Saints and Markets

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Abstract

This paper contains a theoretical exploration of the potential effects of an information-supplying activist on a market for credence goods. Using a non-cooperative game-theoretic model with incomplete information, we find that such an activist can alter the decisions of firms and consumers. In our model, when an activist alters the decisions of firms and consumers, the social welfare of market exchange is enhanced. We also find that an activist can support a strategy in which a firm differentiates its product on some credence characteristic even though this characteristic remains unknown to the consumer both prior and subsequent to consumption. In general, our analysis has several implications for the study of private collective action in markets.

1   Introduction

Consumers sometimes base their purchasing decisions on a firm's operating practices in addition to the utility of its products or services. For example, some consumers avoid products produced by firms whose practices are alleged to harm the environment, promote employment discrimination, or embrace controversial social or political positions even when such practices are lawful or customary.[1] Some consumers may search for goods produced under practices consistent with their moral standards or political goals. In contemporary developed economies, purchasing patterns among consumers can transcend the simple economics of relative value and include broad moral and political calculations.[2]

Information about a firms operating practices, however, can be difficult to obtain. In the parlance of information economics, when consumers base their purchasing decisions on a firms operating methods, the output of the firm is a *credence good*.[3] A credence good has important attributes (e.g., the firms operating practices) that remain undetected even after consumption.[4] Clearly, it is difficult if not impossible for consumers to determine if a firm harms the environment, promotes employment discrimination, or embraces controversial social or political activities simply by purchasing and using a firms product. For consumers concerned with the operating practices of a firm, an alternative source of information is required.[5]

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[1] For specific examples of such consumer behavior, see Baron (1996, Chapter 4). In the Spring of 1994, the Boycott Quarterly listed products subject to organized consumer boycotts (pp. 60-66). This list included more than four hundred products produced by over one hundred firms or industries.

[2] To be sure, it is difficult to gauge the importance of these concerns in aggregate consumer behavior. However, it seems safe to say that such concerns are growing in importance and are relevant considerations for firms. Again, see Baron (1996, Chapter 4) and Vogel (1978) for some examples. Smith (1995) characterizes the current commercial period as the "ethics era" and examines its implications for marketing practices consistent with consumer interests and societal expectations.

[3] For purposes of understanding the role of information on consumer behavior and market performance, there are two broad classes of products in addition to credence goods (Nelson, 1970). Search goods have characteristics that are discoverable through inspection and prior to purchase and consumption. There are few informational difficulties that arise in markets for search goods; the relevant issues in such markets pertain to product selection (i.e., quality) and diversity (i.e., variety). Experience goods have characteristics that are revealed only through consumption. A variety of interesting informational issues arise when evaluating the performance of markets for experience goods. Indeed, the study of experience goods has contributed to our understanding of the importance, for example, reputations and warranties in markets were consumers are imperfectly informed. See Tirole (1988, pp. 106-129) for a survey of the relevant literature.

[4] The concept of a credence good is due to Darby and Karni (1973). Examples of credence goods include repair services supplied by an automotive mechanic or medical care provided by a doctor. In both cases, the purchaser's post-consumption experience is independent of the value of the repair services (e.g., in some cases, the consumer does not have the information to determine whether the automotive repair was actually required or the removed organ diseased). Absent independent additional information (e.g., a "second opinion"), the value of a credence good is difficult to assess. It is generally thought that markets for credence goods, in the absence of supporting mechanism such a private or public inspection or certification, fail is the classical sense identified by Akerloff (1970); that is, the market is characterized by "adverse selection."

[5] One possible source of information may be provided through government intervention or regu-

Activists or activist organizations can be important sources of information for consumers who value the operating methods of firms. Activists use a variety of tactics - picketing, demonstrations, boycott calls, or standing before political or administrative agencies or courts - to attract the media and the public to some moral or political issue pertaining to a firms behavior. Activists also interact in networks and loose affiliations to promulgate information that may be important to consumers.[6] Many activist organizations endorse products or certify producers that satisfy the requisite criteria.[7] Activists and their organizations, then, may affect the information available to consumers when making their purchasing decisions.

The purpose of this paper is to explore the possible effects of an information-supplying activist on the performance of a market for credence goods. We are interested in three specific classes of questions. First, what are the potential normative implications of activists on markets for credence goods? Can activists improve the workings of such markets or affect the distribution of welfare among firms, consumers and the activists themselves? Second, what are the possible positive implications of activists on markets for credence goods? Can activists affect the equilibrium prices and profits of firms or the aggregate demand of consumers? And third, what are the potential strategic implications of activists on markets for credence goods? Can activists support market segmentation strategies by firms? And what types of firms or industries are most likely to alter their operating strategies in the face of an activists involvement?

We conduct our analysis within the context of a non-cooperative game-theoretical model with incomplete information. In the model, we assume that an activist monitors the operating characteristics of a firm. Consumers remain ignorant of these characteristics both prior and subsequent to consumption. We also assume that the activist can engage in strategies that may signal these characteristics to consumers prior to their purchasing decisions. We evaluate the sequential equilibria of the model to assess the potential impacts of an activist on a market for credence goods.

From a positive perspective, we find that an informed activist can affect the technology choices of firms and the demand of consumers. In particular, an activist can support an equilibrium in which a firm adopts operating characteristics that consumers value even though the consumer cannot observe these characteristics either prior or subsequent to consumption. An activist can also increase the amount of such goods consumed. Such equilibria are more likely to exist if the costs of supplying these desirable operating characteristics are not to expensive relative to production with undesirable operating characteristics. These equilibria are also more likely to exist the greater the substitutability among products in an industry. In general,

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lation. As Darby and Karni (1973) note, however, governmental solutions to problems that arise in credence goods markets may be plagued by the same incentives and limitations that exist for private or market participants.

[6] As an example, Baron (1996, pp. 86-87) describes the groups affiliated with the consumer activist Ralph Nader.

[7] As an example, the activist organization "People for the Ethical Treatment of Animals (PETA)" provides a guide of manufacturers and distributors of "cruelty-free" products. By the Spring of 1994, this list contained 530 companies (Boycott Quarterly, Spring, 1994, p. 8).

we identify some substantively interesting properties necessary for the existence of equilibria in which an informed activist can affect a market for credence goods.

In our model, social welfare is a function of the technology (e.g., operating characteristics) decisions of firms. When the demands for goods produced by firms are independent, social welfare is maximized when firms choose identical, desirable (from the consumers view) technologies. When goods are highly substitutable, social welfare is maximized when firms choose different technologies and, therefore, differentiate their goods on the basis of their operating characteristics. We find that an activist can support either type - same or different technology choice - equilibria. Thus, activists can potentially improve the workings of a market for credence goods. Since there is no hint that the activist supports the right type of equilibria, however, an activist does not guarantee that social welfare is maximized.

From a strategic perspective, we find that the endorsements of an informed activist can be essential to a firm that wishes to adopt an operating practice valued by consumers. Absent such an endorsement, the firm is unable to convey creditably its operating strategy to consumers and, thus, has no incentive to adopt costly practices with desirable operating characteristics. The presence of an informed activist can, however, help a firm differentiate its product through the adoption of costly yet desirable operating practices. An activist can be an essential component to a firm's market segmentation strategy.

This paper compliments recent work that examines the role of independent intermediaries in markets characterized by incomplete information (Lizzeri, 1994). The results of our analysis are similar in that the presence of a certification intermediary - the activist - can enhance the information available to buyers as well as support production using technologies that would not be chosen in the absence of the intermediary. However, the augmentation of market opportunities created by the intermediary is limited to those technology choices that enhance the intermediary's payoff (e.g., those that improve the activist's utility). We do find that the presence of an intermediary may enhances the profits of sellers and the utility of buyers.

This paper also suggests a broader approach to the effects of political behavior on market performance. Economists generally study such effects by analyzing competition among organized interests over the output of a monopolistic supplier of some service typically referred to as regulation (Peltzman, 1978; and Becker, 1983). In such models, the opportunities of firms are affected by collective action within well-defined political institutions. Our model suggests that the opportunities of firms whose operating practices are important to consumers can be altered by collective action even when a public intermediary - the regulator - has no direct influence on behavior within a market. That is, private (as opposed to public) collective action can exert a direct effect on consumer behavior and market performance independent of any formal political or regulatory institutions.

The remainder of this section presents an illustration intended to highlight some important features of interactions among consumers, firms and activists in markets. Section 2 presents our model and analysis. Section 3 contains a brief discussion of some obvious limitations of our analysis.

1.1 Illustration

During the Spring of 1995 Shell UK was proceeding with its disposal plan for the Brent Spar, an obsolete oil storage and tanker loading facility located in the North Sea. The plan was to sink the facility in the deep waters of the North East Atlantic Ocean. This plan was developed from a range of options that included, for example, on-shore dismantling of the facility. The plan had obtained the approval of British authorities and other interested parties such as the Joint Nature Conservancy Committee and fishermens associations. The plan was also submitted to the European governments for their approval. None of these governments protested Shells plan.

Greenpeace, the worlds largest environmental organization, had conducted studies that concluded that on-shore dismantling was preferable to deep sea dumping for the Brent Spar. Greenpeace activists also devised a plan to confront Shell and publicize the environmental issues surrounding the disposal plan. The activists plan included extensive media coverage of the boarding and occupation of the Brent Spar before and during its voyage to the disposal site, direct negotiations with Shell and several of its employee groups, and boycott calls of Shell UK and Shell Germany products. Greenpeaces characterization of Shells disposal plan (one that turns the sea into a trash pit) resonated with many German and Dutch consumers.

By June of 1995 the pressure on Shell UK to alter its disposal plan had grown dramatically. Sales were off by 20% to 30% at German Shell gas stations and the boycott was spreading to the Netherlands and Denmark. In many European countries the boycott was adopted by organized political, labor and other environmental organizations. The British government was criticized by German authorities for persisting with the deep-sea dumping proposal. And a fire-bomb exploded at a Shell gas station in Hamburg, Germany. On June 20, at the urging of Shell Germany and the Royal Dutch/Shell Groups managing directors, Christopher Fay, chairman of Shell UK, announced that Shell would abandon its disposal plan to sink the Brent Spar facility.

The story of the Brent Spar disposal plan illustrates many important facets of the interaction among of consumers, firms and activists in markets. First, it illustrates that the operating characteristics of a firm (e.g., the disposal of obsolete facilities) can affect the utility of at least some consumers. Thus, knowledge of a firms operating methods may affect the consumption patterns of consumers. Second, the Brent Spar story illustrates that such knowledge is not a natural by-product of the consumptive process. That is, it is difficult for consumers to deduce such knowledge through the process of inspecting, purchasing and consuming a firms product. Third, the Brent Spar story illustrates that activists can play an important role in disseminating information about a firms operating methods. The activists strategies can affect the information on which consumers base their purchasing decisions. And fourth, the Brent Spar episode illustrates that the participation of an activist can alter the operating decisions of a firm. The demand of consumers informed by activist strategies may alter the production decisions of firms. Below we attempt to build a model with these features.

2 Model

Production, endorsment and consumption decisions are modeled as the outcome of a non-cooperative game under incomplete information. The players in the game are a representative consumer, two firms and an activist. Each firm chooses a product quality g for good or b for bad. It is more costly to the firm to choose g than b but consumers prefer to consume more of a firm's product as the firm's quality increases. The firm's products have a *credence* good component: the consumer is not able to directly observe the firms' quality choices. The consumer chooses a quanitity of each firm's product to consume that is a function of what it believes each firm's quality to be. We assume that the firm's products are neither perfectly independent or perfect substitutes. Ceteris parabus, the higher the probability the consumer assigns to a firm's product being of good quality the more of that firm's product the consumer wishes to purchase.

The purpose of this paper is to investigate the potential role of activists as informational intermediaries between firms and consumers. In the first section we evaluate a baseline model without activists and examine the social welfare properties of the model. In the second section we introduce an activist and demonstrate that the activist can result in welfare improvements and that activists may lead to market segmentation.

2.1 Baseline Model

The game without an activist occurs in three stages. In the first stage two firms, $i = 1, 2$, choose a production technology: $t_i \in \{g, b\}$ (g for good and b for bad) where $b > g > 0$. We assume that each firm incurs a fixed cost $k(t_i)$ for choosing technology t_i and that it is more costly for the firm to choose the good technology than the bad one i.e., $k(g) > k(b) > 0$. Let $d = k(g) - k(b)$ where d is the cost advantage of adopting the bad technology.

The consumer observes each firm's technology choice and chooses a quantity $q_i(t_1, t_2)$ of each firm's product.

2.1.1 The payoffs.

Firm payoffs are the quantity consumed minus the fixed cost. We do not consider prices in this model. The rationale for omitting prices is that in subsequent sections we will be looking at a signalling model in which prices may themselves serve as signals of quality. In such a model the relationship between price and consumer demand is non-trivial. In the current model prices are, in effect, fixed and normalized to one. Firm i's payoff for choosing technology t_i given the other firm chooses $t_{\sim i}$ is

$$\pi_i(t_1, t_2) = q_i(t_1, t_2) - k(t_i).$$

The representative consumer has a utility function that is quadratic, strictly concave, symmetric and both linear and seperable in the numeraire good. The consumer's

payoff function for choosing the quantity vector (q_1, q_2) given (t_1, t_2) is:

$$\pi_c(t_1, t_2, q_1, q_2) = (\alpha - t_1)q_1 + (\alpha - t_2)q_2 - (q_1^2 + q_2^2)/2 - \gamma q_1 q_2$$

where $\alpha > b$, $\gamma \in (0, 1)$. The two products are more substitutable the greater the value of γ. Demand for the two products is independent when $\gamma = 0$. We also assume that $b - g > 2d$. This assumption guarantees that the potential shift in demand from producing with the good technology is large relative to the change in cost of production. The consumer's payoff function induces the following demand function:

$$q_i(t_1, t_2) = \begin{cases} 0 & \text{if } t_i = b, t_{\sim i} = g \text{ and } \gamma \geq \frac{\alpha - b}{\alpha - g} \\ \alpha - g & \text{if } t_i = g, t_{\sim i} = b \text{ and } \gamma \geq \frac{\alpha - b}{\alpha - g} \\ \frac{\alpha(1 - \gamma) - t_i + \gamma t_{\sim i}}{1 - \gamma^2} & \text{if } t_i = t_{\sim i} \text{ or } \gamma \leq \frac{\alpha - b}{\alpha - g} \end{cases} \tag{1}$$

A profile for the game is $\sigma = \{t_1, t_2, q_1, q_2\}$. We first analyze the subgame perfect Nash equilibrium.

Proposition 1 *In any subgame perfect Nash equilibrium both firms choose g and demand is given by (1).*

Proof. The demand function follows as a straightforward consequence of the first order conditions. Given consumer demand the payoff difference for firm i between choosing g and b is given by

$$\frac{\alpha - g}{1 + \gamma} - d$$

when $t_{\sim i} = g$ and $\gamma \geq \frac{\alpha - b}{\alpha - g}$,

$$(\alpha - g) - \left(\frac{\alpha - b}{1 + \gamma}\right) - d$$

when $t_{\sim i} = b$ and $\gamma \geq \frac{\alpha - b}{\alpha - g}$, and

$$\frac{b - g}{1 - \gamma^2} - d$$

when $\gamma \leq \frac{\alpha - b}{\alpha - g}$. It is easy to verify that when $b - g > 2d$ and $\alpha > b$ all three payoff differences are positive. ∎

Proposition 1 shows that given the assumption of complete information, both firms adopt the good technology. Thus, any differentiation that exists between the products is represented by the parameter γ. We conclude this section by examining the social welfare properties of the model with perfect information. Assume the consumer chooses the quantity of each firm's product according to (1). Define social welfare to be

$$SW(t_1, t_2) = \pi_1(t_1, t_2) + \pi_2(t_1, t_2) + \pi_c(t_1, t_2, q_1(t_1, t_2), q_2(t_1, t_2)).$$

The following proposition demonstrates that social welfare is maximized either when both firms choose g or when one firm chooses g and the other chooses b.

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Proposition 2 *There exists a $\bar\gamma > \frac{\alpha-b}{\alpha-g}$ such that $SW(g,g) > SW(g,b) > SW(b,b)$ for $\gamma < \bar\gamma$ and $SW(g,b) > SW(g,g) > SW(b,b)$ otherwise.*

Proof. To see that $SW(g,g) > SW(b,b)$ observe that

$$SW(g,g) - SW(b,b)$$
$$= 2(\frac{\alpha-g}{1+\gamma} - k(g)) + \frac{(\alpha-g)^2}{1+\gamma} - 2(\frac{\alpha-b}{1+\gamma} - k(b)) - \frac{(\alpha-b)^2}{1+\gamma}$$
$$= 2(\frac{b-g}{1+\gamma} - d) + \frac{(\alpha-g)^2}{1+\gamma} - \frac{(\alpha-b)^2}{1+\gamma} > 0$$

and the inequality follows from $b - g > 2d$ and $b > g$.

To see that $SW(g,b) > SW(b,b)$ first consider the case when $\gamma \le \frac{\alpha-b}{\alpha-g}$. In this case we have

$$\pi_1(g,b) - \pi_1(b,b) = \frac{b-g}{1-\gamma^2} - d$$

$$\pi_2(g,b) - \pi_2(b,b) = -\gamma\frac{b-g}{1-\gamma^2}.$$

It follows that

$$\pi_1(g,b) - \pi_1(b,b) + \pi_2(g,b) - \pi_2(b,b) = \frac{b-g}{1+\gamma} - d$$

which is always positive by $b - g > 2d$. Now consider

$$\pi_c(g,b) - \pi_c(b,b) = (\alpha-g)\frac{\alpha(1-\gamma) - g + \gamma b}{1-\gamma^2} + (\alpha-b)\frac{\alpha(1-\gamma) - b + \gamma g}{1-\gamma^2}$$
$$-\left(\left(\frac{\alpha(1-\gamma) - g + \gamma b}{1-\gamma^2}\right)^2 + \left(\frac{\alpha(1-\gamma) - b + \gamma g}{1-\gamma^2}\right)^2\right)/2$$
$$-\gamma\frac{\alpha(1-\gamma) - g + \gamma b}{1-\gamma^2}\frac{\alpha(1-\gamma) - b + \gamma g}{1-\gamma^2} - \frac{(\alpha-b)^2}{1+\gamma}$$
$$= \left(\frac{(b-g)}{1+\gamma}\left(\alpha + \frac{1}{1-\gamma}(2\gamma b - b - g)\right)\right)$$

Therefore $\pi_c(g,b) > \pi_c(b,b)$ follows from $b > g$, $\frac{1}{1-\gamma}(2\gamma b - b - g)$ increasing in γ over $\gamma \in (0,1)$ and $\alpha > b + g$.

Suppose $\frac{\alpha-b}{\alpha-g} < \gamma$. Then

$$\pi_1(g,b) - \pi_1(b,b) = \alpha - g - \frac{\alpha-b}{1+\gamma} - d$$

$$\pi_2(g,b) - \pi_2(b,b) = -\frac{\alpha-b}{1+\gamma}$$

$$\pi_1(g,b) - \pi_1(b,b) + \pi_2(g,b) - \pi_2(b,b) = \alpha - g - d$$

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which is always positive by $\alpha > b$ and $b - g > 2d$. Next observe that

$$\pi_c(g, b) - \pi_c(b, b) = \frac{(\alpha - g)^2}{2} - \frac{(\alpha - b)^2}{1 + \gamma}$$

But $\gamma \geq \frac{\alpha - b}{\alpha - g}$ implies

$$\frac{(\alpha - g)^2}{2} - \frac{(\alpha - b)^2}{1 + \gamma} \geq \frac{(\alpha - g)^2}{2} - \frac{(\alpha - b)^2}{1 + \frac{\alpha - b}{\alpha - g}}$$

and

$$\frac{(\alpha - g)^2}{2} > \frac{(\alpha - b)^2}{1 + \frac{\alpha - b}{\alpha - g}}$$

by $\alpha > b > g$.

We next show that $SW(g, g) > SW(b, g)$ whenever $\gamma \leq \frac{\alpha - b}{\alpha - g}$. In this case we have

$$\pi_1(g, g) - \pi_1(b, g) = \frac{b - g}{1 - \gamma^2} - d$$

$$\pi_2(g, g) - \pi_2(b, g) = -\gamma \frac{(b - g)}{1 - \gamma^2}$$

$$\pi_1(g, g) - \pi_1(b, g) + \pi_2(g, g) - \pi_2(b, g) = \frac{(b - g)}{1 + \gamma} - d$$

which is always positive by $b - g > 2d$. Similarly,

$$\pi_c(g, g) - \pi_c(b, g) = \frac{(b - g)}{1 + \gamma} \left(\alpha + \frac{1}{2(1 - \gamma)} (2\gamma g - b - g) \right)$$

Thus for $\gamma > \frac{2\alpha - b - g}{2\alpha - 2g}$ it is the case that $SW(g, b) > SW(g, g)$. However, $\gamma < \frac{2\alpha - b - g}{2\alpha - 2g}$ by $\frac{\alpha - b}{\alpha - g} > \gamma$. So $\frac{\alpha - b}{\alpha - g} > \gamma$ implies $SW(g, g) > SW(g, b) > SW(b, b)$.

Now consider the case when $\gamma \geq \frac{\alpha - b}{\alpha - g}$. We show that there is an $\bar{\gamma}$ such that $SW(g, g) > SW(g, b) > SW(b, b)$ when $\bar{\gamma} > \gamma$ and $SW(g, b) > SW(g, g) > SW(b, b)$ when $\gamma > \bar{\gamma}$. When $\gamma \geq \frac{\alpha - b}{\alpha - g}$ it is the case that

$$\pi_1(g, g) - \pi_1(b, g) = \frac{\alpha - g}{1 + \gamma} - d$$

$$\pi_2(g, g) - \pi_2(b, g) = -\gamma \frac{\alpha - g}{1 + \gamma}$$

and

$$\pi_1(g, g) - \pi_1(b, g) + \pi_2(g, g) - \pi_2(b, g) = \frac{(\alpha - g)(1 - \gamma)}{1 + \gamma} - d$$

Furthermore,

$$\pi_c(g, g) - \pi_c(b, g) = \frac{(\alpha - g)^2}{1 + \gamma} - \frac{(\alpha - g)^2}{2} > 0.$$

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It is clear by inspection that there must be a $\bar{\gamma}$ such that $\gamma > \bar{\gamma}$ implies $SW(b,g) > SW(g,g)$. Indeed $\bar{\gamma}$ is given by

$$\frac{(\alpha - g)(2 + \alpha - g) - 2d}{(\alpha - g)(2 + \alpha - g) + 2d}$$

∎

Proposition 2 shows that, as expected, when the goods are close substitutes ($\gamma > \bar{\gamma}$), social welfare is maximized when the firms adopt different technologies. When demand for the two goods is fairly independent ($\gamma \leq \bar{\gamma}$), social welfare is maximized only if both firms use the good technology.

Our final proposition considers the case in which consumers are unable to observe each firm's technology choice.

Proposition 3 *If the consumer is unable to observe the firm's technology choice then each firm will choose the bad technology with probability 1 in any subgame perfect Nash equilibrium.*

Proof. Obvious. ∎

2.2 Activists

We now examine a model in which the consumer does not observe the firm's technology choices and there is an activist who observes each firm's quality choice with positive probability. We model the interaction between firms, activists and consumers as a four stage game of incomplete information. As above, in the first stage two firms, indexed by $i = 1, 2$, choose a production technology: $t_i \in \{g, b\}$ where $b > g > 0$ and $k(g) > k(b) > 0$. We denote a mixed strategy for firm i by $p_i(t_i)$: the probability firm i chooses t_i.

In the second stage nature selects one of the two firm's to be monitored by an activist. Consumers learn which firm the activist has monitored and the activist learns what technology the monitored firm has chosen. We represent the probability the firm i is monitored by $\tau_i \in [0, 1]$ where $\tau_1 + \tau_2 = 1$. We assume without loss of generality that $\tau_1 \in [1/2, 1]$.

In the third stage the activist chooses a message $m \in \{g, b\}$. A mixed strategy for the activist is denoted by the function $r_m : \{1, 2\} \times \{g, b\} \to [0, 1]$ where $r_m(i, t)$ is the probability the activist sends signal m given she observes firm i choose quality t.

In the fourth stage the consumer observes which firm has been monitored and the activist's signal m and forms beliefs $\boldsymbol{\mu} : \{1, 2\} \times \{g, b\} \to \nabla\{g, b\}^2$ where $\mu_i(t|j, m)$ is the probability assigned by the consumer to the event that firm i has chosen t conditional upon firm j being monitored and the activist sending message m. The consumer then chooses a quantity $q_i(j, m)$ of each firm's product.

We denote a behavioral strategy profile by $\sigma = \{p_1, p_2, r_m(\cdot), \mathbf{q}(\cdot), \boldsymbol{\mu}(\cdot)\}$.

2.2.1 Payoffs.

As before firm payoffs are the quantity consumed minus the fixed cost. A firm's payoffs now depend upon the probability it is monitored by the activist, the signal the activist sends to the consumer and how the consumer interprets the activist's signal. Formally, firm i's expected payoff function for choosing technology t given the behavioral strategy profile σ is

$$\pi_i(t_i, \sigma) = \tau_i \sum_m r_m(i, t_i) q_i(i, m)$$
$$+ \tau_{\sim i} \sum_{t_{\sim i} \in \{g,b\}} p_{\sim i}(t_{\sim i}) \sum_m r_m(\tilde{i}, t_{\sim i}) q_i(\tilde{i}, m) - k(t_i)$$

Holding the quanity consumed by consumers constant, firms prefer to choose $t_i = b$.

We model the activist as an agent who wants both to minimize overall consumption and to shift consumption from firms that use the bad technology to those that use the good technology. Absent uncertainty, the activist's payoff is $\sum_{i=1}^{2} t_i q_i$. However, the activist only observes the technology choice of one of the firms. The activist's expected payoff function given she monitors firm j, firm j chooses t_j and firm $\tilde{j}$ chooses according to $p_{\sim j}$ is

$$\pi_a(j, t_j, \sigma) = -\sum_m r_m(j, t_j) \left(q_j(j, m) t_j + q_{\sim j}(j, m) \sum_{t_{\sim j}} t_{\sim j} p_{\sim j}(t_{\sim j}) \right)$$

As above the representative consumer has a utility function that is quadratic, strictly concave, symmetric and both linear and seperable in the numeraire good. The consumer's expected payoff function for choosing the quantity vector $\mathbf{q}$ given firm i is monitored and the activist sends message $m \in \{g, b\}$ is:

$$\pi_c(\mathbf{q}; i, m) = (\alpha - E(t_1; i, m))q_1 + (\alpha - E(t_2; i, m))q_2 - (q_1^2 + q_2^2)/2 - \gamma q_1 q_2$$

where $\alpha > b$, $\gamma \in (0, 1)$ and

$$E(t_j; i, m) = \sum_{t \in \{g,b\}} t \mu_j(t; i, m) = g + (b - g) \mu_j(b; i, m).$$

We analyze the sequential equilibrium of the game.

Remark 1 *The behavioral strategy profile $\sigma^e = \{\mathbf{p}^e, \mathbf{r}^e, \mathbf{q}^e\}$ and belief vector $\boldsymbol{\mu}^e$ constitute a sequential equilibrium if and only if the following conditions hold:*

*t) For every $i = 1, 2$, $t \in \{g, b\}$ such that $p_i^e(t) > 0$ and $t' \neq t$ it must be the case that
$$\tau_i(r_g^e(i, t) - r_g^e(i, t'))(q_i^e(i, g) - q_i^e(i, b)) \geq k(t) - k(t')$$

*m) For any $i \in \{1, 2\}$ and $m \in \{g, b\}$ such that $r_m^e(i, t) > 0$ for some $t \in \{g, b\}$ and any $m' \neq m$ it must be the case that
$$(q_i^e(i, m) - q_i^e(i, m'))t_i \leq (q_{\sim i}^e(i, m') - q_{\sim i}^e(i, m))E(t_{\sim i}; i, m)$$

*q) For any $i = 1, 2$, $j = 1, 2$ and $m \in \{g, b\}$ it must be the case that

$$q_i^e(j, m) = \begin{cases} \alpha - E(t_i; j, m) & \gamma \geq \frac{\alpha - E(t_{\text{-}i}; j, m)}{\alpha - E(t_i; j, m)} \\ \frac{\alpha(1-\gamma) - E(t_i; j, m) + \gamma E(t_{\text{-}i}; j, m)}{1 - \gamma^2} & \frac{\alpha - E(t_i; j, m)}{\alpha - E(t_{\text{-}i}; j, m)} \geq \gamma \text{ and } \frac{\alpha - E(t_{\text{-}i}; j, m)}{\alpha - E(t_i; j, m)} \geq \gamma \\ 0 & \gamma \geq \frac{\alpha - E(t_i; j, m)}{\alpha - E(t_{\text{-}i}; j, m)} \end{cases}$$

*μ) For any $i = 1, 2$, $t \in \{g, b\}$ and $m \in \{g, b\}$ the belief function $\mu_j^e(t|i, m)$ is fully consistent with σ i.e., there exists some sequence $(\hat{\mathbf{p}}^k(\cdot), \hat{\mathbf{r}}^k(\cdot))_{k=1}^{\infty}$ such that following conditions are satisfied:

$$\hat{p}_i^k(t) \in (0, 1) \text{ for any } i = 1, 2 \text{ and } t \in \{g, b\} \tag{2}$$
$$\hat{r}_m^k(i, t) \in (0, 1) \text{ for any } i = 1, 2, \ m \in \{g, b\} \text{ and } t \in \{g, b\},$$

for every $i \in \{1, 2\}$, $m \in \{g, b\}$ and $t \in \{g, b\}$

$$(p_i^e(t), r_m^e(i, t)) = \lim_{k \to \infty} (\hat{p}_i^k(t), \hat{r}_m^k(i, t)) \tag{3}$$

and

$$\mu_i^e(t|i, m) = \lim_{k \to \infty} \frac{\hat{p}_i^k(t)\hat{r}_m^k(i, t)}{\sum_{t'} \hat{p}_i^k(t')\hat{r}_m^k(i, t')} \tag{4}$$

$$\mu_{\text{-}i}^e(t|i, m) = \lim_{k \to \infty} \frac{\hat{p}_{\text{-}i}^k(t) \sum_{t_i} \hat{p}_i^k(t_i)\hat{r}_m^k(i, t_i)}{\sum_{t'} \hat{p}_{\text{-}i}^k(t') \sum_{t_i} \hat{p}_i^k(t_i)\hat{r}_m^k(i, t_i)} = p_i^e(t).$$

2.3   Results with an Activist

Our first result establishes some useful and substantively interesting properties of any sequential equilibrium in which at least one firm chooses g with positive probability.

The first property establishes that a firm chooses g with positive probability only if it is monitored with sufficiently high probability. This critical monitoring probability is increasing in both the cost advantage of adopting the bad technology and magnitude of g. Recall that as g get larger, the difference between the two technologies to the consumer becomes less significant.

The second property demonstrates that in order for firm i to choose g with positive probability the activist must send the g signal with higher probability when the firm i chooses g than when it chooses b. This critical difference in the probability of sending the good message - endorsing the firm - is, again, increasing in both the cost advantage of adopting the bad technology and magnitude of g but decreasing in the exogenous probability that the firm is monitored by the activist.

The third property demonstrates that the consumer must consume more of firm $i's$ product when the activist sends the signal that the firm has chosen g than when the activist sends signal b. This critical difference in demand caused by the activist's endorsement of a firm is increasing in the cost advantage of adopting the bad technology and in the exogenous probability that the firm is monitored by the activist.

The fourth property establishes that if one firm is good with positive probability there is an upper bound on the probability the other firm chooses g i.e., there is

no sequential equilibrium in which both firms choose g with probability 1. This upper bound depends on the consumer's asessment of the relative importance of the technologies and on the substitutability between goods.

The final property demonstrates that firm i can only choose g with positive probability when both firm's products are sufficiently close substitutes. This critical degree of substitutability is greater the lower is the consumer's assessment of the relative importance of the alternative technologies.

The proposition restricts attention to possible equilibruim profiles such that $r_g^e(i,g) \geq r_g^e(i,b)$ for any $i = 1,2$ i.e., that the activist is weakly more likely to send the message g when it observes that the firm chooses g than it is to send the message g when the firm chooses b. This restriction does not preclude the activist from always sending either message or sending both signals with identical probability (babbling).

Proposition 4 *In any sequential equilibrium such that $r_g^e(i,g) \geq r_g^e(i,b)$ for any $i = 1,2$ it is the case that $p_i^e(g) > 0$ only if*

1. $\tau_i \geq \frac{d}{\alpha - g}$

2. $r_g^e(i,g) - r_g^e(i,b) \geq \frac{d}{\tau_i(\alpha - g)}$

3. $q_i^e(i,g) - q_i^e(i,b) \geq \frac{d}{\tau_i}$

4. $\frac{b\gamma - g}{\gamma(b-g)} \geq p_{\sim i}^e(g)$

5. $\gamma \geq \frac{g}{b}$

Proof. It follows from *t that $p_i^e(g) > 0$ only if

$$\tau_i \left(q_i^e(i,g)(r_g^e(i,g) - r_g^e(i,b)) + q_i^e(i,b)(r_b^e(i,g) - r_b^e(i,b)) \right) \geq d$$
$$\tau_i \left(q_i^e(i,g)(r_g^e(i,g) - r_g^e(i,b)) + q_i^e(i,b)(r_g^e(i,b) - r_g^e(i,g)) \right) \geq d$$
$$\tau_i(r_g^e(i,g) - r_g^e(i,b)) \left(q_i^e(i,g) - q_i^e(i,b) \right) \geq d$$

Results 1-3 follow from $1 \geq r_g^e(i,g) - r_g^e(i,b) \geq 0$ for any $i = 1,2$,

$$\alpha - g \geq q_i^e(i,g) - q_i^e(i,b) \text{ by *q}$$

and

$$1 \geq r_g^e(i,g) - r_g^e(i,b).$$

Result 2 implies $r_g^e(i,g) > 0$ and $r_b^e(i,b) > 0$. Condition *m then requires the following two equations

$$[q_i^e(i,g) - q_i^e(i,b)]g \leq [b - (b-g)p_{\sim i}^e(g)][q_{\sim i}^e(i,b) - q_{\sim i}^e(i,g)]$$
$$[q_i^e(i,g) - q_i^e(i,b)]b \geq [b - (b-g)p_{\sim i}^e(g)][q_{\sim i}^e(i,b) - q_{\sim i}^e(i,g)]$$

We now show result 4: $p_i^e(g) > 0$ implies $p_{\sim i}^e(g) \leq \frac{b\gamma - g}{\gamma(b-g)}$. WLOG suppose $p_1^e(g) > 0$ and let $E_g = E(t_1; 1, g)$, $E_b = E(t_1; 1, b)$, $E_2 = E(t_2; 1, g) = E(t_2; 1, b)$. Let $\Delta q_1 =$

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$q_1^e(1,g) - q_1^e(1,b)$ and $\Delta q_2 = q_2^e(1,g) - q_2^e(1,b)$ Result 3 implies $E_g < E_b$. There are five cases to consider. If $\gamma \geq \frac{\alpha - E_g}{\alpha - E_2}$ then $\Delta q_1 = 0$ violating result 3. If $\gamma \geq \frac{\alpha - E_2}{\alpha - E_b}$ then $\Delta q_1 > 0$ and $\Delta q_2 = 0$ violating *m. If $\gamma \leq \frac{\alpha - E_2}{\alpha - E_b}$, $\gamma \leq \frac{\alpha - E_2}{\alpha - E_g}$, $\gamma \leq \frac{\alpha - E_g}{\alpha - E_2}$ and $\gamma \leq \frac{\alpha - E_b}{\alpha - E_2}$ then $\Delta q_1 = -\frac{1}{\gamma}\Delta q_2$. Since condition *m requires

$$\frac{\Delta q_1}{-\Delta q_2} \leq \frac{E_2}{g}$$

we get the condition that

$$p_2^e(g) \leq \frac{b\gamma - g}{\gamma(b - g)}.$$

Similarly when $\gamma \geq \frac{\alpha - E_b}{\alpha - E_2}$, $\gamma \leq \frac{\alpha - E_2}{\alpha - E_g}$ and $\gamma \leq \frac{\alpha - E_g}{\alpha - E_2}$ we get

$$\frac{\Delta q_1}{-\Delta q_2} = \frac{\frac{\alpha(1-\gamma) - E_g + \gamma E_2}{1 - \gamma^2}}{\alpha - E_2 - \frac{\alpha(1-\gamma) - E_2 + \gamma E_g}{1 - \gamma^2}} = \frac{1}{\gamma}$$

and as above

$$p_2^e(g) \leq \frac{b\gamma - g}{\gamma(b - g)}.$$

Finally, if $\gamma \geq \frac{\alpha - E_2}{\alpha - E_g}$, $\gamma \leq \frac{\alpha - E_2}{\alpha - E_b}$ and $\gamma \leq \frac{\alpha - E_b}{\alpha - E_2}$ then since $\frac{\alpha - E_2}{\alpha - E_g} \geq \frac{\alpha - E_2}{\alpha - g}$ it must be the case that

$$\gamma \geq \frac{\alpha - E_2}{\alpha - g}$$

and therefore

$$p_2^e(g) \leq \frac{b - \gamma g - \alpha(1 - \gamma)}{b - g}.$$

We have shown that

$$p_2^e(g) \leq \max\left(\frac{b\gamma - g}{\gamma(b - g)}, \frac{b - \gamma g - \alpha(1 - \gamma)}{b - g}\right).$$

Note that

$$\frac{b - \gamma g - \alpha(1 - \gamma)}{b - g} < \frac{b\gamma - g}{\gamma(b - g)}$$

whenever $\gamma \in (\frac{1}{\alpha - g}g, 1)$. But the constraint $p_2^e(g) \leq \frac{b - \gamma g - \alpha(1 - \gamma)}{b - g}$ only applies when $\gamma \geq \frac{\alpha - E_2}{\alpha - E_g} \geq \frac{\alpha - b}{\alpha - g}$ and since $\alpha > b + g$ implies

$$\frac{\alpha - b}{\alpha - g} > \frac{1}{\alpha - g}g$$

it follows that

$$p_2^e(g) \leq \frac{b\gamma - g}{\gamma(b - g)}.$$

Result 5 follows from Result 4 and $p^e{}_i(g) \geq 0$. ∎

The first three results in the proposition follow from condition *t which requires that there be a sufficient gain in quanitity of firm i's product consumed to compensate the firm for its increased cost of production. This can only occur when the activist's signal is informative to the consumer and the consumer acts on the activist's signal.

The fourth result that both firms cannot choose g with probability too close to one follows as a consequence of the activist's utility function. For example, suppose both firms choose g with probability one in a potential equilibrium profile. Results 2 and 3 imply that when the activist sends the message b upon observing firm i consumers reduce their consumption of firm $i's$ product. Now since the firms products are not perfect substitutes the overall level of consumption must be lower than when the activist sends signal g. But given both firms are identical the activist will prefer to send the signal b even when it observes g.

The fifth result that requires the firm's products to be sufficiently close substitutes arises because if the only consequence of the activist reporting b is a reduction in the quantity consumed of firm i then the activist will prefer to always send signal b. Results 4 and 5 make clear that the credibility of the activist depends on the potential negative effects of shifting consumption from a firm that is known to have chosen g to a firm that has probably chosen b.

The previous proposition demonstrated necessary conditions for an equilibrium in which at least one firm chooses g with positive probability. The next proposition establishes that when the activist monitors at least one firm's choice and the products are sufficiently close substitutes there is a sequential equilibrium in which one firm chooses g with probability one.

Proposition 5 *If $\gamma \geq \frac{g}{b}$ then there is a sequential equilibrium such that $p_i^e(g) = 1$ and $p_{-i}^e(g) = 0$ for some $i = 1, 2$.*

Proof. The proof is by construction. Since $\tau_i + \tau_{-i} = 1$ WLOG assume $\tau_1 \geq 1/2$ and let the equilibrium behavioral strategy profile be $\sigma^e = \{\mathbf{p}^e, \mathbf{r}_m^e, \mathbf{q}^e\}$ and the belief vector be $\boldsymbol{\mu}^e$ where

$$
\begin{aligned}
p_1^e(g) &= 1 \\
p_2^e(g) &= 0 \\
r_m^e(1, g) &= \begin{cases} 1 & \text{if } m=g \\ 0 & \text{otherwise} \end{cases} \\
r_m^e(1, b) &= \begin{cases} 1 & \text{if } m=b \\ 0 & \text{otherwise} \end{cases} \\
r_m^e(2, t) &= .5 \text{ for any } m \text{ and } t. \\
\mathbf{q}^e(i, m) &\text{ as in *q}
\end{aligned}
$$

and for any $t, m \in \{g, b\}$

$$
\begin{aligned}
\mu_1^e(m|1, t) &= \begin{cases} 1 & \text{if } m=t \\ 0 & \text{otherwise} \end{cases} \\
\mu_2^e(g|j, m) &= 0 \text{ for any } j, m \in \{1, 2\}
\end{aligned}
$$

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The consumer's strategy satisfies *q by construction. To see that the activist's strategy is in equilibrium recall that $p_2^e(g) = 0$. Condition *m requires four equations to be satisfied:

$$[q_1^e(1,g) - q_1^e(1,b)]g \leq b[q_2^e(1,b) - q_2^e(1,g)] \tag{5}$$

$$q_1^e(1,g) - q_1^e(1,b) \geq q_2^e(1,b) - q_2^e(1,g) \tag{6}$$

$$[q_2^e(2,g) - q_2^e(2,b)]g = b[q_1^e(2,b) - q_1^e(2,g)] \tag{7}$$

$$q_2^e(2,g) - q_2^e(2,b) = q_1^e(2,b) - q_1^e(2,g) \tag{8}$$

Equations (5) and (6) guarantee that when the activist monitors firm 1 she has an incentive to send message g when firm 1 chooses g and to send message b when firm one chooses b. Equations (7) and (8) guarantee that when the activist monitors firm 2 she is indifferent between sending message g and b whatever firm 2 chooses. It is easy to verify that Equations (7) and (8) are satisfied because $\mu_i^e(b|2,g) = \mu_i^e(b|2,b)$ for any $i = 1, 2$ and therefore $q_1^e(2,b) - q_1^e(2,g) = q_2^e(2,g) - q_2^e(2,b) = 0$. To verify that equations (5) and (6) are satisfied we must consider two cases. When firm 1 is monitored consumer beliefs imply that $E(t_1; 1, g) = g$, $E(t_1; 1, b) = b$ and $E(t_2; 1, m) = b$ for any $m \in \{b, g\}$. When $\gamma \leq \frac{\alpha - b}{\alpha - g}$ *q implies that

$$q_1^e(1,g) - q_1^e(1,b) = \frac{\alpha(1-\gamma) - g + \gamma b}{1 - \gamma^2} - \frac{\alpha - b}{1 + \gamma} = \frac{b - g}{1 - \gamma^2}$$

and

$$q_2^e(1,b) - q_2^e(1,g) = \frac{\alpha - b}{1 + \gamma} - \frac{\alpha(1-\gamma) - b + \gamma g}{1 - \gamma^2} = \gamma \frac{b - g}{1 - \gamma^2}$$

Thus $\gamma \leq \frac{\alpha - b}{\alpha - g}$ implies

$$q_1^e(1,g) - q_1^e(1,b) = \frac{1}{\gamma}\left(q_2^e(1,b) - q_2^e(1,g)\right) > 0 \tag{9}$$

Equation (5) is satisfied by $\gamma \geq \frac{g}{b}$ and equation (6) follows from $\gamma < 1$. When $\gamma > \frac{\alpha - b}{\alpha - g}$

$$q_1^e(1,g) - q_1^e(1,b) = (\alpha - g) - \frac{\alpha - b}{1 + \gamma}$$

and

$$q_2^e(1,b) - q_2^e(1,g) = \frac{\alpha - b}{1 + \gamma}.$$

Equation (5) requires that

$$\frac{\alpha - g}{\alpha - b}(1 + \gamma) \leq \frac{b}{g} + 1$$

which is obviously true for α sufficiently large since $b > g$, more precisely we get the requirement that $\alpha > b + 2g$. Equation (6) requires that

$$\frac{\alpha - g}{\alpha - b} \geq \frac{2}{1 + \gamma}$$

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But $\gamma > \frac{\alpha-b}{\alpha-g}$ implies that

$$\frac{2}{1+\frac{\alpha-b}{\alpha-g}} > \frac{2}{1+\gamma}.$$

Thus we need only verify that

$$\frac{\alpha-g}{\alpha-b} \geq \frac{2}{1+\frac{\alpha-b}{\alpha-g}} = 2\frac{\alpha-g}{2\alpha-g-b}$$

which follows from $b > g$.

Condition *t requires

$$\tau_1\left(r_g^e(1,g)-r_g^e(1,b)\right)\left(q_1^e(1,g)-q_1^e(1,b)\right) \geq d \tag{10}$$

and

$$\tau_2\sum_m q_2^e(2,m)(r_m^e(2,b)-r_m^e(2,g)) \geq -d. \tag{11a}$$

Equation (11a) is satisfied because $r_m^e(2,b)-r_m^e(2,g)=0$ for any m. Equation (10) is satisfied because $r_g^e(1,g)-r_g^e(1,b)=1$, $\tau_1 \geq 1/2$, $q_1^e(1,g)-q_1^e(1,b) \geq b-g$ and $b-g \geq 2d$. To see that $q_1^e(1,g)-q_1^e(1,b) \geq b-g$ note that when $\gamma \leq \frac{\alpha-b}{\alpha-g}$ condition *q implies that

$$q_1^e(1,g)-q_1^e(1,b) = \frac{b-g}{1-\gamma^2} \geq b-g$$

When $\gamma > \frac{\alpha-b}{\alpha-g}$ we have

$$q_1^e(1,g)-q_1^e(1,b) = (\alpha-g) - \frac{\alpha-b}{1+\gamma} > b-g$$

Thus

$$q_1^e(1,g)-q_1^e(1,b) \geq b-g.$$

It only remains to show that *μ is satisfied. It is easy to see that *μ is satisfied for $\mu_i^e(t|1,g)$, $\mu_i^e(t|2,g)$, $\mu_i^e(t|2,b)$ because the firm, message pairs $\{(1,g),(2,g),(2,b)\}$ all occur with positive probability in equilibrium. It is only necessary to show that we can construct a sequence of fully mixed behavioral strategy profiles, $(\hat{\mathbf{p}}^k(\cdot),\hat{\mathbf{r}}^k(\cdot))_{k=1}^\infty$, that converge to the equilibrium profile with the property that for every $i \in \{1,2\}$ and $t \in \{g,b\}$

$$\mu_i^e(t|1,b) = \lim_{k\to\infty} \hat{\mu}_i^k(t|1,b)$$

Let $\varepsilon \in (0,1)$ and

$$\begin{aligned}
\hat{p}_1^k(g) &= 1-\varepsilon^k \\
\hat{p}_2^k(b) &= 1-\varepsilon^k \\
r_m^e(1,t) &= \begin{cases} 1-\varepsilon^{k^2} & \text{if } m=t \\ \varepsilon^{k^2} & \text{otherwise} \end{cases} \\
r_m^e(2,t) &= .5 \text{ for any } m \text{ and } t.
\end{aligned}$$

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Then

$$\mu_1^e(g|1,b) = \cfrac{1}{1 + \lim_{k\to\infty} \frac{\varepsilon^k(1-\varepsilon^{k^2})}{\varepsilon^{k^2}(1-\varepsilon^k)}} = 0$$

$$\mu_1^e(b|1,b) = \cfrac{1}{1 + \lim_{k\to\infty} \frac{\varepsilon^{k^2}(1-\varepsilon^k)}{\varepsilon^k(1-\varepsilon^{k^2})}} = 1$$

It follows from (4) that

$$\mu_2^e(g|1,b) = \lim_{k\to\infty} \hat{p}_2^k(g) = \lim_{k\to\infty} \varepsilon^k = 0$$

and

$$\mu_2^e(b|1,b) = \lim_{k\to\infty} \hat{p}_2^k(bg) = \lim_{k\to\infty} 1 - \varepsilon^k = 1$$

■

One implication of Proposition 5 concerns the welfare implications of activists. As we stated in the previous section, when the consumer observes the firm's quality choice it is the case that one firm choosing g and the other firm choosing b results in a welfare improvement over both firms choosing b. In equilibrium the consumer knows the quality choice of each firm and therefore the presence of an activist can actually result in a welfare improvement. Note however that the activist does not guarantee welfare maximization because for some values of γ both firm's choosing g is optimal and such a result is not possible according to Proposition 4.

While Proposition 4 implies that both firm's choosing g cannot be an equilibrium it does allow the possibility that both firms may choose g with probability approaching one as γ goes to 1. The next proposition complements proposition 5 by showing that there always exists a mixed strategy equilibrium in which both firms choose g with positive probability if the cost difference d is not large.

Proposition 6 *There exists a SE σ^e such that $p_i^e(g) = \frac{\gamma b - g}{\gamma(b-g)}$ for all $i \in \{1,2\}$ if $\gamma \geq g/b$ and $\tau_i \geq \frac{2d}{g}$ for all $i \in \{1,2\}$*

Proof. The proof is by construction. For all $i \in \{1,2\}$ define

$$p_i^e(g) = \frac{\gamma b - g}{\gamma(b-g)}$$

$$r_g^e(i,g) = \rho_i$$
$$r_b^e(i,b) = 1$$

$$q_i^e(i,m) \text{ as in *q}$$

$$\mu_i(g|i,b) = (\gamma b - g)\frac{1-\rho_i}{\gamma b - \gamma g - \rho_i \gamma b + \rho_i g}$$
$$\mu_i(g|i,g) = 1$$
$$\mu_{\sim i}(g|i,m) = \frac{\gamma b - g}{\gamma(b-g)}$$

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where $\rho_i \in (0,1)$ is defined in equation (14) below. Observe that

$$E(t_i : i, g) = g$$

$$E(t_i : i, b) = g\frac{b - \rho_i\gamma b - g + \rho_i g}{\gamma b - \gamma g - \rho_i\gamma b + \rho_i g}$$

$$E(t_i : \tilde{i}, m) = b - (b - g)p^e_i(g) = \frac{g}{\gamma}$$

Therefore $E(t_i : i, g) < E(t_i : \tilde{i}, m) \le E(t_i : i, b)$. We now show that

$$q^e_i(i, g) - q^e_i(i, b) = \frac{1}{\gamma}\left(q^e_{\tilde{i}}(i, b) - q^e_{\tilde{i}}(i, g)\right) > 0 \qquad (12)$$

therefore *m is satisfied since

$$\left(q^e_i(i, g) - q^e_i(i, b)\right)g = E(t_i : \tilde{i}, m)\left(q^e_{\tilde{i}}(i, b) - q^e_{\tilde{i}}(i, g)\right)$$

and

$$\left(q^e_i(i, g) - q^e_i(i, b)\right)b > E(t_i : \tilde{i}, m)\left(q^e_{\tilde{i}}(i, b) - q^e_{\tilde{i}}(i, g)\right).$$

We first show that (12) holds whenever $\gamma \le \frac{\alpha - E(t_i : \tilde{i}, g)}{\alpha - E(t_i : i, g)}$ and $E(t_i : i, g) < E(t_i : \tilde{i}, m) \le E(t_i : i, b)$. Then we show that $\gamma \le \frac{\alpha - E(t_i : \tilde{i}, g)}{\alpha - E(t_i : i, g)}$. To see that (12) holds whenever $\gamma \le \frac{\alpha - E(t_i : \tilde{i}, g)}{\alpha - E(t_i : i, g)}$ and $E(t_i : i, g) < E(t_i : \tilde{i}, m) \le E(t_i : i, b)$ suppose that $\gamma \le \frac{\alpha - E(t_i : i, b)}{\alpha - E(t_{\tilde{i}} : i, b)}$. Then *q implies

$$q^e_i(i, g) - q^e_i(i, b) = \frac{E(t_i : i, b) - E(t_i : i, g)}{1 - \gamma^2}$$

and

$$q^e_{\tilde{i}}(i, b) - q^e_{\tilde{i}}(i, g) = \gamma\frac{E(t_i : i, b) - E(t_i : i, g)}{1 - \gamma^2}$$

Equation (12) follows from $E(t_i : i, g) < E(t_i : i, b)$ and $\gamma \in (0, 1)$. On the other hand if $\gamma > \frac{\alpha - E(t_i : i, b)}{\alpha - E(t_{\tilde{i}} : i, b)}$ then $q^e_i(i, b) = 0$ and

$$q^e_i(i, g) - q^e_i(i, b) = \frac{\alpha}{1 + \gamma}$$

and

$$q^e_{\tilde{i}}(i, b) - q^e_{\tilde{i}}(i, g) = \alpha - \frac{g}{\gamma} - \frac{\alpha(1 - \gamma) - \frac{g}{\gamma} + \gamma g}{1 - \gamma^2} = \gamma\frac{\alpha}{1 + \gamma}$$

Since *q and *μ are satisfied by construction it only remains to show that *t is satisfied. Condition *t requires

$$\tau_i(r^e_g(i, g) - r^e_g(i, b))(q^e_i(i, g) - q^e_i(i, b)) = d. \qquad (13)$$

Let $\Delta q_i(\rho_i) = q^e_i(i, g) - q^e_i(i, b)$. Then

$$\Delta q_i(\rho_i) = \begin{cases} \frac{g(b - g)}{(1 + \gamma)(\gamma b - \gamma g - \rho_i\gamma b + \rho_i g)} & if \quad \rho_i \le (b - g)\frac{\alpha\gamma - g}{\alpha(\gamma b - g)} \\ \frac{\alpha}{1 + \gamma} & if \quad \rho_i \ge (b - g)\frac{\alpha\gamma - g}{\alpha(\gamma b - g)} \end{cases}$$

It follows from $\alpha > b > g$ and $\alpha > b + g$ that

$$\Delta q_i(\rho_i) \geq \Delta q_i(0) = \frac{g}{(1+\gamma)\gamma} > \frac{g}{2}.$$

Since $g > 2\frac{d}{\tau_i}$ by assumption and since

$$\tau_i\big(r_g^e(i,g) - r_g^e(i,b)\big)\big(q_i^e(i,g) - q_i^e(i,b)\big) = \tau_i\rho_i\Delta q_i(\rho_i) = 0$$

when $\rho_i = 1$ it follows that there is a $\rho_i \in (0,1)$ that solves (13). Thus ρ_i is defined as follows:

$$\rho_i \in \{\rho \in (0,1) : \tau_i\rho\Delta q_i(\rho) = d\} \tag{14}$$

∎

Thus, the activist can support equilibria in which both firms adopt the good technology with positive probability. The maximum probability both firms choose the good technology is increasing in the degree of substitutability between products.

3   Implications and Discussion

It is fitting to end by highlighting two important limitations and possible extensions of our analysis. These limitations and possible extensions pertain to our representation of consumers and the activists ability to commit to its endorsement strategy prior to a firms technology choice.

One important limitation of our model is the assumption that consumers are identical. That is, all consumers value the social costs of production at all and by the same quantitative amount. To be sure, in many of the circumstances to which our model might apply, consumers may value the unit social costs of production differently. Some consumers, indeed, may have different qualitative assessments of a firms production practices. An important extension of our model would introduce heterogeneous consumers with different quantitative and qualitative assessments of a firms unit social costs of production.

Another important limitation of our model involves the sequential rationality of the activists endorsement strategy. The activists endorsement decision is made subsequent to the technology decisions of firms. In attempting to obtain an activists endorsement, many firms respond to the published criteria or established guidance of the activists organization. That is, some activists appear to commit to a standard that insures endorsement (when met) or excoriation (when deficient) in advance of the technology decisions of firms. The ability to commit to such a standard can affect activists influence on a market for credence goods. Commitment to a standard might also enable the activist to support social cost standards unachievable under its sequentially rational endorsement strategy.

References

[1] Akerloff, George F. 1970. "The Market for Lemons: Qualitative Uncertainty and the Market Mechanism." *Quarterly Journal of Economics*, 84:488-500.

[2] Baron, David P. 1996. *Business and Its Environment*, 2nd Edition. Upper Saddle River, New Jersey: Prentice-Hall, Inc.

[3] Becker, Gary A. 1983. "A Theory of Competition Among Pressure Groups for Political Influence." *Quarterly Journal of Economics*, 98:371-400.

[4] Darby, Michael R. and Edi Karni. 1973. "Free Competition and the Optimal Amount of Fraud." *Journal of Law and Economics*, 16:67-88.

[5] Diermeier, Daniel. 1995. "Shell, Greenpeace, and Brent Spar." Typescript. Graduate School of Business, Stanford University.

[6] Lizzeri, Alessandro. 1994. "Information Revelation and Certification Intermediaries." Typescript, Northwestern University.

[7] Lyons, Zachary D. *Boycott Quarterly*, Vol. 1, No. 4. Spring, 1994.

[8] Nelson, P. 1970. "Information and Consumer Behavior." *Journal of Political Economy*, 78:311-329.

[9] Peltzman, Sam. 1978. "Toward a More General Theory of Regulation." *Journal of Law and Economics*. 19:211-240.

[10] Smith, N. Craig. 1995. "Marketing Strategies for the Ethics Era." *Sloan Management Review*, 36:85-97.

[11] Tirole, Jean. 1988. *The Theory of Industrial Organization*. Cambridge, MA: MIT Press.

[12] Vogel, David. 1978. *Lobbying the Corporation: Citizen Challenges to Business Authority*. New York: Basic Books.

[13] Institute for Consumer Responsibility. *National Boycott News*. Issue 8, 1992-3.