# The Fat-Cat Effect, the Puppy-Dog Ploy, and the Lean and Hungry Look

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*By* Drew Fudenberg and Jean Tirole*

Let me have about me men that are fat.... *Julius Caesar*, Act 1, Sc. 2

The idea that strategic considerations may provide firms an incentive to "overinvest" in "capital" to deter the entry or expansion of rivals is by now well understood. However, in some circumstances, increased investment may be a strategic handicap, because it may reduce the incentive to respond aggressively to competitors. In such cases, firms may instead choose to maintain a "lean and hungry look," thus avoiding the "fat-cat effect." We illustrate these effects with models of investment in advertising and in *R&D*. We also provide a taxonomy of the factors which tend to favor over- and underinvestment, both to deter entry and to accommodate it. Such a classification, of course, requires a notion of what it means to overinvest; that is, we must provide a benchmark for comparison. If entry is deterred, we use a monopolist's investment as the basis for comparison. For the case of entry accommodation, we compare the incumbent's investment to that in a "precommitment" or "open-loop" equilibrium, in which the incumbent takes the entrant's actions as given and does not try to influence them through its choice of preentry investment. We flesh out the taxonomy with several additional examples.

Our advertising model was inspired by Richard Schmalensee's (1982) paper, whose results foreshadow ours. We provide an example in which an established firm will underinvest in advertising if it chooses to deter entry, because by lowering its stock of "goodwill" it establishes a credible threat to cut prices in the event of entry. Conversely, if the established firm chooses to allow entry, it will advertise heavily and become a fat cat in order to soften the entrant's pricing behavior. Thus the strategic incentives for investment depend on whether or not the incumbent chooses to deter entry. This contrasts with the previous work on strategic investment in cost-reducing machinery (Michael Spence, 1977, 1979; Avinash Dixit, 1979; our 1983a article) and in "learning by doing" (Spence, 1981; our 1983c article) in which the strategic incentives always encourage the incumbent to overaccumulate. Our *R&D* model builds on Jennifer Reinganum's (1983) observation that the "Arrow effect" (Kenneth Arrow, 1962) of an incumbent monopolist's reduced incentive to do *R&D* is robust to the threat of entry so long as the *R&D* technology is stochastic.

Our examples show that the key factors in strategic investment are whether investment makes the incumbent more or less "tough" in the post-entry game, and how the entrant reacts to tougher play by the incumbent. These two factors are the basis of our taxonomy. Jeremy Bulow et al. (1983) have independently noted the importance of the entrant's reaction. Their paper overlaps a good deal with ours.

## I. Advertising and Goodwill

In our goodwill model, a customer can buy from a firm only if he is aware of its existence. To inform consumers, firms place ads in newspapers. An ad that is read informs the customer of the existence of the firm and also gives the firm's price. In the first period, only the incumbent is in the market; in the second period the entrant may

enter. The crucial assumption is that some of the customers who received an ad in the first period do not bother to read the ads in the second period, and therefore buy only from the incumbent. This captive market for the incumbent represents the incumbent's accumulation of goodwill. One could derive such captivity from a model in which rational consumers possess imperfect information about product quality, as in Schmalensee (1982), or from a model in which customers must sink firm-specific costs in learning how to consume the product.

There are two firms, an incumbent and an entrant, and a unit population of *ex ante* identical consumers. If a consumer is aware of both firms, and the incumbent charges $x_1$, and the entrant charges $x_2$, the consumer's demands for the two goods are $D^1(x_1, x_2)$ and $D^2(x_1, x_2)$, respectively. If a consumer is only aware of the incumbent (entrant), his demand is $D^1(x_1, \infty)$ and $(D^2(\infty, x_2))$. The (net of variable costs) revenue an informed consumer brings the incumbent is $R^1(x_1, x_2)$ or $R^1(x_1, \infty)$ depending on whether the consumer also knows about the entrant or not, and similarly for the entrant. We'll assume that the revenues are differentiable, quasi concave in own-prices, and they, as well as the marginal revenue, increase with the competitor's price (these are standard assumptions for price competition with differentiated goods).

To inform consumers, the firms put ads in the newspapers. An ad that is read makes the customer aware of the product and gives the price. The cost of reaching a fraction $K$ of the population in the first period is $A(K)$, where $A(K)$ is convex for strictly positive levels of advertising, and $A(1) = \infty$.[1] There are two periods, $t = 1, 2$. In the first period, only the incumbent is in the market. It advertises $K_1$, charges the monopoly price, and makes profits $K^1 \cdot R^m$. In the second period the entrant may enter.

To further simplify, we assume that all active firms will choose to cover the remaining market in the second period at cost $A_2$.

[1] See Gerard Butters (1977), and Gene Grossman and Carl Shapiro (1984) for examples of advertising technologies.

Then assuming entry, the profits of the two firms, $\Pi^1$ and $\Pi^2$, can be written

$$(1) \quad \Pi^1 = \left[ -A(K_1) + K_1 R^m \right]$$
$$+ \delta \left[ K_1 R^1(x_1, \infty) \right.$$
$$+ (1 - K_1) R^1(x_1, x_2) - A_2 \right]$$
$$\Pi^2 = \delta \left[ (1 - K_1) R^2(x_1, x_2) - A_2 \right],$$

where $\delta$ is the common discount factor.

In the second period, the firms simultaneously choose prices. Assuming that a Nash equilibrium for this second-stage game exists and is characterized by the first-order conditions, we have

$$(2) \quad K_1 R_1^1(x_1^*, \infty)$$
$$+ (1 - K_1) R_1^1(x_1^*, x_2^*) = 0;$$
$$(3) \quad R_2^2(x_1^*, x_2^*) = 0,$$

where $R_j^i \equiv \partial R^i(x_1, x_2)/\partial x_j$, and $x_i^*$ is the equilibrium value of $x_i$ as a function of $K_1$.

From equation (2), and the assumption that $R_{ij}^i > 0$, we see that

$$R_1^1(x_1^*, \infty) > 0 > R_1^1(x_1^*, x_2^*).$$

The incumbent would like to increase its price for its captive customers, and reduce it where there is competition; but price discrimination has been assumed impossible.

Differentiating the first-order conditions, and using $R_{ij}^i > 0$, we have

$$(4) \quad \partial x_1^*/\partial K_1 > 0, \qquad \partial x_1^*/\partial x_2^* > 0,$$
$$\partial x_2^*/\partial K_1 = 0, \qquad \partial x_2^*/\partial x_1^* > 0.$$

The heart of the fat-cat effect is that $\partial x_1^*/\partial K_1 > 0$. As the incumbent's goodwill increases, it becomes more reluctant to match the entrant's price. The large captive market makes the incumbent a pacifistic "fat cat." This suggests that if entry is going to occur, the incumbent has an incentive to increase $K_1$ to "soften" the second-period equilibrium.

To formalize this intuition we first must sign the *total* derivative $dx_1^*/dK_1$. While one would expect increasing $K_1$ to increase the incumbent's equilibrium price, this is only true if firm 1's second-period reaction curve is steeper than firm 2's. This will be true if $R_{11}^1 \cdot R_{22}^2 > R_{12}^1 \cdot R_{21}^2$. If $dx_1^*/dK_1$ were negative the model would not exhibit the fat-cat effect.

Now we compare the incumbent's choice of $K_1$ in the open-loop and perfect equilibria. In the former, the incumbent takes $x_2^*$ as given, and thus ignores the possibility of strategic investment. Setting $\partial \pi^1/\partial K_1 = 0$ in (1), we have

$$(5) \qquad R^m + \delta \big( R^1(x_1^*, \infty) \\ - R^1(x_1^*, x_2^*) \big) = A'(K_1).$$

In a perfect equilibrium, the incumbent realizes that $x_2^*$ depends on $K_1$, giving first-order conditions

$$(6) \quad R^m + \delta \big( R^1(x_1^*, \infty) - R^1(x_1^*, x_2^*) \\ + (1 - K_1) R_2^1 (dx_2^*/dK_1) \big) = A'(K_1).$$

As $R_2^1$ and $dx_2^*/dK_1$ are positive, for a fixed $K_1$ the left-hand side of (6) exceeds that of (5), so if the second-order condition corresponding to (6) is satisfied, its solution exceeds that of (5).

The fat-cat effect suggests a corollary, that the incumbent should underinvest and maintain a "lean and hungry look" to deter entry. However, while the "price effect" of increasing $K_1$ encourages entry, the "direct effect" of reducing the entrant's market goes the other way. To see this, note that

$$(7) \quad \Pi_K^2 = \delta \big[ (1 - K_1) R_1^2 (dx_1^*/dK_1) - R^2 \big].$$

The first term in the right-hand side of (7) is the strategic effect of $K_1$ on the second-period price, the second is the direct effect. One can find plausible examples of demand and advertising functions such that the indirect effect dominates. This is the case, for example, for goods which are differentiated by their location on the unit interval with linear "transportation" costs, if first-period advertising is sufficiently expensive that the incumbent's equilibrium share of the informed consumers is positive. In this case, entry deterrence requires underinvestment.

## II. Technological Competition

We now develop a simple model of investment in $R \& D$ to illustrate the lean and hungry look, building on the work of Arrow and Reinganum. In the first period, the incumbent, firm 1, spends $K_1$ on capital, and then has constant average cost $\bar{c}(K_1)$. The incumbent receives the monopoly profit $V^m(\bar{c}(K_1))$ in period 1. In the second period, both the incumbent and firm 2 may do $R \& D$ on a new technology which allows constant average cost $c$. If one firm develops the innovation, it receives the monopoly value $V^m(c)$. Thus the innovation is "large" or "drastic" in Arrow's sense. If both firms develop the innovation, their profit is zero. If neither firm succeeds, then the incumbent again receives $V^m(\bar{c})$. The second-period $R \& D$ technology is stochastic. If firm $i$ spends $x_i$ on $R \& D$, it obtains the new technology with probability $\mu_i(x_i)$. We assume $\mu_i'(0) = \infty$, $\mu_i' > 0$, $\mu_i'' < 0$. The total payoffs from period 2 on are

$$(9) \quad \Pi^1 = \mu_1(1 - \mu_2) V^m(c) \\ + (1 - \mu_1)(1 - \mu_2) V^m(\bar{c}) - x_1,$$

$$\Pi^2 = \mu_2(1 - \mu_1) V^m(c) - x_2.$$

The first-order conditions for a Nash equilibrium are

$$(10) \quad \mu_1'[V^m(c) - V^m(\bar{c})](1 - \mu_2) = 1,$$

$$\mu_2' V^m(c)(1 - \mu_1) = 1.$$

We see that since the incumbent's gain is only the difference in the monopoly profits, it has less incentive to innovate than the entrant. This is the Arrow effect.[2] We have

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[2] For large innovations, the monopoly price with the new technology is less than the average cost of the old one. Richard Gilbert and David Newbery (1982) showed

derived it here in a model with each firm's chance of succeeding independent of the other's, so that we have had to allow a nonzero probability of a tie. Reinganum's model avoids ties, because the possibilities of "success" (obtaining the patent) are not independent.

Because $\mu'_i > 0$ and $\mu''_i < 0$, the reaction curves in (10) slope downward—the more one firm spends, the less the other wishes to. Since increasing $K_1$ decreases the incumbent's regain from the innovator's we expect that the strategic incentive is to reduce $K_1$ to play more aggressively in period 2. As in our last example, this is only true if the reaction curves are "stable," which in this case requires $\mu''_1 \mu''_2 (1 - \mu_1)(1 - \mu_2) > (\mu'_1 \mu'_2)^2$. This is true for example for $\mu_i(x) = \max(1, bx^{1/2})$, with $b$ small. We conclude that to accommodate entry the incumbent has a strategic incentive to underinvest. Because $K_1$ has no direct effect on $\Pi^2$, we can also say that to deter entry the incumbent has an incentive to underinvest.[3]

## III. Taxonomy and Conclusion

In the goodwill model the incumbent could underinvest to deter entry, while in the $R \& D$ model the strategic incentives always favored underinvestment. To relate these results to previous work, we next present an informal taxonomy of pre-entry strategic investment by an incumbent. In many cases, one might expect both "investment" and "production" decisions to be made post-entry. We have restricted attention to a single post-entry variable for simplicity. We should point out

that this involves some loss of generality. Strategic underinvestment requires that the incumbent not be able to invest after entry, or more generally that pre- and post-entry investments are imperfectly substitutable. This was the case in both of our examples. However, if investment is in productive machinery and capital costs are linear and constant over time, then underinvestment would be ineffective, as the incumbent's post-entry investment would make up any previous restraint.

Before presenting the taxonomy, it should be acknowledged that since Schmalensee's (1983) article, several authors have independently noticed the possibility of underinvestment. J. Baldani (1983) studies the conditions leading to underinvestment in advertising. Bulow et al. present a careful treatment of two-stage games in which either production or investment takes place in the first period, with production in the second, and costs need not be separable across periods. They focus on cost minimization as the benchmark for over- and underinvestment. The starting point for the Bulow et al. paper was the observation that a firm might choose not to enter an apparently profitable market due to strategic spillovers on other product lines. This point is developed in more detail in K. Judd (1983).

Our taxonomy classifies market according to the signs of the incentives for strategic investments. Because only the incumbent has a strategic incentive, given concavity, we can unambiguously say whether the incumbent will over- or underinvest to accommodate entry (compared to the open-loop equilibrium).[4] We continue to denote the incumbent's first-period choice $K_1$, the post-entry decisions $x_1$ and $x_2$, and the payoffs $\Pi^1$ and $\Pi^2$. For entry deterrence there are

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that for "small" innovations, because the sum of the duopoly profits is (typically) less than $\Pi'''(c)$, the incumbent loses more than the entrant gains if the entrant obtains the patent. With a deterministic $R\&D$ technology, the incumbent's incentive to innovate thus exceeds the entrant's, because the incumbent's current patent is certain to be superceded and thus the current profits are not "sacrificed" by the incumbent's $R\&D$. Reinganum showed that with stochastic $R\&D$ and a small innovation, either effect can dominate. In her $R\&D$ model the reaction curves slope up.

[3] For small innovations the direct effect goes the other way.

[4] This does not generalize to the case in which both firms make strategic decisions. In our paper on learning by doing (1983c), we give an example in which one firm's first-period output declined in moving from the precommitment to the perfect equilibrium. The problem is that if, as expected, firm 1's output increases when it plays strategically, firm 2's strategic incentive to increase output can be outweighed by its response to firm 1's change.

two effects, as we noted before: the "direct effect" $\partial \Pi^2 / \partial K_1$, and the "strategic effect" $\partial \Pi^2 / \partial x_1^* \cdot \partial x_1^* / \partial K_1$. We saw in the goodwill case that these two effects had opposite signs, and so the overall incentives were ambiguous. In all the rest of our examples, these two effects have the same sign.

In Table 1, first the entry-accommodating strategy and then the entry-deterring one is given. The fat-cat strategy is overinvestment that accommodates entry by committing the incumbent to play less aggressively postentry. The lean and hungry strategy is underinvestment to be tougher. The top dog strategy is overinvestment to be tough; this is the familiar result of Spence and Dixit.

Last, the puppy-dog strategy is *underinvestment* that accommodates entry by turning the incumbent into a small, friendly, nonaggressive puppy dog. This strategy is desirable if investment makes the incumbent tougher, and the second-period reaction curves slope up.

One final caveat: the classification in Table 1 depends as previously on the second-period Nash equilibria being "stable," so that changing $K_1$ has the intuitive effect on $x_2^*$.

Our goodwill model is an example of Case I: goodwill makes the incumbent soft, and the second-period reaction curves slope up. The $R\&D$ model illustrates Case II. Case III is the "classic" case for investing in productive machinery and "learning by doing" (Spence, 1981; our paper, 1983c) with quantity competition. Case IV results from either of these models with price competition (Bulow et al.; our paper, 1983b; Judith Gelman and Steven Salop, 1983). A more novel example of the puppy-dog ploy arises in the P. Milgrom and J. Roberts (1982) model of limit pricing under incomplete information, if we remove their assumption that the established firm's cost is revealed once the entrant decides to enter, and replace quantity with price as the strategic variable. To accommodate entry, the incumbent then prefers the entrant to believe that the incumbent's costs are relatively high.

We conclude with two warnings. First, one key ingredient of our taxonomy is the slope of the second-period reaction curves. In many

TABLE 1

| Slope of Reaction Curves | Investment Makes Incumbent: | |
|---|---|---|
| | Tough | Soft |
| Upward | Case IV | Case I |
| | A: Puppy Dog<br>D: Top Dog | A: Fat Cat<br>D: Lean and Hungry |
| Downward | Case III | Case II |
| | A: Top Dog<br>A: Top Dog | A: Lean and Hungry<br>A: Lean and Hungry |

*Note:* $A$ = Accommodate entry; $D$ = Deter entry.

of our examples, downward slopes correspond to quantity competition and upward slopes to competition in prices.[5] These examples are potentially misleading. We do not intend to revive the Cournot vs. Bertrand argument. As David Kreps and José Scheinkman (1983) have shown, "Quantity Precommitment and Bertrand Competition Yield Cournot Outcomes." Thus, "price competition" and "quantity competition" should not be interpreted as referring to the variable chosen by firms in the second stage, but rather as two different reduced forms for the determination of both prices and outputs. Second, our restriction to a single post-entry stage eliminates many important strategic interactions. As our 1983a paper shows, such interactions may reverse the over- or underinvestment results of two-stage models.

[5]Bulow et al. point out that while these are the "normal" cases, it is possible, for example, for reaction curves to slope up in quantity competition.

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