Temporary Boycotts as Self-Fulfilling Disruptions of Markets*

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Abstract

We consider a two-period durable goods monopoly model with demand uncertainty. When uncertainty is non-multiplicative, there can be equilibria in which, whenever the period 0 price exceeds a threshold, then with positive probability all consumers boycott in period 0. A consumer who in period 0 would purchase in the non-boycott equilibrium is willing to join a boycott because a boycott prevents the firm from learning demand. This dampens period 1 prices on average and makes the boycott self-fulfilling. Connections to the bank runs literature are discussed.

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1. Introduction

When each individual consumer has a negligible effect on the market, and derives utility only from his consumption bundle (of the good and money), it is usually assumed that collective action such as a consumer boycott cannot arise in equilibrium. If a consumer would purchase in the absence of a boycott, why would he forego the purchase to join a boycott? We show here that the expectation that all consumers will join a boycott can be self-fulfilling, without requiring a preference for punishing the firm, a preference for participating in a boycott or a fear of social pressure, bounded rationality, or other departures from the standard model of consumer behavior.

The setting is a two-period durable goods monopoly model with demand uncertainty. In the "non-boycott" equilibrium, the price in period 0, \( p_0 \), is such that consumers with sufficiently high valuations purchase, while consumers with lower valuations prefer to wait and hope for a lower price in period 1. The firm updates its beliefs about the state of demand based on period 0 sales, which affects the optimal price in period 1. A consumer with the cutoff valuation is indifferent between purchasing in period 0 and purchasing in period 1 at a price that will depend on period 0 sales. However, in the subgame following the firm’s choice of \( p_0 \), if consumers boycott the product then the firm must set \( p_1 \) having learned nothing about demand. If this \( p_1 \) is less than the expected price that would prevail without a boycott, then it is possible that all consumers would refuse to pay \( p_0 \) during a boycott, while consumers with valuations above a cutoff would pay \( p_0 \) in the absence of a boycott. We use the term boycott success probability to refer to the probability that a boycott equilibrium is selected in the subgame following \( p_0 \), when such an equilibrium exists. If the boycott success probability is small, then boycotts can take place on the equilibrium path of the full game. If the boycott success probability is large, then the firm will be induced to acquiesce and choose \( p_0 \) lower than what it would have chosen without the boycott threat.

To be sure, many real world boycott movements are led by activists who object to the policies of firms or nations. Baron (2001) and Baron and Diermeier (2007) model the interplay between a monopolist, who faces a cost of reducing its objectionable behavior, and an activist, who receives utility based on the firm’s behavior and its own efforts in organizing a boycott or otherwise punishing the firm. The activist, being a large player, avoids the free rider problem faced by an individual consumer. Innes (2006) models an environmental activist who interacts with duopolistic polluters, and shows that boycotts can arise on the equilibrium
path even with symmetric information. John and Klein (2003) study the purchase decisions of individual consumers who object to an "egregious act" on the part of the producer. Thus, consumers care directly about the firm's policy, but there is a free rider problem due to the absence of a large activist. John and Klein (2003) find that a consumer will join a boycott only if he (i) can significantly affect the firm's probability of abandoning the egregious act, (ii) incorrectly believes that his purchase decision directly influences the firm, (iii) is extremely altruistic, or (iv) derives utility from participating in the boycott, having a clean conscience from not purchasing, etc. All of these features are absent from the current model.

Not all real world boycotts involve egregious acts--sometimes consumers simply object to the high prices being charged. Friedman (1995) documents a series of consumer boycotts during the twentieth century, triggered by high prices and mostly supported by social pressure and local monitoring. Rea (1974) provides a theoretical analysis of boycotts, where again the only egregious act is the setting of high prices, but under the assumption that social pressure can enforce cooperation at the individual level.

When the market for e-books was first taking off in 2007 and 2008, some Amazon Kindle e-book owners attempted to boycott e-books priced over $10, and Amazon decided to incentivize its authors to price at or below $10. See the popular press and new media articles by Ganapati (2009), Rich (2010), Eckstein (2012), and Catan et al (2012). This is a complicated industry with competition from Apple and others, supply chain issues, and antitrust issues. This paper is not a model of the e-book industry. However, some features of this industry are captured by the present model. This is a market in which there is significant uncertainty about optimal prices, both for e-books relative to print books during 2007 and 2008 and for new titles in general. Consumers are forward looking and decide on the timing of their purchase. It is difficult to see how social pressure can be applied to enforce a boycott, so the question of individual incentives emerges. For a potential best seller, an equilibrium of the model could support a self-fulfilling boycott threat inducing the seller to accept an initial release price at $10, which would avoid a boycott and allow demand to be learned. Then if the title turns out to have high demand, the price is increased, and if demand is moderate to low, the price is maintained or decreased.

The layout of the paper is as follows. Section 2 lays out the model and shows that if demand uncertainty is multiplicative, boycott equilibria do not arise. Intuitively, when the firm knows the demand curve up to a multiplicative factor, it has
nothing to learn about optimal prices and the model can be solved by backward induction. Section 3 studies an example with non-multiplicative uncertainty and constructs an equilibrium where the subgame following \( p_0 \) has a boycott equilibrium. It also constructs a second equilibrium with a different value for \( p_0 \), in which the firm cuts its price to avoid a boycott. Section 4 constructs an equilibrium in which boycotts occur on the equilibrium path with positive probability. Section 5 offers some concluding remarks on the close connection to the Diamond-Dybvig bank runs literature.

2. The Model

A monopoly seller with production cost normalized to zero sells a durable good over two periods. Consumers demand either 0 or 1 unit of the good, and demand uncertainty is captured by the parameter \( \alpha \in [\alpha, \bar{\alpha}] \), so the measure of active consumers with valuation at least \( v \) in state \( \alpha \) is given by \( D(v, \alpha) \). We assume that \( D(v, \alpha) \) is twice continuously differentiable and strictly decreasing in \( v \), over the support of valuations in state \( \alpha \), \([0, \bar{\alpha}(\alpha)]\). The highest possible valuation, \( \bar{\alpha} \), satisfies \( D(\bar{\alpha}, \alpha) = 0 \). We also assume that \( D(v, \alpha) \) is strictly increasing in \( \alpha \) for all \( v < \bar{\alpha}(\alpha) \), and satisfies the revenue concavity condition,

\[
\frac{\partial^2 D(p, \alpha)}{\partial p^2} + 2 \frac{\partial D(p, \alpha)}{\partial p} < 0.
\]

The firm and all consumers share the same discount factor between period 0 and period 1, denoted by \( \delta \). Thus, if a consumer with valuation \( v \) purchases the good at price \( p \) in period 0, his utility is \( v - p \), and if he purchases in period 1, his utility is \( \delta(v - p) \).

The firm and consumers know the distribution of \( \alpha \), characterized by the continuous density function \( f(\alpha) \), but they do not observe the realization. Think of the following process generating the set of active consumers. First, nature draws the demand state according to \( f(\alpha) \). Then, out of the population of “potential” consumers \( D(0, \bar{\alpha}) \), nature randomly and independently selects each consumer to be active with probability \( \frac{D(0, \alpha)}{D(0, \bar{\alpha})} \). Finally, for the selected active consumers, nature randomly and independently selects a valuation \( v \) from the distribution \((1 - \frac{D(v, \alpha)}{D(0, \alpha)}) \).

The timing of the game is as follows. At the beginning of period 0, the firm selects a price, \( p_0 \). Then, active consumers find out that they are active and

\[^1\text{See Deneckere and Peck (2012).}\]
decide whether to purchase at the price $p_0$ or wait until period 1. The firm observes the quantity of sales in period 0. At the beginning of period 1, the firm chooses a price, $p_1$, and active consumers who did not purchase in period 0 decide whether to purchase at the price $p_1$ or to not consume. The solution concept is Perfect Bayesian Equilibrium (PBE). However, since all equilibria involve a cutoff valuation $v^*(p_0)$ above which a consumer purchases in period 0 and below which a consumer does not purchase in period 0, the only relevant belief is the firm’s probability distribution over $\alpha$ in period 1, contingent on observed purchases in period 0.

**Definition 1:** The subgame following $p_0$ has a boycott equilibrium if it has a PBE in which no consumer purchases in period 0 for any $\alpha$ (that is, we have $v^*(p_0) = \overline{v}$).

We now characterize the value of $p_0$ above which a boycott equilibrium exists for the subgame. This result is not interesting by itself, because $p_0$ is treated as exogenous, but it will be useful later on. If consumers boycott in period 0, then consistency requires the firm to believe that $\alpha$ is distributed according to $f(\alpha)$. In period 1, sequential rationality on the part of a consumer with valuation $v$ requires him to purchase at price $p$ if and only if we have $v \geq p$. Therefore, the sequentially rational period 1 price $p_1^B$ solves

$$\max_p \int_{\overline{\alpha}}^{\alpha} pD(p, \alpha)f(\alpha)d\alpha.$$  

Because of our concavity assumption on revenue, $p_1^B$ is the unique solution to the first order condition

$$\int_{\overline{\alpha}}^{\alpha} \left[ p \frac{\partial D(p, \alpha)}{\partial p} + D(p, \alpha) \right] f(\alpha)d\alpha = 0. \quad (2.1)$$ 

Given $p_1^B$, we have the following characterization.

**Lemma 1:** The subgame following $p_0$ has a boycott equilibrium if and only if $p_0 \geq \overline{v}(1 - \delta) + \delta p_1^B$ holds.

**Proof.** Suppose $p_0 \geq \overline{v}(1 - \delta) + \delta p_1^B$ holds. Having specified the period 1 actions and beliefs above, it remains to show that all consumers prefer not to purchase in period 0. This will be the case if the highest valuation consumer prefers not to
purchase in period 0, which occurs if $\tau - p_0 \geq \delta(\tau - p_1^B)$. Thus, the subgame has a boycott equilibrium.

Now suppose $p_0 < \tau(1 - \delta) + \delta p_1^B$ holds. Then if no other consumers purchase in period 0, a consumer with valuation $\tau$ is better off purchasing, contradicting the possibility of a boycott equilibrium. ■

**Definition 2:** Demand uncertainty is multiplicative if there exists a function $\tilde{D}$ such that we have $D(p, \alpha) = \alpha \tilde{D}(p)$.

Proposition 1 below shows that when demand uncertainty is multiplicative, for any equilibrium period 0 price $p_0$, there are positive sales in period 0, revealing the state, and there is no boycott equilibrium to the subgame. Intuitively, under multiplicative uncertainty the firm knows the per capita demand curve $\tilde{D}(p)$ but not the size of the market. Since pricing decisions do not depend on $\alpha$, there is no benefit from boycotting in period 0. A boycott would increase the residual demand in period 1, to the disadvantage of consumers.

**Proposition 1:** If demand uncertainty is multiplicative, then in any equilibrium, sales are positive in period 0, and the subgame following the equilibrium $p_0$ does not have a boycott equilibrium.

**Proof.** In period 1 after any history, the unique sequentially rational action for a consumer with valuation $v$ is to purchase at price $p$ if and only if we have $v \geq p$. Now consider the firm’s pricing decision in period 1 following a history in which $v^*(p_0) \geq \tau$ holds. Denoting the firm’s beliefs about the state by $\mu(\alpha)$, the sequentially rational $p_1$ solves

$$\max_p \int_{\Omega} p \alpha \tilde{D}(p) \mu(\alpha) d\alpha = p \tilde{D}(p) \int_{\Omega} \alpha \mu(\alpha) d\alpha,$$

characterized by the first order condition

$$p \frac{d\tilde{D}(p)}{dp} + \tilde{D}(p) = 0. \quad (2.2)$$

Since (2.1) simplifies to (2.2) when we have multiplicative uncertainty, it follows that the solution to (2.2) is $p_1^B$. Following a history in which $v^*(p_0) < \tau$ holds and
period 0 sales are \( q_0 \), Bayes’ rule allows the firm to assign probability one to the state satisfying \( \alpha \hat{D}(v^*(p_0)) = q_0 \). The sequentially rational \( p_1 \) solves

\[
\max_p \alpha p [\hat{D}(p) - \tilde{D}(v^*(p_0))],
\]
given by the unique solution to the first order condition

\[
p \frac{d\hat{D}(p)}{dp} + \hat{D}(p) - \tilde{D}(v^*(p_0)) = 0. \tag{2.3}
\]

Notice that \( p_1 \) depends only on \( v^* \) and not the firm’s beliefs. We denote the price by \( p_1(v^*) \) and the period 1 profit by \( \alpha p_1(v^*(p_0)) [\hat{D}(p_1(v^*(p_0))) - \tilde{D}(v^*(p_0))] \equiv \alpha \pi_1(v^*(p_0)). \)

Now consider the period 0 decision of a consumer with valuation \( \pi \) facing the price \( p_0 \). If \( p_0 \geq \pi(1 - \delta) + \delta p_1^B \) holds, then this consumer prefers to wait if \( v^*(p_0) = \pi \) holds, and is even better oﬀ waiting if there is an interior cutoff. Therefore, \( p_0 \geq \pi(1 - \delta) + \delta p_1^B \) implies \( v^*(p_0) = \pi \). If \( p_0 < \pi(1 - \delta) + \delta p_1^B \) holds, then a consumer with valuation \( \pi \) prefers to purchase in period 0 if \( v^*(p_0) = \pi \) holds, so there must be an interior cutoff, given by the indifference condition

\[
\begin{align*}
    v^*(p_0) - p_0 &= \delta(v^*(p_0) - p_1(v^*(p_0))), \text{ or} \\
    (1 - \delta)v^*(p_0) &= p_0 - \delta p_1(v^*(p_0)). \tag{2.4}
\end{align*}
\]

Since \( p_1(v^*(p_0)) \) is increasing in \( v^*(p_0) \), the left side of (2.4) is increasing in \( v^*(p_0) \) and the right side is decreasing in \( v^*(p_0) \), so the solution is unique.

We finally consider the firm’s pricing decision in period 0. The optimal \( p_0 \) solves

\[
\max_p \int_\pi \frac{\alpha \hat{D}(v^*(p)) + \delta \alpha \pi_1(v^*(p))}{f(\alpha)} d\alpha
\]

\[
= \max_p [p \hat{D}(v^*(p)) + \delta \pi_1(v^*(p))] \int_\pi \alpha f(\alpha) d\alpha.
\]

Notice that the optimal \( p_0 \) does not depend on the distribution of \( \alpha \). For \( p < \pi(1 - \delta) + \delta p_1^B \) we can compute the derivative of the term in brackets with respect
to $p$ as

$$
\tilde{D}(v^*(p)) + p \frac{d\tilde{D}(v^*(p))}{dp} \frac{dv^*(p)}{dp} + \delta \frac{d\pi_1(v^*(p))}{dv^*(p)} \frac{dv^*(p)}{dp}
$$

$$
= \tilde{D}(v^*(p)) + p \frac{d\tilde{D}(v^*(p))}{dp} \frac{dv^*(p)}{dp} + \delta [-p_1(v^*(p)) \frac{d\tilde{D}(v^*(p))}{dp}] \frac{dv^*(p)}{dp}
$$

$$
= \tilde{D}(v^*(p)) + \frac{d\tilde{D}(v^*(p))}{dp} \frac{dv^*(p)}{dp} [p - \delta p_1(v^*(p))]. 
$$

(2.5)

Evaluated at $p = \pi (1 - \delta) + \delta p_1^B$ (where we have $v^*(p) = \pi$), expression (2.5) simplifies to

$$
\frac{d\tilde{D}(v^*(p))}{dp} \frac{dv^*(p)}{dp} [\pi (1 - \delta)] < 0.
$$

Therefore, the firm strictly prefers to induce an interior cutoff, with $p < \pi (1 - \delta) + \delta p_1^B$, so given the equilibrium $p_0$, there does not exist a boycott equilibrium. In fact, the equilibrium is unique if there is a unique $p$ such that expression (2.5) is zero. 

3. Boycott Equilibrium with Non-Multiplicative Uncertainty

When demand uncertainty is not multiplicative, then the optimal price in period 1 depends on the firm’s beliefs about demand. We show here that this can lead to multiple equilibria based on the possibility of a boycott. In the non-boycott equilibrium of this example, the period 0 price leads to an interior cutoff $v^*(p_0)$. However, the equilibrium $p_0$ satisfies $p_0 > \pi (1 - \delta) + \delta p_1^B$, so the subgame following $p_0$ also has a boycott equilibrium. In this section, we use this boycott threat to construct other equilibria with a smaller price in period 0. In the following section, we introduce the augmented game with a sunspot variable that triggers a boycott with a probability between zero and one, which allows for equilibrium with actual (and not just threatened) boycotts on the equilibrium path.

3.1. Example.

For the remainder of this paper, we assume a linear/uniform demand structure:

$$
D(p, \alpha) = \alpha - p \\
\alpha \sim U[0, 1].
$$
Because the upper support of the valuations depends on the state, there is an equilibrium in which period 0 sales are positive if $\alpha$ is above some threshold, denoted by $\hat{\alpha}$, and sales are zero if $\alpha$ is below the threshold. Then a positive quantity sold allows the firm to infer the state perfectly, and a zero quantity sold allows the firm to infer that the state is below the threshold.

Let us construct this equilibrium by working backwards. In period 1 after any history, a consumer with valuation $v$ will purchase at price $p$ if and only if $v \geq p$ holds.

For histories in which nothing is sold in period 0, Bayes’ rule requires the firm to believe that $\alpha$ is uniformly distributed over the interval $[0, \hat{\alpha}]$, where $\hat{\alpha}$ is the largest state such that all valuations are below the (yet to be determined) cutoff $v^*(p_0)$, i.e., $\hat{\alpha} = v^*(p_0)$. Therefore, the sequentially rational price $\tilde{p}_1$ solves

$$\max_p \int_0^{\hat{\alpha}} p(\alpha - p) d\alpha,$$

with solution $\tilde{p}_1(\hat{\alpha}) = \frac{\hat{\alpha}}{2}$. The corresponding profits are given by $\tilde{\pi}_1(\hat{\alpha}) = \frac{\hat{\alpha}^2}{2}$.

For histories in which output $q_0$ is sold in period 0 at price $p_0$, Bayes’ rule requires the firm to assign probability one to a particular state $\alpha$, determined from the equilibrium cutoff $v^*(p_0)$ according to the equation

$$q_0 = \alpha - v^*(p_0).$$

Therefore, the sequentially rational price $p_1$ solves

$$\max_p p(\alpha - p - q_0) = \max_p p(v^*(p_0) - p),$$

with solution $p_1 = \frac{v^*(p_0)}{2}$. The corresponding profits are given by $\pi_1(v^*(p_0)) = \frac{v^*(p_0)^2}{4}$.

Now let us determine the cutoff consumer valuation as a function of $p_0$, above which consumers purchase and below which consumers do not purchase in period 0. The indifference condition determining $v^*(p_0)$ is

$$v^*(p_0) - p_0 = \delta[v^*(p_0) - E(p_1|\text{active type } v^*)].$$

Notice that a consumer with valuation $v^*(p_0)$, by virtue of being active, assigns probability one to $\alpha > v^*(p_0)$ and a strictly positive quantity sold. Therefore,
the state will be revealed and the firm will set the price \( p_1 = \frac{v^*(p_0)}{2} \). Therefore, equation (3.1) simplifies to:

\[
v^*(p_0) = \frac{2p_0}{2 - \delta}.
\]  

(3.2)

The firm’s choice of \( p_0 \) affects the cutoff consumer valuation given by (3.2) and the set of states that are revealed. Sequential rationality requires that this price solve

\[
\max_{p_0} \int_0^{2p_0 / (2 - \delta)} \frac{2(2p_0)^2}{27} d\alpha + \int_{2p_0 / (2 - \delta)}^1 \left[ p_0(\alpha - \frac{2p_0}{2 - \delta}) + \frac{(2p_0 - 2\delta)^2}{4} \right] d\alpha,
\]  

(3.3)

with solution

\[
p_0 = \frac{3}{4}(2 - \delta)(9\delta - 12 + \sqrt{35\delta^2 - 70\delta + 36})}{23\delta - 27}.
\]  

(3.4)

This completes the construction of the equilibrium with an interior cutoff. We can derive the expression for \( v^*(p_0) \) by substituting (3.4) into (3.2). Notice that for all \( \alpha > v^*(p_0) \), there are sales in period 0 and we have \( p_1 = \frac{1}{2}v^*(p_0) \), and for all \( \alpha < v^*(p_0) \), there are no sales in period 0 and we have the lower price, \( p_1 = \frac{1}{3}v^*(p_0) \).

**Remark 1.** The result that \( p_1 \) does not depend on the revealed state depends on the special properties of this demand function. Of course, this makes trivial the computation of the marginal consumer’s expectation of \( p_1 \). For other demand functions, where \( p_1 \) depends on the revealed state, the marginal consumer’s expectation of \( p_1 \) is computed using the density of \( \alpha \), conditional on being active of type \( v^* \), given by

\[
\frac{\partial D(v^*\alpha)}{\partial p} \frac{1}{D(0,\alpha)} f(\alpha) \int_{\alpha}^{p_0} \frac{\partial D(v^*\alpha)}{\partial p} \frac{1}{D(0,\alpha)} f(\alpha) d\alpha.
\]

See Deneckere and Peck (2012) for details.

### 3.2. Boycott Equilibrium.

Using Lemma 1 and the fact that \( p_1^B = \frac{1}{3} \), we can determine the values of \( \delta \) for which there is a boycott equilibrium in the subgame after the firm sets the price.

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\(^2\)If (3.2) yields a cutoff greater than 1, then we are at a corner in which all valuations delay their purchase. Taking into account corner solutions, we have \( v^*(p_0) = \min\left[\frac{2p_0}{2 - \delta}, 1\right] \).
according to (3.4). One can verify that a boycott equilibrium exists whenever 
\[ \delta > 0.94832. \]

For example, suppose we have \( \delta = 0.96. \) Then the equilibrium as derived in 
Section 3.1 is given by\(^3\)

\[
\begin{align*}
p_0 &= 0.36977 \\
v^*(p_0) &= \min[1.92308 \cdot p_0, 1] \\
p_1 &= \frac{v^*(p_0)}{3} \text{ if } q_0 = 0 \\
p_1 &= \frac{v^*(p_0)}{2} \text{ if } q_0 > 0 \\
\text{firm beliefs} & : \ 
\alpha \sim U[0, v^*(p_0)] \text{ if } q_0 = 0 \\
\alpha &= q_0 + v^*(p_0) \text{ w.p. } 1 \text{ if } q_0 > 0.
\end{align*}
\]

On the equilibrium path, we have \( p_0 = 0.36977, \ v^* = 0.71109, \ p_1 = 0.23703 \) when 
there are no sales in period 0, and \( p_1 = 0.35555 \) when there are positive sales 
in period 0. Equilibrium profits are 0.07606. If a consumer with valuation \( v^* = 0.71109 \) 
eeds that he and all consumers with higher valuations will purchase in 
period 0, then he knows that the demand state will be revealed and he antipates 
\( p_1 = 0.35555. \) Then indeed he is indifferent between purchasing in period 0 and 
waiting, and higher valuation consumers strictly prefer to purchase. Thus the 
continuation of the game is an equilibrium of the subgame following \( p_0 = 0.36977. \)

From Lemma 1, a boycott equilibrium exists for the subgame whenever \( p_0 > 0.36, \) so it exists following \( p_0 = 0.36977 \) as specified in (3.5). Here is the intuition. 
If everyone joins the boycott, then the firm cannot rule out the low demand states, 
so the optimal \( p_1 \) is only \( \frac{1}{3}. \) Anticipating that price, all consumers prefer to wait 
rather than pay \( p_0 = 0.36977 \) in period 0. Thus, a boycott equilibrium exists.

The example demonstrates the following result:

**Proposition 2:** If demand uncertainty is not multiplicative, then there are economies 
for which the subgame following the equilibrium \( p_0 \) has a boycott equilibrium.

If consumers are prepared to boycott whenever \( p_0 \) admits a boycott equilibrium, then the firm is not best responding by choosing that price. It would be

\(^3\)In this and subsequent specifications of equilibrium, we presume for ease of presentation 
that \( q_0 \) does not exceed the quantity sold in state \( \alpha = 1. \) If instead we have \( q_0 > 1 - v^*(p_0), \) 
then let the firm believe that \( \alpha = 1 \) and price in period 1 based on \( v^* = 1 - q_0. \)
better off choosing \( p_1^B \) in period 0, due to discounting. Thus, the certainty of a boycott cannot be an equilibrium to the full game. However, the threat of a boycott introduces multiple equilibria to the full game. In our example, any \( p_0 \in (0.36, 0.36977) \) is consistent with equilibrium, based on the threat to boycott when the firm deviates to a higher price. Here is one such equilibrium:

\[
\begin{align*}
    p_0 &= 0.365 \\
    v^*(p_0) &= 1.92308 \cdot p_0 \quad \text{if } p_0 \leq 0.365 \\
    v^*(p_0) &= 1 \quad \text{if } p_0 > 0.365 \\
    p_1 &= \frac{v^*(p_0)}{3} \quad \text{if } q_0 = 0 \\
    p_1 &= \frac{v^*(p_0)}{2} \quad \text{if } q_0 > 0 \\
    \text{firm beliefs} : \quad &\alpha \sim U[0, v^*(p_0)] \quad \text{if } q_0 = 0 \\
    &\alpha = q_0 + v^*(p_0) \quad \text{w.p. } 1 \quad \text{if } q_0 > 0
\end{align*}
\]

On the equilibrium path, we have \( p_0 = 0.365, \ v^* = 0.70192, \ p_1 = 0.23397 \) when there are no sales in period 0, and \( p_1 = 0.35096 \) when there are positive sales in period 0.

### 4. Boycotts on the Equilibrium Path

In the previous section, we showed how the threat of a boycott can credibly force the firm to offer lower prices. In this section, we show that boycotts can occur with positive probability on the equilibrium path. To model the uncertainty over whether a boycott effort will be successful, we introduce to the game a stage in which agents observe a public random variable that has no intrinsic effect on payoffs but may serve to coordinate actions. In the bank runs and macro literatures, this is called a sunspot variable. Here is the timing of the augmented game. At the beginning of period 0, the firm selects a price, \( p_0 \). Then, all agents (including the firm) observe the realization of a sunspot variable, \( \sigma \), which without loss of generality is uniformly distributed on the unit interval. Next, active consumers find out that they are active and decide whether to purchase at the price \( p_0 \) or wait until period 1. The firm observes the quantity of sales in period 0. At the beginning of period 1, the firm chooses a price, \( p_1 \), and active consumers who did
not purchase in period 0 decide whether to purchase at the price $p_1$ or to not consume.

We will construct an equilibrium of the augmented game, corresponding to our example with $\delta = 0.96$, parameterized by a boycott success probability $\sigma$. That is, a boycott occurs if the subgame following $p_0$ and $\sigma$ has a boycott equilibrium and $\sigma \leq s$. Here is the candidate equilibrium.

$$
\begin{align*}
p_0 &= 0.36977 \\
v^*(p_0, \sigma) &= \min[1.92308 \cdot p_0, 1] \text{ if } \sigma > s \\
v^*(p_0, \sigma) &= 1.92308 \cdot p_0 \text{ if } \sigma \leq s \text{ and } p_0 \leq 0.36 \\
v^*(p_0, \sigma) &= 1 \text{ if } \sigma \leq s \text{ and } p_0 > 0.36
\end{align*}
$$

(4.1)

$$
\begin{align*}
p_1 &= \frac{v^*(p_0, \sigma)}{3} \text{ if } q_0 = 0 \\
p_1 &= \frac{v^*(p_0, \sigma)}{2} \text{ if } q_0 > 0
\end{align*}
$$

The subgames, following $\sigma > s$ and following $p_0 \leq 0.36$ and $\sigma \leq s$, correspond to our original game and are therefore in equilibrium based on the analysis above. The subgame following $p_0 > 0.36$ and $\sigma \leq s$ has a boycott equilibrium with $p_1 = \frac{1}{3}$, and it is easy to see that the continuation strategies and belief specified in (4.1) satisfy sequential rationality and consistency. Therefore, the candidate will be a PBE if, given the parameter $s$, the firm’s choice of $p_0$ is sequentially rational. Let us consider the possible deviations. For deviations $p_0 > 0.36$, the firm’s payoff does not change if $\sigma \leq s$ holds, since a boycott occurs in both cases; if $\sigma > s$ holds, then the continuation strategies are as specified in (3.5), so $p_0 = 0.36977$ is optimal within this range of prices. For deviations $p_0 \leq 0.36$, then the subgame does not have a boycott equilibrium and the continuation strategies are as specified in (3.5). Therefore, the optimal price within this range is $p_0 = 0.36$. Intuitively, the firm must decide either to (i) tolerate a small probability of a boycott and choose $p_0 = 0.36977$, since changes in $p_0$ do not affect what happens following a boycott, or (ii) prevent the possibility of a boycott, in which case the optimal $p_0$ is the highest price for which there is no boycott equilibrium.

For what values of $s$ will $p_0 = 0.36977$ yield higher profits than $p_0 = 0.36$, in
which case the candidate (4.1) is a PBE? This occurs if and only if we have
\[(1 - s) \cdot 0.07606 + s \cdot 0.074074 \geq 0.07603, \tag{4.2}\]
which follows from the fact that 0.07606 is the firm’s profit in (3.5), 0.074074 (or \(\frac{2}{3} \)) is the profit following a boycott, and 0.07603 is the profit from substituting \(p_0 = 0.36\) into (3.3). Equating both sides of (4.2) and solving for the highest boycott success probability \(\bar{\sigma}\), we find that (4.1) is a PBE whenever \(s \leq \bar{\sigma} = 0.015505\).

The more patient the agents (higher \(\delta\)), the higher the probability of boycotts that the firm would be willing to tolerate on the equilibrium path.\(^4\) Also, the more certain the demand (perhaps \(\alpha \sim U[\alpha, 1]\) for this example, where higher \(\alpha\) corresponds to less demand uncertainty), the lower the probability of boycotts that the firm would be willing to tolerate on the equilibrium path.

Several features of this equilibrium are worth discussing. Sales in period 0, on the equilibrium path, can be zero for two different reasons in this example. The first possibility is that we have \(\sigma \leq s\), and consumers of all valuations join the boycott. The second possibility is that we have \(\sigma > s\), so consumers with valuations above \(v^* = 0.71109\) would purchase, but the realization of \(\alpha\) is small enough that no consumers with valuations above \(v^* = 0.71109\) are active. Our assumption that the firm observes \(\sigma\) guarantees that the firm can distinguish these two possibilities; without it, upon seeing that sales are zero, the firm’s beliefs about \(\alpha\) depend on the parameter \(s\), and the equilibrium changes. We believe that for most markets, consumers could not organize a boycott without the firm finding out about it.

The equilibrium has the property that, with fixed probability \(s\), the consumers boycott whenever a boycott equilibrium exists. Different equilibria are also possible. One could construct an equilibrium in which, with fixed probability \(s\), consumers boycott only a subset of the period 0 prices admitting a boycott equilibrium. Alternatively, one could construct a more complicated equilibrium in which the probability of a boycott following \(p_0\) depends on the value of \(p_0\).

There are many demand functions with non-multiplicative uncertainty in which the support of valuations does not depend on \(\alpha\).\(^5\) With such a demand function, whenever a boycott is not in place, there will always be a positive quantity sold in period 0 which reveals the state. Unfortunately, it is difficult to find closed-form solutions for \(v^*(p_0)\) (see Remark 1).

\(^4\)For \(\delta = 0.99\), a similar computation yields a boycott whenever \(s \leq \bar{\sigma} = 0.11429\).

\(^5\)For example, \(D(v, \alpha) = 1 - v^\alpha\).
5. Concluding Remarks

One aspect of the boycotts modeled in this paper seems very unrealistic. That is, even the most successful of boycotts will not be 100% effective. Are there equilibria of the model in which only a fraction of consumers participate in a boycott? If a known fraction of consumers do not participate, then the firm would be able to infer demand, undermining the incentive for others to join a boycott. However, if signals are not perfectly correlated, I conjecture that there can be equilibria with partial boycotts on the equilibrium path, supported by uncertainty about the extent of the boycott. Consumers receiving a signal to join a boycott would update their beliefs in favor of large boycotts and fewer sales in period 0, while consumers not receiving a signal to join a boycott would update their beliefs in favor of small boycotts and more sales in period 0. Thus, for a given valuation, a consumer receiving a signal to join a boycott would expect a lower price in period 1 than a consumer not receiving a signal to join a boycott, thereby incentivizing the former consumer to join and the latter consumer not to join. Such an exercise would be considerably more complicated than the exercise performed here.

We conclude with a discussion on the connection to the Diamond-Dybvig (DD) bank runs model. In the DD model, the bank offers a deposit contract and agents deposit their endowment in period 0. In period 1, some agents learn that they are “impatient” and must consume during that period, while others are “patient” and can consume during either period 1 or period 2. One unit of consumption yields a return of 1 if liquidated in period 1 and a return of $R > 1$ if liquidated during period 2. Assuming the fraction of impatient consumers is known, the equilibrium (simple) contract provides insurance against being impatient, offering $c_1 > 1$ units for those who withdraw in period 1, and $c_2 < R$ units for those who withdraw in period 2. In the non-run equilibrium, patient consumers prefer to withdraw in period 2, since when all patient consumers wait, the promised consumption $c_2$ is feasible and $c_2 > c_1$. However, there is also a run equilibrium, since if everyone withdraws in period 1, the bank will liquidate all of its resources in period 1 and there will be nothing left for a patient deviator who waits until period 2.\(^6\)

\(^6\)The DD bank runs literature looks at the case in which the fraction of impatient consumers is not known and looks at more complicated contracts that allow partial or full suspension of convertibility. It also considers other issues such as lack of commitment, deposit insurance, and bailouts. See Diamond and Dybvig (1983), Wallace (1988), Cooper and Ross (1998), Green and Lin (2003), Peck and Shell (2003), Ennis and Keister (2009a, 2009b), and Shell and Zhang (2015).
is, the boycott equilibrium corresponds to the non-run equilibrium, because consumers coordinate on the most efficient equilibrium (for them) and wait to transact. The more standard equilibrium specified in (3.5) corresponds to the run equilibrium; we can think of consumers as panicking and failing to coordinate on the more efficient boycott equilibrium. The boycott success probability, in which sunspots serves to coordinate whether or not a boycott equilibrium occurs in the subgame, plays the same role as the propensity to run in Peck and Shell (2003), in which sunspots serves to coordinate whether or not a run equilibrium occurs in the post-deposit subgame.

Of course, the similarities only go so far. The economic contexts are completely different: durable goods monopoly vs. a mutually held bank that invests and insures against the timing of consumption needs. While consumers in the present model face a monopolist seeking to maximize its profits, depositors in the DD model face a bank that seeks to maximize the ex ante expected utility of the representative depositor. Because the firm and the bank have different objectives, the role of sunspots is somewhat opposite in the two models. A small enough boycott success probability allows a boycott on the equilibrium path, since if the firm was sure that the consumers would boycott given the chance, then it would offer a low enough $p_0$ to eliminate the boycott equilibrium. Thus, the probability of the more efficient equilibrium (to consumers) must be sufficiently small. On the other hand, a small enough propensity to run allows a bank run on the equilibrium path, since if all agents were sure that a bank run would occur, no one would deposit in the first place. Thus, the probability of the more efficient equilibrium, the non-run equilibrium, must be sufficiently large.

References


