Advertising, Market Structure,
and Innovation

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1. Introduction

Two classic economic treatises written in the twentieth century have challenged the meaning of market competition and have questioned the relevance of its stationary equilibrium state. In Individualism and Economic Order, Friedrich von Hayek responded to Oskar Lange's case for socialism by arguing that the price system's primary benefit rests not in its allocative efficiency (which Lange's planning board might have secured as well) but rather in its ability to transmit information, assimilate changes in economic conditions, and register people's expectations about the future. In Capitalism, Socialism, and Democracy, Joseph A. Schumpeter suggested that the ultimate concern of an economic system should be the economy's rate of technological advance and innovation; the profit incentives needed for innovation arose from the very market imperfections which presumably were absent from pure competition. These two classics have served as the intellectual foundations for some of the very innovative work which has emerged in microtheory in the past thirty years.

Advertising represents a particular class of information that is transmitted between producer and consumer in the market. The benefit of advertising and the potential for its abuse arises

because consumers lack information about all products and their respective attributes. Many economists have examined the relationship betwen advertising, market structure, and social welfare (e.g., Telser, P. Nelson , Schmalensee (a), Dixit and Norman, Grossman and Shapiro); these articles have concentrated on a product market with a stationary production technology and unchanging, though perhaps different, products. Economic arguments have considered whether the benefits of the information which advertising provides adequately balance its anticompetitive potential, the social costs of misinformation, and the waste created when market rivals engage in high-priced advertising wars.

One (to my knowledge) unexplored area involving advertising, competition, and social welfare involves technological change and product innovation; this gap is somewhat surprising. For if market information is indeed imperfect, then the greatest problems would reside where product attributes have yet to emerge; i.e., where products are in the process of development. Do advertising, market power, and R&D interact beneficially or not?

In a somewhat Schumpeterian vein, Nicholas Kaldor wrote:

> This is, in my view, the real issue involved in examining the economic effects of advertising, in comparison with which other aspects of the problem are relatively insignificant. That advertising promotes the concentration of economic power cannot reasonably be doubted ... A wide range of manufactured consumers' goods ... are now supplied through [modern oligopolies where a few firms control the vast bulk of the market]. It would be idle to ascribe the whole of this change to the influence of advertising ... but advertising was an

> important contributing factor, in certain cases perhaps the dominant one. Has it, on balance, enhanced economic welfare?

While I would not wish to term other aspects of the problem "relatively insignificant", I would agree with Kaldor (and Galbraith for that matter) that relevant discussion of markets in the twentieth century should consider market power, technological innovation, and advertising.

This paper attempts to examine some fundamental synergies between advertising, market structure, R&D, and society's basic ability to provide and transmit information. Most unsettling is a to-be-demonstrated agnosticism regarding "Kaldorian" competition. Smith and Schumpeter regarded the competitive process as basically beneficial if not optimal; modern economic theory tends to view technological competition as beneficial though probably not optimal. We now shall examine circumstances where the driving engines of modern technological competition -- R&D and advertising -- produce more social harm than good; furthermore, advertising can serve as a necessary contributant to the adoption of a harmful innovation. (I shall adopt the following distinction between excessive and harmful; excessive will refer to a quantity which is superoptimal but which, on balance, provides net social benefits. Harmful will refer to an event which presents a net social loss.) By contrast, situations will emerge where advertising serves as an essential ingredient in providing the incentive sufficient for a beneficial innovation. Furthermore, in the presence of advertising,

presumably salubrious events -- such as lower entry barriers, more consumer receptiveness to and easier transmission of accurate information, and economies in the production of basic knowledge -- will be shown, at times, to be undesirable.

2. Steady-State Equilibria

In this section, assume initially that two firms constitute the sellers' side of the market. At time 0, each sells one product; the products are identical. Firm i has fixed costs of 0 and marginal costs of c_i. At time 0, assume that $c_1 = c_2 = c$. Each firm is a Cournot strategist.

For simplicity, assume three categories of consumers: those who are aware of neither firm, those who are aware of only firm 1, and those who are aware of only firm 2. For ease but without loss of generality, no one is aware of both products. Write the respective proportions of consumers in each of these categories as a_0, a_1, and a_2; assume $a_1 = a_2 = a = (1 - a_0)/2$.

In every time period, n consumers enter an age-group which would consider buying the product. Once he ages beyond the active age-group, a consumer no longer is interested in the product. The number of consumers in the active vintage remains fixed over time.

Each consumer in the active vintage who is aware of a firm will purchase at most one unit of the product; this is a familiar assumption in imperfect information theory (see Salop and Stiglitz, Schmalensee(b), Shapiro). Specifically, a consumer will purchase a unit if its price is below his

reservation price q; assume that consumer reservation prices are uniformly distributed between (lower limit) s and (upper limit) t with frequency $f(q) = 1/(t - s)$ and distribution $F(q) = (q - s)/(t - s)$. Without advertising, the number of customers n_i who patronize firm i is then (remember that we have assumed that $a_1 = a_2 = a$):

2.1) $n_i = a_i n[1 - F(p_i)] = an(t - p_i)/(t - s)$

where:

n = total number of possible customers

Profits for firm i are then:

2.2) $\Pi_i = (p_i - c_i)n_i$

Without advertising, the demands of the two firms are independent of one another (since we have assumed that no consumer is aware of both); consequently, Cournot-Nash equilibrium prices are also Stackelberg and joint profit-maximizing. Profit-maximizing prices must satisfy first-order conditions for a local maximum, which are obtained by differentiating eq. 2.2 with respect to p_i for each firm i:

2.3) $\partial\Pi_i/\partial p_i = (p_i - c)(\partial n_i/\partial p_i) + n_i = 0$

or

2.4) $p_i = (t + c)/2$

Eq. 2.4 follows from eq. 2.1 and some basic algebra.

We now introduce advertising into the model. Temporarily assume no word-of-mouth between customers. Reach r_i is defined as the percentage of the population that has learned, through advertising, of firm i's product (see Grossman and Shapiro); r_i depends upon firm i's number of advertising messages A_i.

Make the following assumptions. One received ad is sufficient to inform a customer; all additional ads that a customer receives are redundant and do not affect his loyalties. Firms cannot target ads only to non-customers. Also, $dA/dr > 0$ and $d^2A/dr^2 > 0$ (these two assumptions are quite reasonable and Grossman and Shapiro provide a believable example of an advertising technology that conforms to both). Finally, any consumer who is aware of two firms chooses firm i with probabilities b_{ij} where $b_{ij} = 1$ if product i represents a better buy (i.e., lower price or better quality), $b_{ij} = 0$ if product j represents a better buy, and $b_{ij} = 1/2$ if the two products are equally good.

Of firm i's initial endowment of customers $a_i n$, $a_i b_{ji} r_j n$ will switch to firm j. However, firm i will be able to attract $a_j b_{ij} r_i n$ from its rival. Finally, some advertisements will reach previously unaware customers $a_0 n$; if firm j would not advertise, firm i would get $a_0 r_i n$ of these. With advertising by firm j, firm i gets $a_0 r_i [1 - r_j(1 - b_{ij})]n$.

Based on the above paragraph, the number of customers served by firm i can then be expressed:

2.5) $n_i = b_i n[1 - F(p_i)]$

where:

$$b_i = a_i(1 - b_{ji}r_j) + r_i d_i = a(1 - b_{ji}r_j) + r_i d_i$$

$$d_i = a_j b_{ij} + a_0[1 - r_j(1 - b_{ij})] = ab_{ij} + a_0[1 - r_j(1 - b_{ij})]$$

Firm profits are:

2.6) $$\pi_i = (p_i - c)n_i - A(r_i)$$

$$= (p_i - c)b_i n[1 - F(p_i)] - A(r_i)$$

Since producer demands are now interdependent, firms can compete with one another by lowering prices. If the two firms were to price identically, one could slightly undercut the other, advertise its discount, and attract converts from its higher-priced rival. Cournot-Nash equilibrium will occur where the additional profits from new converts cannot offset the losses which result when prices to existing customers are lowered. In Cournot-Nash equilibrium, $b_{12} = b_{21} = 1/2$ and $p_1 = p_2 = p^*$. Differentiating eq. 2.6 with respect to r_i, each firm i would secure a reach of r^* where:

2.7) $$[a/2 + a_0(1 - r^*/2)]n(p^* - c)[1 - F(p^*)] - A_r = 0$$

In duopolistic Cournot-Nash competition, advertising can increase consumer awareness and, as a result, enhance competition and lower prices. Even if the two products were identical and each customer were aware of at least one firm prior to

advertising ($a_0 = 0$), advertising could still be net socially beneficial should market prices fall sufficiently from their pre-advertising levels to offset the costs of additional advertising. Of course, this is not always the case; advertising can be profitable to each competitor but socially excessive or harmful nonetheless. The final outcome would depend on the nature of the advertising technology (i.e., how costly it is to obtain a high value of r) and how far product prices would drop in Cournot-Nash equilibrium.

3. Number of Firms and Entry

In order to explore the effects of changing the number of firms in the market, we shall develop the monopolistic case and compare it with duopolistic equilibrium.

If firm i were a monopoly, it would set price using eq. 2.5 and set r_m:

$$3.1) \quad a_0 n(p - c)[1 - F(p)] - A_r = 0$$

If a_0 were sufficiently large, the monopoly could advertise more than each duopolist in eq. 2.7. Furthermore, the monopoly's reach r_m could exceed the reach of both duopolists combined ($r_i + r_j - r_i r_j$); this would depend upon the nature of the advertising technology -- i.e., how sensitive r is to changes in A_r. If the monopoly does indeed provide more information to the economy (i.e., $r_m > r_i + r_j - r_i r_j$ the additional consumer surplus which results from this larger reach could exceed the reduction in

consumer surplus which results from its higher price. Consequently, a monopoly could be socially preferable to a more competitive market even if its prices are higher.

The monopoly can be socially desirable in another case as well. If a_0 is small, the monopoly might advertise less than two duopolists. Although duopolists will charge lower prices than the monopolist, the additional benefit to consumers might not offset the social costs of the advertising. In such a case, a monopolistic market is again socially preferable.

If the market were monopolistic, a potential rival could still find entry profitable; such entry could nonetheless be socially harmful (On socially harmful entry in other contexts, see Spence.) There is then no assurance that the market provides the correct economic signals for entry.

If the monopolist were to adopt limit pricing strategies to discourage entry, it will lower price and will advertise less. Instead of advertising functioning as a barrier to entry, the threat of entry now serves as a barrier to advertising. This could be socially beneficial or undesirable.

This discussion exemplifies more general truths. Increases in the number of firms may or may not be in the public interest. Although Cournot-Nash equilibrium prices will drop, each firm might advertise less; this might not be socially desirable. Alternatively, having more firms in the market may result in more advertising, the social costs of which could exceed the benefits that consumers enjoy from lower prices. Furthermore, entry in any sized market -- or even its possibility -- is not necessarily

socially beneficial.

4. Cybernetic Considerations

The size of A_r depends not only upon the costs of advertising A but also upon people's ability to receive, process, and pass along additional information. For example, if consumers required hearing or seeing an advertisement of a particular product more than once before "tuning in" to its message (i.e., a threshold effect), the implicit costs of "reaching" a consumer via advertising would increase; A_r would then increase. Furthermore, if information were passed along more readily between consumers by word-of-mouth, any one advertisement could effectively reach more people; consequently, A_r would fall.

If the "marginal cost of reach" A_r increases (decreases), each firm's reach r will decrease (increase). If A_r rises and r decreases, the number of advertising messages and the total advertising budget can increase or decrease depending on whether the change in r more or less offsets the change in A_r.

This produces an interesting result. If advertising were socially excessive in a particular instance, then it might be socially desirable (harmful) for the marginal cost of reach A_r to increase (decrease) in order to discourage advertising. Under these circumstances, higher consumer thresholds to advertising and more resistance to word-of-mouth would actually be socially beneficial. While perfect information is socially optimal (no

advertising would be needed here at all), increases in consumers' ability -- while in a state of imperfect information -- to receive, process, and transmit information are not unambiguously socially desirable at all times. This discussion accentuates the need to view information flows as part of a complete cybernetic network.

5. Schumpeterian Competition

Schumpeter's claimed advantage of market power resides in its ability to stimulate more innovation and to hasten technological progress. Process innovation would lower the production costs of a particular good and product innovation would improve its quality. This section introduces process innovation into the basic duopolistic model that Section 2 developed; Section 6 considers product innovation.

Any results to be obtained will depend upon market parameters and corporate strategies that prevail in the pre-innovation state (time 0). For simplicity, assume that no firm finds advertising profitable in Cournot equilibrium in time 0. Also assume that only firm 2 is engaged in research and that its innovation, if successful, can be effectively patented for an indefinite amount of time.

Given the above assumptions about time 0, each firm would price at $p_o = (c + t)/2$ (see eq. 2.4); since no firm advertises and reservation prices are uniformly distributed, profits π_0 for each firm i then are $a_i n_i (p_0 - c) = a[n(t - p_0)/(t - s)](p_0 - c) = an(t - c)^2/[4(t - s)]$. (The first equality follows from eq. 2.1

and the second from eq. 2.4.) Cournot-Nash, Stackelberg, and joint profit maximizing prices are identical to one another.

a. Equilibrium after Technological Change

Suppose firm 2 process-innovates and lowers its production cost to c_2, thereby possibly enabling it to reduce p_2 as well. Advertising can now become profitable for the firm. (For simplicity, assume that firm 1 does not profitably lower p_1 to counter firm 2's price reduction/advertising campaign; see below.) Let r_2 represent the reach of firm 2's advertising. The number of customers served by the firm is then $n_2 = n[a_2 + (1 - a_2)r_2][1 - F(p_2)]$ and its profits $\Pi_2 = n_2(p_2 - c_2) - A$. Cournot-Nash equilibrium prices p_1, p_2, A_1, and A_2 are then obtained by:

5.1a) $p_1 = (c_1 + t)/2 = p$

5.1b) $p_2 = (c_2 + t)/2$

5.1c) $A_1 = 0$

5.1d) $(1 - a_2)n(p_2 - c_2)[1 - F(p_2)] - A_r = 0$

Rewriting eq. 5.1d,

5.2) $Q_2 - A_r = 0$

where:

$$Q_2 = (1 - a_2)n(p_2 - c_2)[1 - F(p_2)] = nx_2$$

$$x_2 = (1 - a_2)(p_2 - c_2)[1 - F(p_2)]$$

$$= (1-a)(t-c_2)^2/[4(t-s)] = (a+a_0)(t-c_2)^2/[4(t-s)]$$

The second equality in the definition of x_2 results from the fact that $F(p_2) = (p_2 - s)/(t - s)$ and eq. 5.1b.

Firm 1 now serves n_1 customers, where $n_1 = a_1 n(1 - r_2)[1 - F(p_1)] = an(1 - r_2)[1 - F(p_1)]$. In the new equilibrium:

5.3) $$\Pi_1 = an(1 - r_2)(p_1 - c)[1 - F(p_1)]$$

$$= n(1 - r_2)x_1$$

where:

$$x_1 = a(p_1 - c_1)[1 - F(p_1)] = a(t - c)^2/[4(t - s)]$$

The second equality in the definition of x_1 results from the fact that $F(p_1) = (p_1 - s)/(t - s)$ and eq. 5.1a. If $r_2 > 0$, $\Pi_1 < \Pi_0$; firm 1 is less profitable in the new equilibrium.

(To this moment, we have assumed that firm 1 cannot profitably lower its price in response to firm 2's innovation; this disqualifies from consideration minor innovations and price reductions by firm 2 to which firm 1 could respond by lowering p_1. If there were a danger of firm 1 lowering its price in response to a decrease in p_2, firm 2 might not choose the optimal r_2 and p_2 of eqs. 5.1b and 5.1d. In such a case, firm 2 would not then reduce p_2 and/or advertise as much as it would ideally like. This strategy of staying small to avoid retaliation by rivals is an example of "judo economics" (Gelman

and Salop); for the sake of simplicity, we shall assume that its innovation is substantial enough so that firm 2 can safely ignore "judo-economic" considerations when determining its price and advertising levels.)

b. Benefits of Advertising

Having derived first-order conditions for Cournot-Nash equilibrium which allow $A_2 > 0$, we now consider whether this advertising can be, on balance, beneficial or harmful. Advertising would have three different benefits. First, it can relocate some purchasers of good 1 to good 2. The number of relocated customers is $a_1nr_2[1 - F(p_1)] = anr_2[1 - F(p_1)]$; the social benefit per relocated customer is the cost-savings $c_1 - c_2$. The total social benefit is the product of cost-savings per customer times the number of relocated customers. Second, advertising can inform some people who had not been aware of any product at all; the number of new customers is $a_0nr_2[1 - F(p_2)]$; since reservation prices of customers are uniformly distributed between p_2 and t, social benefit per customer is $R_0 - c_2$ where $R_0 = (p_2 + t)/2$. As before, total social benefit is the product of the number of new customers times the social benefit per customer. Third, advertising can attract people who were aware originally of good 1 but did not buy because their reservation price $q < p_1$. The number of these customers newly attracted to firm 2 is $anr_2[F(p_1) - F(p_2)]$ and the average social benefit per customer is $(R_1 - c_2)$ where $R_1 = (p_1 + p_2)/2$. (Total benefit is the product of the two.) Consequently, total social

benefit of the innovation and its associated advertising campaign is measured:

5.4) $$W = anr_2\{(c_1 - c_2)[1 - F(p_1)] + (R_1 - c_2)[F(p_1) - F(p_2)]\}$$

$$+ a_0nr_2(R_0 - c_2)[1 - F(p_2)] - A = ny_2(1 + r_2) - A(r_2)$$

where:

$$y_2 = [a(c_1 - c_2)(t - p_1) + a(R_1 - c_2)(p_1 - p_2)$$

$$+ a_0(R_0 - c_2)(t - p_2)]/(t - s)$$

The socially optimal reach r_2 is obtained:

5.5) $$\partial W/\partial r_2 = ny_2 - A_r = 0$$

Eq. 5.4 can be compared with eq. 5.1d to determine whether or not firm 2 under- or over-advertises its product. Using the definitions of R_0, R_1, eq. 5.1a, eq. 5.1b, and some simple but long-winded algebra, y_2 can be rewritten:

5.5) $$y_2 = [3a(c_1 - c_2)(t - C)/4 + 3a_0(t - c_2)^2/8]/(t - s)$$

where:

$$C = (c_1 + c_2)/2$$

Comparing eqs. 5.2 and 5.5., Firm 2 will over- (under-) advertise when x_2 is greater than (less than) y_2. For the model to be meaningful, $t > c_1 > c_2$. Consider x_2 and y_2 as functions

of c_1. $\lim_{c_1 \to c_2^+} y_2 = 3a_0(t - c_2)^2/[8(t - s)] = I_y$ and $\lim_{c_1 \to c_2^+} x_2 = (a + a_0)(t - c_2)^2/[4(t - s)] = I_x$. If $a > a_0/2$, firm 2 will overadvertise relative to its social optimum if c_2 is slightly below c_1. However, $\lim_{c_1 \to t} y_2 = 3(a + a_0)(t - c_2)^2/[8(t - s)]$ and $\lim_{c_1 \to t} x_2 = (a + a_0)(t - c_2)^2/[4(t - s)]$. Therefore, the firm will underadvertise if c_1 is substantially above c_2. Note that $dx_2/dc_1 = 0$, $dy_2/dc_1 = 3a(t - c_1)/[4(t - s)] > 0$ and $d^2y_2/dc_1^2 = -3a/[4(t - s)] < 0$. Figure 1 portrays the relationship between x_2 and y_2 as a function of c_1 (assuming that $a > a_0/2$). If $c_1 >$ ($<$) c^*, A_2 will be undersized (oversized) relative to its socially optimal level.

Without loss of generality, we shall assume, for the duration of this paper, that $a_0 = 0$. Continuing to assume that $a_1 = a_2$, $a_1 = a_2 = a = 1/2$.

c. Destructive Competition

Overadvertising by firm 2 will reduce the net social benefit of a new innovation. In Figure 2, private (social) benefits of an advertising campaign equal the area ABC (AB'C' - BB'D). A campaign will be undertaken when ABC > 0; it will be socially harmful when AB'C' - BB'D < 0. Depending on the nature of the

Figure 1: x and y as Functions of c_1

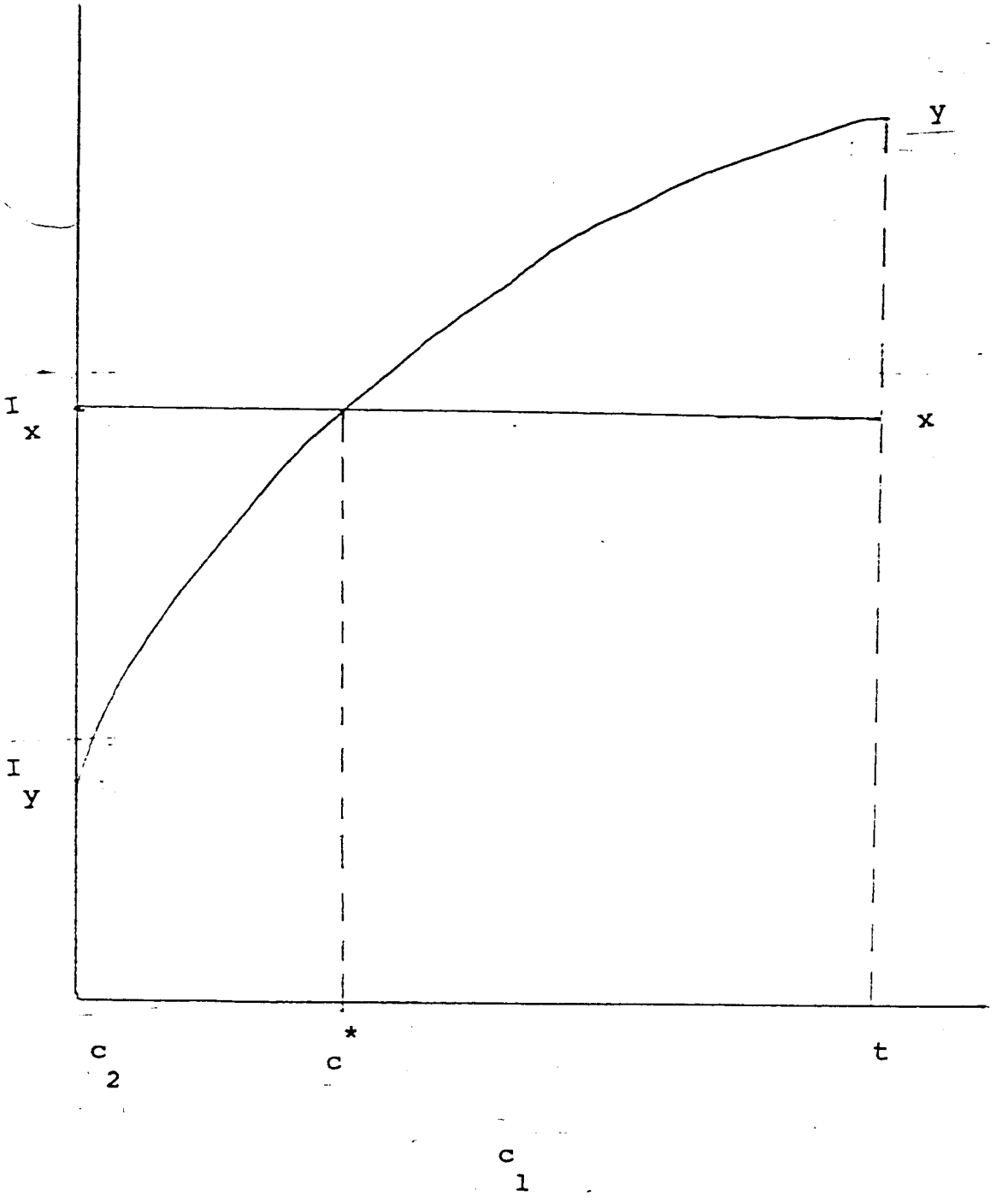
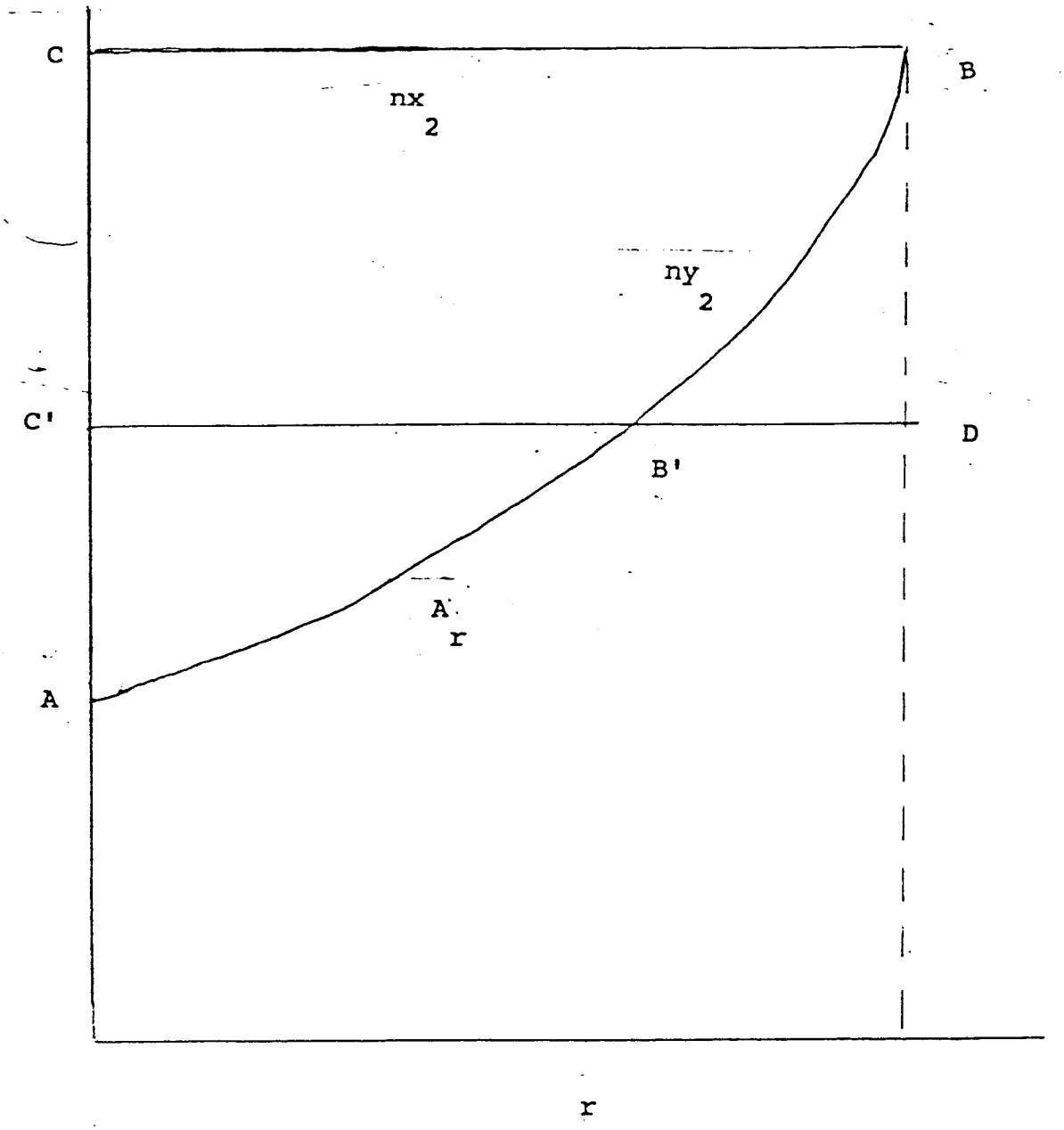


Figure 2: Profit-Maximizing and Socially Optimal Advertising



advertising technology, firm 2 can overadvertise to such an extent that the entire advertising campaign is, on balance, harmful to society; i.e., net social benefits are negative although private benefits are positive.

Not only can an advertising campaign itself be harmful, its synergies with R&D can produce harmful social effects as well. The social benefit of an innovation includes the innovator's profits (i.e., revenues net of production, advertising, and R&D costs) plus additional consumer surplus minus the lost profits of its competitor. (On harmful innovation in a different context, see Mansfield et. al.) The private benefits of an innovation include the additional profits that the innovator will earn.

Without advertising, the private benefit to firm 2 of innovating is then its change in profits less its costs of innovating:

$$5.6)\quad \bar{\pi}_N = a_2 n\{(p_2 - c_2)[1 - F(p_2)] - (p_1 - c_1)[1 - F(p_1)]\} - k$$

$$= n(x_2 - x_1) - k$$

where:

k = amortized costs of innovation/product development

The second equation follows from the definition of x_1 and x_2 (see eqs. 5.2 and 5.3) and the fact that $a_1 = a_2 = 1/2$. With advertising, this benefit becomes:

5.7) $\pi_A = n[(1 + r_2)x_2 - x_1] - A - k$

Without advertising, social benefits of an innovation can be expressed (compare eq. 5.4):

5.8) $W_N = ny_2 - k$

With advertising, social benefits can be expressed:

5.9) $W_A = ny_2(1 + r_2) - A - k$

$= ny_2 + [nr_2y_2 - A] - k$

$= W_N + M$

where:

$M = nr_2y_2 - A$

M is the net benefits from the advertising campaign and corresponds to the area AB'C' - BB'D in Figure 2.

Without advertising, an innovation will be socially beneficial (harmful) if W_N is positive (negative); it will be adopted if π_N is positive (negative). Any of nine possibilities regarding $W_N \gtreqless 0$ and $\pi_N \gtreqless 0$ is possible. Now suppose that $W_N < 0$ and $\pi_N < 0$ without advertising. With advertising, it is possible that $W_A < 0$ and $\pi_A > 0$. Then the ability to advertise can lead the firm to adopt a socially harmful innovation which it would have foregone otherwise.

Since M can be negative, it is possible that $W_N > 0$, $\pi_A > \pi_N > 0$, but $W_A = W_N + M < 0$. Consequently, advertising can

transform a profitable socially beneficial innovation into a more profitable but socially harmful one.

Given the above results, the sanguine Schumpeterian view of technological competition among oligopolies producing positive net social gains (though perhaps not optimal) which exceed the private gains to the innovator can be too optimistic. Indeed, in the model described above, technological competition would actually be harmful. Due to the presence of advertising, "creative destruction" is replaced by "wasteful destruction". As Kaldor pointed out, much innovation takes place precisely because firms can advertise; indeed, the presence of advertising can be absolutely necessary to informing the unaware public of the new attributes of a product. However, the presence of advertising can lead to socially harmful innovations nonetheless.

Consider a simple example of destructive competition. Suppose firm 2 can increase its reach r_2 by mailing out letters to prospective customers; A_r is then constant and equal to the cost of preparing and mailing a letter. If $A_r < x_2 n$, the firm will mail a letter to each person in its market area. If $A_r > y_2 n$, the cost of each letter outweighs its social benefit. Consequently, each letter is privately beneficial but socially harmful. The magnitude of this waste could possibly offset any positive social benefits which might have resulted from the innovation itself; it could also lead the firm to adopt an innovation which it may have foregone otherwise.

d. Net Social Benefits

In contrast to the results in the preceding section, advertising can lead a firm to undertake socially desirable innovations which it would have foregone had it not been able to advertise. It is possible that $W_N > 0$ and $\bar{\Pi}_N < 0$; a beneficial innovation can then be passed up without advertising. With advertising, $\bar{\Pi}_A > 0$ and $W_A > 0$ is possible. In this case, advertising is an essential part of a firm's marketing strategy and must be available for the firm to undertake a socially beneficial innovation.

Under these conditions, the innovation process requires Schumpeterian synergies which justify the incentives of market power. No firm would undertake R & D if it could not enjoy positive profits upon completing its innovation. Furthermore, positive profits might not be obtainable without advertising. Finally, no firm would advertise unless it knew that such profits were attainable.

6. Product Quality

Having discussed process-innovations (i.e., lower production costs c_2), consider improvements in product quality. Suppose that firm 2 can innovate and improve the quality of its product; the intrinsic worth of the innovation to the consumer when $p_1 = p_2$ is v. Accordingly, a consumer's reservation price for product 2 would be $q_2 = q_1 + v$, where q_1 represents his reservation price for product 1. q_2 is then uniformly distributed between $s' = s + v$ and $t' = t + v$. Assume that the marginal cost of

production of both goods is $c_1 = c_2 = c$. Assuming once again that the innovation is patented and that firm 1 can not profitably counter with a price drop, firm 2 will maximize profits at p_2 where:

6.1) $p_2 = (c + t')/2 = (c + t + v)/2 = p_1 + v/2$

The third equality uses eq. 5.1a. The consumer surplus associated with a purchase of good 2 (1) is $q_2 - p_2$ ($q_1 - p_1$) ; since $q_2 - p_2 = (q_1 + v) - (p_1 + v/2) = q_1 - p_1 + v/2 > q_1 - p_1$, each consumer who is aware of the quality of product 2 would prefer it to product 1.

Assume again that $a_0 = 0$ and $a_1 = a_2 = a = 1/2$. The number of people who purchase goods 1 and 2 is:

6.2a) $n_1 = a_1 n(1 - r_2)[1 - F(p_1)] = an(1 - r_2)[1 - F(p_1)]$

6.2b) $n_2 = n(a_2 + a_1 r_2)[1 - F(p_2 - v)] = an(1 + r_2)[1 - F(p_2 - v)]$

Assuming that firm 2 can profitably advertise, respective profits of the two firms are:

6.3a) $\bar{\Pi}_1 = an(1 - r_2)(p_1 - c)[1 - F(p_1)]$

$= n(1 - r_2)x_1$

6.3b) $\bar{\Pi}_2 = an(1 + r_2)(p_2 - c)[1 - F(p_2 - v)] - A(r_2)$

$= n(1 + r_2)x_2 - A(r_2)$

where:

$$x_1 = a(t - c)^2/[4(t - s)]$$

$$x_2 = a(t + v - c)^2/[4(t - s)]$$

The definitions of x_1 and x_2 follow from eq. 5.1a, eq. 6.1, and the facts that $F(p_1) = (p_1 - s)/(t - s)$ and $F(p_2 - v) = (p_2 - v - s)/(t - s)$. Since v is positive, $x_2 > x_1$; firm 2 is clearly more profitable. The optimal reach r_2 of its advertising campaign is given by eq. 5.2, with x_2 defined below eq. 6.3b.

To get the socially optimal reach r_2, realize that $anr_2[1 - F(p_1)]$ buyers of good 1 will convert to good 2 once they learn of it; each enjoys a (net) additional consumer surplus of v/2 and generates an additional net producer surplus of v/2. Per customer social surplus is then the sum v and total social surplus of this group is the product of v times the number of relocated customers. Furthermore, $anr_2[F(p_1) - F(p_2 - v)]$ people who were not buyers of good 1 (although they had been aware of it) will now purchase good 2; each of these customers will generate an additional producer surplus of $p_2 - c$ and, on average, will enjoy a consumer surplus of $(p_1 + p_2 - v)/2 + v - p_2 = (p_1 - p_2 + v)/2$. Per customer social surplus from this group is then the sum of producer and consumer surplus $R + v/2 - c$ where $R = (p_1 + p_2)/2$; total social surplus can be obtained by multiplying per customer surplus by the number of affected customers. Social welfare W is then:

$$6.4) \quad W = vanr_2[1 - F(p_1)] + (R + v/2 - c)anr_2[F(p_1) - F(p_2 - v)] - A(r_2)$$

To obtain the socially optimal reach, differentiate eq. 6.4 by r_2:

6.5) $an[v(1 - F(p_1)) + (R + v/2 - c)(F(p_1) - F(p_2 - v))] - A_r =$

$ny_2 - A_r = 0$

where:

$y_2 = [av(t - p_1) + a(R - c + v/2)(p_1 - p_2 + v)]/(t - s)$

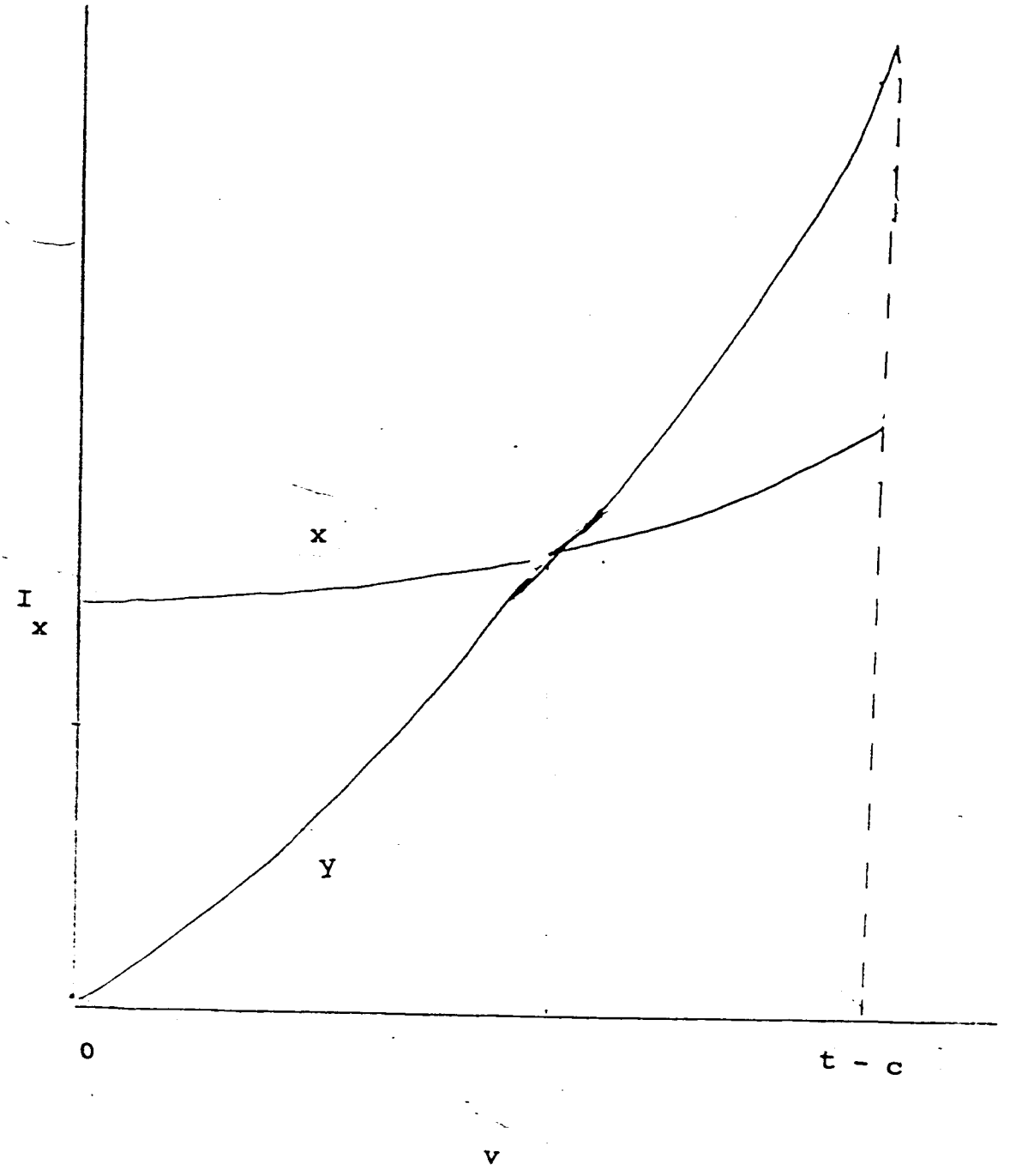
$R = (p_1 + p_2)/2$

With some simple algebra and the fact that $p_1 - p_2 + v = v/2$, y_2 can be expressed:

6.6) $y_2 = 3av[(t - c) + v/2]/[4(t - s)]$

To determine whether advertising is excessive or deficient, compare x_2 and y_2. $\lim_{v \to 0} x_2 = (t - c)^2/[4(t - s)] = I_x > 0$ and $\lim_{v \to 0} y_2 = 0$; consequently, if v is small, $x_2 > y_2$ and firm 2 will overadvertise. However, when $v = t - c$, $y_2 = 9a(t - c)^2/[8(t - s)] > x_2 = a(t - c)^2/(t - s)$; consequently, firm 2 will underadvertise when v is large. Since $dx_2/dv = a(t + v - c)/[2(t - s)]$ and $dy_2/dv = 3a(t + v - c)/[4(t - s)]$, Figure 3 depicts the general relationship between x_2 and y_2. Figure 2 is still relevant; it again shows that the level of advertising can be deficient, optimal, excessive, or downright harmful. As before, a quality-improving innovation which a firm adopts nonetheless can be socially harmful; advertising can be a necessary contributor to the adoption of this innovation. On

Figure 3: x and y as Functions of v



the other hand, the presence of advertising can be an essential component of a profitable, and socially beneficial, R & D program.

6. The Stock and Acquisition of Basic Knowledge

R. Nelson and Barzel point out that increased basic knowledge can reduce the cost of innovation to a firm and can consequently encourage innovations or speed up their development; basic knowledge is often a public good to all potential innovators. As a consequence, multiproduct conglomerates might then offer a social advantage which less diverse firms do not; since multiproduct firms are better positioned to make use of the often-serendipitous breakthroughs which result from basic research, they are likely to undertake more basic research. Furthermore, these firms may enjoy some economies of scope in their research as well.

As noted, certain profitable innovations can be socially harmful and advertising can be a major contributor to such a situation. Consequently, advances in basic knowledge and economies of scope which reduce the costs of R&D and consequently encourage such harmful innovations would be socially harmful. Firms which sell in certain product markets could be excessively innovative and even socially harmful. While one would hesitate to identify particular instances of the latter without very careful scholarly analysis, there is no reason to believe that increases in scientific knowledge are beneficial in all product markets.

7. Conclusion

The theory of pure competition assures us that individual economic agents, through their own self-seeking motives, secure the greatest level of social benefit as well. In Schumpeterian competition, certain economic agents, via the same self-serving profit mechanism, improve (but probably do not maximize) the overall level of economic welfare. We thus have two fairly optimistic views of the competitive process.

By contrast, the results presented here are more pessimistic. The continued agnosticism is disturbing. In all likelihood, the competitive process on balance produces results which are socially beneficial, though probably not optimal. However, the competitive process can also produce some market results which are, on balance, not only nonoptimal, but socially harmful as well. To investigate whether these theoretical nightmares actually exist remains a challenging problem for the "Kaldorian" analyst.

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