\frac{dq_{E1}}{dn}\right\}\{p_1 - c\} - \left\{q_{E2} + n\frac{dq_{E2}}{dn}\right\}\{p_2 - c\} \tag{13}$$

where $$\frac{\partial q_{E1}}{\partial n} = [a + c - 2C]b(n+2)\left\{\frac{-32\alpha^2 - b^2(n+2)^3 - 24b(n+2)\alpha}{\left(b^2(n+2)^3 - 16\alpha^2\right)^2}\right\} < 0$$

and $$\frac{dq_{E2}}{dn} = -\frac{1}{b(n+2)^2}[a + c - 2C + 2\alpha q_{E1}] + \frac{2}{b(n+2)}\alpha\frac{dq_{E1}}{dn} < 0.$$

With $\alpha = 0$, $q_{Et} - n\dfrac{dq_{Et}}{dn} > 0$ so that without learning by doing, the incumbent would always suffer a decrease in profit from additional entrants. However, with $\alpha > 0$,

[8]Typically, studies of learning by doing use a log-linear form pioneered by Wright (1936), but for this two period model a linear technology is sufficient.

$q_{Et} - n\frac{dq_{Et}}{dn}$ may be negative, leading to indeterminacy in the sign of (13). That is to say, the indirect effect of decreased learning by doing may dominate the direct of effect of more competitors.

This linear specification of the model still does not allow a determination of when the indirect effects will predominate, if ever, and so some numerical simulations based on this linear model are presented in Table 1. Table 1, Case 1 shows the case of an industry with $a = 100$, $b = 0.5$, $c = 0$, and $C = 40$. The rate of learning $\alpha$ is set at 1 so that with three entrants, $C_2 = 13$. A higher number of entrants leads to higher second period costs for entrants, lower production, and lower profits for each entrant. Prices are higher, and incumbent production increases, leading to an increase in total incumbent profits from 3334 to 6007 when the number of entrants increases from three to seven. Without consideration of fixed costs, industry profits increase from 3820 to 6171, a surprisingly strong result.

**Table1**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | CASE 1 | | | CASE 2 | | | CASE 3 | | |
| | a | 100 | | a | 100 | | a | 100 | |
| | b | 0.5 | | b | 0.1 | | b | 0.5 | |
| | c | 0 | | c | 0 | | c | 0 | |
| | C | 40 | | C | 40 | | C | 40 | |
| | a | 1 | | a | 0.13 | | a | 0.5 | |
| | | | | | | | | | |
| | | PROFITS | | | PROFITS | | | PROFITS | |
| n | Incumb't | Entrant | Industry | Incumb't | Entrant | Industry | Incumb't | Entrant | Industry |
| 2 | | | | 25510 | 1429 | 28367 | | | |
| 3 | 3334 | 162 | 3820 | 30051 | 541 | 31674 | 6917 | 86 | 7174 |
| 4 | 4978 | 74 | 5275 | 31413 | 307 | 32641 | 6872 | 54 | 7087 |
| 5 | 5563 | 46 | 5790 | 31980 | 204 | 32998 | 6828 | 37 | 7015 |
| 6 | 5846 | 32 | 6036 | 32252 | 147 | 33132 | 6790 | 28 | 6956 |
| 7 | 6007 | 24 | 6171 | 32389 | 112 | 33170 | 6757 | 21 | 6906 |
| 8 | 6107 | 18 | 6253 | 32460 | 88 | 33164 | 6729 | 17 | 6865 |
| 9 | 6174 | 15 | 6306 | 32494 | 71 | 33137 | 6704 | 14 | 6829 |
| 10 | 6220 | 12 | 6342 | 32508 | 59 | 33099 | 6683 | 12 | 6798 |
| 11 | 6254 | 10 | 6366 | 32509 | 50 | 33058 | 6664 | 10 | 6772 |
| 12 | 6280 | 9 | 6384 | 32504 | 43 | 33016 | 6647 | 8 | 6748 |
| 13 | 6299 | 7 | 6396 | 32495 | 37 | 32975 | 6633 | 7 | 6728 |
| 14 | 6314 | 7 | 6406 | 32483 | 32 | 32936 | 6620 | 6 | 6709 |
| 15 | 6326 | 6 | 6413 | 32470 | 29 | 32898 | 6608 | 6 | 6693 |
| 16 | 6336 | 5 | 6418 | 32457 | 25 | 32862 | 6598 | 5 | 6678 |
| 17 | 6344 | 5 | 6422 | 32443 | 23 | 32829 | 6588 | 5 | 6665 |
| 18 | 6351 | 4 | 6425 | 32430 | 20 | 32798 | 6579 | 4 | 6652 |
| 19 | 6356 | 4 | 6427 | 32417 | 18 | 32768 | 6572 | 4 | 6641 |
| 20 | 6361 | 3 | 6428 | 32404 | 17 | 32740 | 6564 | 3 | 6631 |

What is the strategic role of the incumbent here? Clearly, the incumbent would prefer to have more firms in the industry. Thus it may create its own additional brands or license its technology at low cost to other firms. For example, suppose fixed costs in the industry in Case 1 are equal to 100. Then by inspection of the table, only three entrants will enter and each will make positive profits of 162 -100 = 62. The incumbent will earn profits of 3334. However, if the incumbent offers a subsidy of 80 to each entrant, then seven entrants will enter, and each will obtain profits of 24 - 100 + 80 = 4. The incumbent will in that case make profits of 6007 - (7 x 80) = 5447, over 40% higher than if not subsidy were offered. This compares with monopoly profits of 10,000, so the difference is significant.

Such results are of course sensitive to the parameters used. However, a wide variety of "reasonable"-looking parameters will yield similar outcomes. Table 1, Case 2 shows that similar results may be obtained with much lower learning parameter values. Notice that in this case, there is a limit to the number of entrants the incumbent would like in the industry, even without fixed costs, since incumbent profits are maximized with 11 entrants. Case 3 has the same parameters as Case 1, except that the rate of learning is lower, and in this case, the direct effect dominates the indirect effect. However, even in this case, the indirect, learning effect is still causing a "discount" on the price at which the incumbent would be willing to license its technology. Thus, although license fees may seem low when considering only the interaction of the licensor and the licensee, they may not be so low when the effect of the licensee on the industry as a whole is accounted for.

**Figure 1**

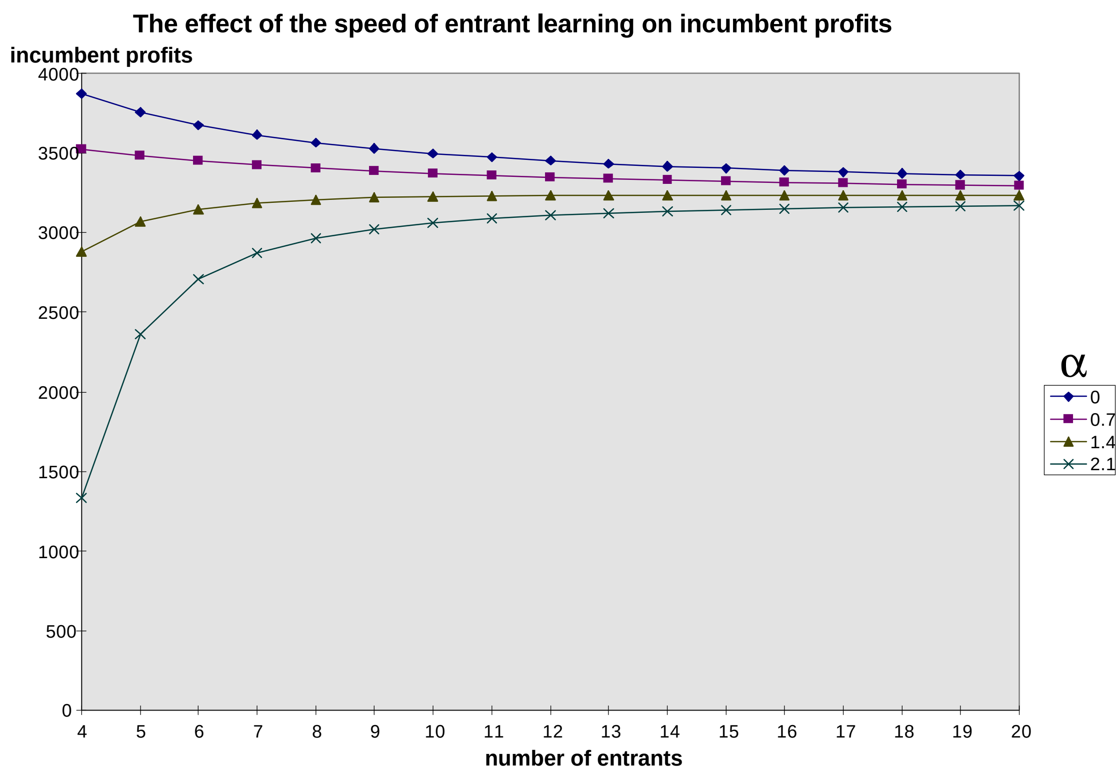


Figure 1 contrasts the effect of different learning parameters on incumbent profits (using the parameters $a=100$, $b=1$, $c=0$, and $C=40$). The highest curve is the case with zero learning, and the lowest is for $\alpha=2.1$. The distance between them is the "cost" to the incumbent of entrant learning: evidently, learning is much more important when there is a small number of entrants. Incumbent profits are also more sensitive to entrant learning when the difference between the marginal costs of the incumbent and the entrants are larger; and when the elasticity of demand is less.

## 4. Other Applications

While the discussion above has been directed to the case of learning by doing, the applications of this model are potentially much wider. There is a variety of cases in which current production creates some externality on demand or costs which have similar characteristics. I briefly discuss some possibilities.

Economies of Scale

As Spence (1981) shows, there is a formal similarity between learning curve economies and multiple markets where economies of scale cross market boundaries and certain firms cannot enter certain segments. Suppose that firm A has a domestic monopoly in its own country, perhaps because of some non-tariff barriers, and that there are economies of scale in production. Firm A thus exports into other countries but faces no competition at home. The implication of this paper is then that Firm A would prefer to face many competitors, rather than just a few, in its export markets, and might even be prepared to assist new competitors. This casts into a new light "technical assistance" from rich countries to poor ones, particularly when a condition of the assistance is no export competition.

Reputation

The learning-by-doing model can also be transformed into a model in which consumer valuation, rather than costs, is in part determined by cumulative production. In this case, it is demand rather than costs which are affected by past production as "reputation" is acquired. Formally, the firms in the model face different demand curves in the same market. For example, in the linear model, the firms' second period objective functions could be transformed so that cost difference became demand difference:

$$\max_{q_{I2}} \left( [a-c] - bq_{I2} - bnq_{E2} \right) q_{I2}, \tag{14}$$

$$\max_{q_{E2}} \left( [a-C_2] - bq_{I2} - bq_{E2} - b(n-1)q_{\overline{E}2} \right) q_{E2}. \tag{15}$$

Here entrants face a lower demand schedule than the incumbent, but the gap narrows as entrants accumulate experience. Clearly, this will have the same properties as the learning-by-doing example. It is also easy to show that similar results will hold in a model with price, rather than quantity, competition.

Consider a product, such as pharmaceuticals, whose reliability is unobservable by consumers but important to them. The product comes from a process which has some unknown constant probability of producing a faulty product, and any firm which produces a faulty product is automatically eliminated. In this case, consumers will be able to make some deductions concerning the expected quality of the product based on the number of successful trials of the product in the past. As the number of trials increases, consumers update their beliefs about the probability of a fault to accommodate this new information. I speculate that it is in part this feature of pharmaceuticals that allows the first brand in a particular market to charge more than competitors and still obtain a healthy market share. The same characterization might be appropriate for other products whose quality is *ex ante* unobservable. For example, if I am considering buying a new car, and hear from 10 people that brand X is very good, and from 2 people that brand Y is very good, then although I have no negative information about either product, I would prefer to buy brand X for the same price. Thus the dominant firm can have a significant advantage because there is more information available on it, which is in turn simply a feature of its higher cumulative sales volume. In these circumstances, the dominant firm may wish to encourage additional competitors in order to make it more difficult for all competitors to acquire reputation through sales.

Network Externalities

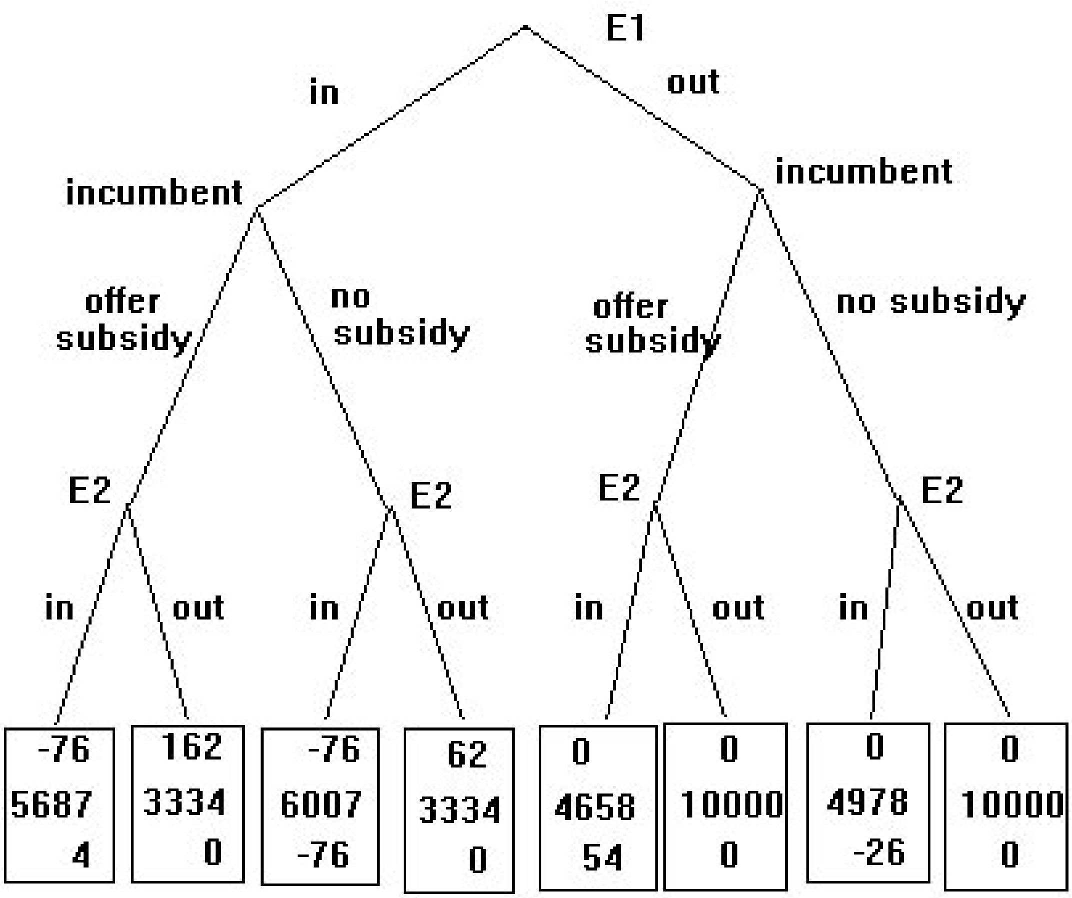
When there are network externalities in a product market, that may have the same result as reputation. As Economides (1995) shows, a firm may be willing to give away its technology when that may assist it to develop a network which consumers value. Economides' idea is that the other firms obtain a compatible technology and thus increase the size of the network. What this paper shows is that even if the technology is not compatible, and each firm thus comprises its own network, the presence of network externalities may cause the firm to license some technology. If the incumbent is in a leadership position, then it may be able to improve the *relative* position of its network by fragmenting the competition. For example, a consortium of banks with an ATM network might be willing to give its technology to a small banking competitor but not to a large rival consortium.

One of the most common proprietary network externalities is fashion, since a certain brand of apparel is often valued in proportion to the number of other people wearing it. Thus makers of the leading designer jeans brand may produce their own in-house rival brands in order to make it more difficult for other brands to challenge their dominance.

## 5. A sequential game

The implication of the analysis above is that in industries where learning by doing, economies of scale in production, reputation, or network externalities are important, we should sometimes expect to observe firms offering subsidies (or low license fees) to entrants. Further analysis, however, reveals that if fixed costs of entry cannot be recovered, the mere potential for incumbent opportunism may be sufficient to deter entry. In that case, no subsidy would in fact be observed, although the possibility of it would determine industry structure. The problem is that no firm may be willing to enter if the incumbent may subsequently induce additional firms to enter.

**Figure 2**




E1 represents the first three entrants, and E2 the four subsequent entrants.
Payoffs are listed for E1, the incumbent, and then E2.
In the subgame perfect equilibrium, the incumbent retains a monopoly.

Consider the following game, presented in extensive form in Figure 2. The payoffs are based on the parameters given in Table 1 Case 1. The structure of the game is as follows. At the start of the game, the incumbent already has the minimum marginal cost of zero, and potential entrants have marginal cost of 40 in the first period and $40-\frac{1}{2}q_{E1}$ in the second period. First three entrants decide whether to enter or not; entering requires a fixed, unrecoverable investment of 100. Second, the incumbent observes the investment of the entrants, and decides whether to offer a subsidy of 80 to four additional entrants, conditional on the entry of the first three firms. Finally, the four additional entrants decide whether to enter or not. Then periods 1 and 2 are played out in a Cournot manner. The first set of entrants will make profits only if the second set stays out; the second set of entrants will make profits only if they receive a subsidy, and the incumbent's profits are higher with all seven entrants than with three. The equilibrium of this game is for the second set of entrants to enter conditional on the subsidy; the incumbent offers the subsidy conditional on entry of the first set of entrants; and the first set of entrants stay out of the market. Thus no firms are willing to enter at all and the incumbent obtains monopoly profits. The strategy followed by the incumbent is akin to "destructive competition," since any firm entering this industry without the benefit of a subsidy can expect an equilibrium in which price is below the level at which fixed costs can be met. In contrast to many other models of entry deterrence, such as the limit-pricing model, this equilibrium is subgame-perfect. The potential for opportunism means that even if dominant firms are willing to subsidize their competitors, it might not be observed, despite having an important impact on industry structure and prices. Ironically, the tool used to deter entry -- subsidies of competitors' fixed costs -- *appears* to be anything but anti-competitive!

**6. Concluding Remarks**

This paper has shown that in some circumstances an incumbent may preserve its advantage in an dynamic environment in which a larger number of competitors is a hindrance on each entrant's performance. Preserving the incumbent's advantage is then achieved by encouraging additional firms or brands to enter the market. The strategy behind this is a refinement of the well-known *dictum*: "My *worst* enemy's enemy is my friend." By subsidizing extra entrants, the incumbent may increase the distance between it and its closest competitor. The same approach is widely used in other strategic situations. For example, a country may keep its enemies weak by ensuring that they have military parity with each other. This appears to have been the strategy of the U.S. in supplying both Iraq and Iran during their war. A similar strategy may also be used by a political or business leader who fears having a close rival. Consider the CEO of a multi-divisional firm with several close rivals for the leadership of the firm. If the divisions are large, then the rival candidates have the opportunity to prove their ability to manage a large firm; by contrast, if the CEO divides the firm so that each division is small, then it will be difficult for a rival to learn how to manage a large company or to demonstrate her competence in doing so. Political leaders face an analogous dilemma: a prime minister with a small cabinet increases the visibility and the importance of the portfolio of each member, allowing other potential leadership candidates to earn more credibility. However, by increasing the size of the cabinet, the leader provides a "subsidy" to the weakest rivals, which may enable them in time to become serious rivals. There is a trade-off between the number of rivals and the strength of the closest ones, analogous to the direct and indirect effects of increasing the number of entrants discussed in Section 2.[9]

The surprising result is that the dominant actor can make its field *less competitive* through the addition of *more competitors*. Indeed, in the linear example of Section 3, when the incumbent firm encourages more entrants, the Herfindahl index of concentration increases, since though the entrants become more numerous they also become smaller. As a rule, the margin of price over cost falls with the number of competitors; however, in some industries market share will also affect the *relative* costs and demand. The incumbent will take both of these effects into consideration when developing a strategy to respond to entry. A testable implication of this model is that in industries in which learning by doing and reputation are important, we should observe that licenses for small competitors are cheaper than those for large competitors, conditioning for firm production levels.

[9]Note that this strategy is different from the commonplace observation that some (poor) leaders surround themselves with weak or incompetent advisors, displacing competent, but threatening advisors. That would be analogous to Rockett's (1990) paper on choosing the competition.

How can we identify when a firm's licensing (or potential licencing) of technology is motivated by the monopolistic strategy discussed in this paper? Necessary conditions are first that the firm be dominant in its industry; second, that there be some identifiable externality from the firm's production; and third, that the licensee is also competing with the licensor's competitor. When these conditions, at least, are met, the licensing may well not be as benign as its appearance.

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