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Are consumer boycotts effective?

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Abstract This paper derives the conditions of success of a consumer boycott generated by environmental preferences. Overall the chance of success of this kind of boycott appears to be small. Indeed, the consumers the most able to hurt the targeted firm's profit are those with the highest opportunity cost of boycotting. Thus they are less likely to participate in the boycott. Conversely, people the most involved in the boycott are those with high environmental preferences and small amounts of consumption, which prevent them from hurting the firm's profit enough. Moreover, a consumer boycott is a kind of prisoner dilemma, which reduces its likelihood of success.

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1 Introduction

A boycott campaign consists of concerted economic or social ostracism of an individual, group or nation to express its disapproval or coerce change. The term "boycott" refers to C. Boycott, an English civil servant, whose rudeness led his employees to refuse all cooperation with him. In September 1880, protesting tenants demanded that Captain Boycott give them a substantial reduction in their rents. He refused. Charles Stuart Parnell, the President of the Land League, suggested in a speech that the way to force Boycott to give way was for everyone in the locality to refuse to have any dealings with him.

"Economic consumer boycotts" (Friedman, 1999), i.e. the individual or collective choice of not buying some product, is now a frequently used tool by NGOs or lobby groups in order to protest against unfair marketing, social or environmental practices. For example, in 1959, a group of South African exiles and their British supporters called for a boycott of fruits, cigarettes and other goods imported from South Africa to oppose apartheid. More recently, a boycott of Israeli products and tourism followed decades of refusal to abide by UN resolutions, International Humanitarian law and the Fourth Geneva Convention.

Consumer boycotts upon environmental arguments are quite frequent and a strategy commonly used by many environmental NGOs. A first example is the boycott of cosmetic firms (e.g: Procter and Gamble, Colgate-Palmolive), because of their use of animal testing. Another case is the boycott of major oil companies (e.g: Total, ESSO, Shell), for their environmental damages and their supposed lobbying efforts to deter climate change policies. Some large fast-food companies (e.g: McDonald's) are targeted by a boycott campaign because of their supposed environmentally unfriendly way to produce meat. Finally, some NGOs support the boycott of non-certified tropical timber, to protest against unsustainable harvest practices.

Boycotts constitute for unsatisfied consumers a way to compensate for government inactivity. In the case of environmental degradation, consumer boycotts are a substitute to environmental policies or rules. The objective is to put enough pressure on the target to make it change its behavior.

Most researchers have focused on field studies (Miller and Sturdivan, 1977; Pruitt and Friedman, 1986; Garrett, 1987; Koku et al., 1997; Teoh et al. 1999) or history of consumer

boycotts (Friedman, 1985, 1995; Smith, 1990). To our knowledge, only one paper provides an experimental analysis of consumer boycotts (Tyran and Engelmann, 2005).

This paper makes two contributions. First, it studies analytically under which conditions a consumer boycott is successful. We consider a boycott as successful if, according to the boycott group's objectives, it induces a positive change in the behavior of the targeted firm or sector. Therefore, we do not discuss the case of a boycott of which the aim is only to signal disapproval to its target. Second, the paper focuses on environmental boycott, which is yet a topic to be addressed in the economic literature. Note here that consumer boycotts upon social and health considerations follow roughly the same analysis.

Take the case of a firm producing a good with a polluting technology. There is no government intervention to internalize the negative externality. This firm could opt for another technology, less or not polluting, but more expensive. A first comment is that the choice of the cheap and polluting technology is probably the result of a profit maximization. The success of an environmental boycott is therefore determined by its capacity of hurting the firm's profit enough to make the second technology more profitable. In this context, the main factor determining the success of the boycott is probably the consumers preferences, which induce the demand structure.

The conditions of success of an environmental boycott depend on several market characteristics. First, the consumers environmental preferences may create some scale for ecological certification and product differentiation. With free entry, a second firm may choose to enter the market and provide the good with clean production. Market structure is not considered explicitly here. Only one firm is boycotted and the existence of an imperfect substitute is considered, of which the production is clean but which provides lower utility.

Second, information is crucial on both sides of the problem. On the one hand, the firm needs to have complete and perfect information of the demand side and of the consumers preferences in its profit maximization (for otherwise, there is room for signaling boycott). On the other hand, the consumers need also good information on the demand characteristics, available technologies and the boycott's modalities, in order not to get involved in a boycott which has no chance to succeed.

Finally, strategic considerations are to be taken into account. Indeed, a consumer boycott represents a prisoner dilemma. Any individual consumer, even if unsatisfied with the use of

the polluting technology and hoping for the boycott to succeed, has an incentive to free ride and continue to consume the good. The total or relative anonymity of consuming behaviors reinforces this incentive.

Of course, with perfect information and no free rider behavior, one could only witness successful boycotts. Indeed, in that case, the perfectly informed consumers would only follow a boycott if its success is certain. However, we will first consider this case as a benchmark, in order to determine which patterns of the demand provide room for a successful environmental consumer boycott. We assume therefore that both consumers and the firm have perfect information about the demand patterns and the producing process. Moreover, by assumption, the consumers never free ride. Imperfect information and strategic behaviors are to be introduced later.

In this context, an environmental consumer boycott resembles a complete information war of attrition with asymmetric preferences between the targeted firm and the boycotting consumers. Complete information war of attrition models were first introduced by Maynard Smith (1974, 1982), studying animal behavior. Economic applications of war of attrition models include predatory pricing (Roth, 1996), exit in oligopoly (Fudenberg and Tirole, 1986) and the provision of public goods (Bilodeau and Slivinsky, 1996). Kornhauser et al. (1989) and Fudenberg and Tirole (1986) proposed criteria for selection among potential perfect equilibria.

Burton (2004) first considers asymmetry in the players motivations in a war of attrition model. A group of environmentalists decides to blockade the access to an indivisible resource in order to preserve it, while a firm projects to harvest it. The player winning the conflict has *de facto* property rights on the resource. The following model is an application of Burton's asymmetry in the context of a consumer boycott. A group of consumers decides to stop consuming a good produced with a polluting technology, to induce the targeted firm to opt for a clean technology. The firm prefers to use the polluting technology because it is profit maximizing. Overall, the chance of success of a consumer boycott depends on the trade off between the hurting capacity of the boycott group and the opportunity cost of boycotting. The consumers the most able to hurt the firm 's profit have large amounts of consumption. Thus, their opportunity cost of boycotting is large.

Section 2 presents a complete information war of attrition model and section 3 analyzes the conditions under which a boycott is successful.

2 Environmental boycott as a war of attrition with perfect information

A war of attrition is a model of aggression between two players. The game takes the form of a succession of identical periods. Each period, the two players choose simultaneously between remaining into the game or withdrawing. The model is stationary: each period represents the same type of problem for both players, with no information gain nor change in costs or benefits. The winning player is the one able to remain the longer in the game.

In the context studied here, the two players considered are a group of consumers and a firm. Some consumers refuse to consume the firm's good as long as it is produced with a polluting technology. This model differs from other war of attrition models, because it considers asymmetric motivations and payoffs.

2.1 Technology choice and consumers behavior

Firm's technology choice: The firm has chosen between two technologies. Technology 1 is cheap but polluting. Each unit of the good produced with technology 1 emits one unit of pollution. The equilibrium total production thus equals the total volume of pollution, e. Technology 2 is clean but more expensive. In equilibrium, total production with technology 2 is c and does not imply any pollution.

We consider the case in which the firm has chosen technology 1, which implies that, in equilibrium, it generates larger profit than technology 2, i.e. $\pi_1(e) > \pi_2(c)$. The equilibrium production, e and c, and the profit schedules, π_1 and π_2, are different simply because the production costs, the price of the good and the demand structure are not the same whether produced with the dirty or the clean technology.

Consumption patterns: The consumers population is of size 1. Two homogeneous groups can be distinguished. The environmentalists (type-i) represent a share α, exogenously given,

of the population. The utility of an environmentalist U_i increases with his individual consumption and decreases with the total amount of pollution: $U_i(e_i; e)$; $\frac{\partial U_i}{\partial e_i} > 0$, $\frac{\partial U_i}{\partial e} < 0$. e_i is the individual consumption of type-i consumers, that maximizes their utility (implicitly subject to a budget constraint) when the good is produced with technology 1. The environmentalists are unsatisfied with technology 1 and would prefer the firm to produce with technology 2. c_i is the equilibrium consumption of type-i consumers with technology 2.

$$U_i(e_i, e) < U_i(c_i, 0) \tag{1}$$

A share $(1-\alpha)$ of consumers (type-j) only considers individual consumption in its utility function: $U_j(e_j)$; $\frac{\partial U_j}{\partial e_j} > 0$, $\frac{\partial U_j}{\partial e} = 0$. e_j is the type-j individual consumption that maximizes their utility, when the good is produced with technology 1. Type-j consumers prefer the firm to produce with technology 1, because they do not care about pollution and technology 1 is cheaper. Thus they have larger consumption when the good is produced with the dirty technology, $e_j > c_j$.

$$U_j(e_j) > U_j(c_j) \tag{2}$$

Type-j consumers consume more than type-i consumers if the firm produces with technology 1, because type-i consumers take into account the pollution induced by their own consumption: $e_j > e_i$.

Boycott as a war of attrition: Type-i consumers would prefer the firm to use technology 2. To get this goal, a consumer boycott is announced (with perfect information), requiring for any consumer unsatisfied with the use of technology 1 to stop consuming the good produced. Any boycotting consumer switches its consumption of the good for the consumption of an imperfect substitute that provides lower utility ($U_i(s; e) < U_i(e_i, e)$, $\forall e$), but of which the production is clean.

The success of the boycott consists of hurting the firm's profit enough to make technology 2 more profitable. In this context, a consumer boycott represents a kind of war of attrition, with an asymmetry in the players motivations. The firm and the consumers act simultaneously within a single time period. The model is stationary: each period represents the same type of problem for both players, with no information gain nor change in costs or benefits. The winning player is the one able to stay the longer in the game without making loss.

The firm has the choice between keeping technology 1 (remaining in the game) or switching to technology 2 (withdrawing): $p = [0, 1]$. Type-i consumers have the choice between continuing (remaining) or stopping (withdrawing) the boycott: $q_i = [0, 1]$. Type-j consumers never boycott: $q_j = 1$.

Each period, both players consider the net benefit of remaining into the game. If the net benefit is positive, the player chooses to remain in the game. If it is negative, the player withdraws and lets the other player win the game.

Of course, each player's net benefit of remaining in the game depends on the other player's strategy. Each period, the outcome is therefore a couple of strategies $(p^*(q_i), q_i^*(p))$.

2.2 Firm's net benefit of keeping the polluting technology

Each period, the firm chooses between keeping technology 1 and switching to technology 2. Switching technology is assumed to be costless, but switching back is not possible.

If the environmentalists stop the boycott ($q_i = 1$), the firm keeps using technology 1 and gets the full profit $\pi_1(e)$. If the boycott continues ($q_i = 0$) and the firm keeps using technology 1, only type-j consumers (who never boycott) consume the good. The residual consumption under boycott is $\underline{e}(\alpha, e_i, e_j)$, which decreases with the importance of type-i consumption and increases with type-j consumption: $\frac{\partial \underline{e}}{\partial \alpha} < 0$, $\frac{\partial \underline{e}}{\partial e_i} < 0$, $\frac{\partial \underline{e}}{\partial e_j} > 0$. It generates profit $\pi_1(\underline{e}) < \pi_1(e)$. Finally, the firm can choose to switch technology and to get $\pi_2(c)$.

The net benefit of keeping technology 1 is therefore the expected benefit of keeping technology 1 (considering type-i consumers choice) minus the benefit generated by switching to technology 2:

$$B_f = q_i \pi_1(e) + (1 - q_i)\pi_1(\underline{e}(\alpha, e_i, e_j)) - \pi_2(c) \tag{3}$$

If B_f is positive, the firm keeps using technology 1, and sets $p = 0$. If B_f is negative, the firm switches to technology 2 and sets $p = 1$. This net benefit depends on the type-i consumers strategy of continuing or not the boycott. The net benefit of the firm is positive if q_i is above the threshold:

$$\overline{q} \equiv \frac{\pi_2(c) - \pi_1(\underline{e})}{\pi_1(e) - \pi_1(\underline{e})} \tag{4}$$

Thus the firm's optimal strategy $p^*(q_i)$ is:

$$\begin{cases} p^* = 0 \ for \ q_i > \overline{q} \\ p^* = 1 \ for \ q_i \leq \overline{q} \end{cases} \tag{5}$$

Note that for $q_i = \overline{q}$, the firm is indifferent between the two strategies. We assume however that in that case, the firm chooses to switch to technology 2 (let call it an implicit preference for compromise).

2.3 Consumers net benefit of continuing the boycott

Type-j consumers prefer the firm to use technology 1, and therefore always set $q_j = 1$. Each period, each type-i consumer weighes the benefits of continuing the boycott. Continuing the boycott has an opportunity cost $\Delta U = U_i(e_i, e) - U_i(s, \underline{e})$. Indeed, the consumer has to switch his consumption for an imperfect substitute which provides lower utility, but does not imply any pollution. Thus, the boycott represents a decrease in pollution due to the decrease in type-i consumption: $\underline{e} < e$. This decrease in pollution depends on the share of consumers participating in the boycott and on their consumption. The residual pollution is $\underline{e}(\alpha, e_i, e_j)$, with $\frac{\partial \underline{e}}{\partial \alpha} < 0$, $\frac{\partial \underline{e}}{\partial e_i} < 0$, $\frac{\partial \underline{e}}{\partial e_j} > 0$. Finally, the firm may withdraw ($p = 1$). In this case, the consumer wins the game and gets the utility provided by the use of technology 2. The net benefit of continuing the boycott for an additional period is therefore the utility derived with the clean technology, minus the opportunity cost of boycotting, conditioned by the firm's strategy:

$$B_c = pU_i(c_i, 0) - (1-p)\Delta U(e_i, s, \underline{e}(\alpha, e_i, e_j)) \tag{6}$$

Three elements of the opportunity cost can be distinguished. First, the amount consumed by type-i consumers increases directly the cost of not consuming: $\frac{\partial \Delta U}{\partial e_i} > 0$. Second, the quality of the substitute decreases the cost of boycotting: $\frac{\partial \Delta U}{\partial U_i(s;\underline{e})} < 0$. Finally, boycotting decreases total pollution. The residual pollution increases the opportunity cost: $\frac{\partial \Delta U}{\partial \underline{e}} > 0$. Thus a larger boycotting population decreases the opportunity cost: $\frac{\partial \Delta U}{\partial \underline{e}} \frac{\partial \underline{e}}{\partial \alpha} < 0$. Moreover, type-i consumption indirectly decreases pollution and thus decreases the opportunity cost: $\frac{\partial \Delta U}{\partial \underline{e}} \frac{\partial \underline{e}}{\partial e_i} < 0$.

If B_c is positive, type-i consumers set $q_i = 0$ and continue the boycott. If it is negative, the consumers choose to withdraw, $q_i = 1$. B_c is positive if p is above the threshold:

$$\overline{p} \equiv \frac{\Delta U}{U_i(c_i, 0) + \Delta U} \tag{7}$$

We assume in that case that the consumer continues the boycott. The optimal pure strategy for type-i consumers is therefore:

$$\begin{cases} q_i^* = 0 \ for \ p \geq \overline{p} \\ q_i^* = 1 \ for \ p < \overline{p} \end{cases} \tag{8}$$

2.4 Possible outcomes of the boycott

2.4.1 Consumer boycott as a chicken game

For some values of the parameters, the multi-periods war of attrition game collapses on a one-period game close to a chicken game. Indeed, if the critical values $\overline{q}$ and $\overline{p}$ are negative or greater than 1, the one-period payoffs determine the outcome of the game. In that case, it can be represented as follow.

Consumer boycott as a chicken game

	$p = 0$	$p = 1$
$q_i = 0$	$U_i(s; \underline{e}); \pi_1(\underline{e})$	$U_i(c_i, 0); \pi_2(c)$
$q_i = 1$	$U_i(e_i; e); \pi_1(e)$	$U_i(c_i, 0); \pi_2(c)$

First, if $\pi_2(c) > \pi_1(e)$, technology 2 is more profitable than technology 1, and the boycott has no reason ($\overline{q} > 1$). Thus the outcome is: $(q_i^*, p^*) = (1, 1)$.

Figure 1: Outcome of the chicken game

	$\overline{p}$, $\overline{q}$	(q_i^*, p^*)	Outcome
$\pi_2(c) > \pi_1(e)$	$\overline{q} \geq 1$	$(1, 1)$	Technology 2 chosen by the firm
$\Delta U > 0$; $\pi_2(c) \leq \pi_1(\underline{e})$	$\overline{q} \leq 0$, $\overline{p} > 0$	$(1, 0)$	T1 kept, No boycott
$\Delta U < 0$; $\pi_2(c) \leq \pi_1(\underline{e})$	$\overline{p} < 0$, $\overline{q} \leq 0$	$(0, 0)$	T1 kept, boycott
$\Delta U > 0$; $\pi_2(c) > \pi_1(\underline{e})$	$\overline{p} \in [0; 1[$, $\overline{q} \in]0; 1]$	$(1, 0); (0, 1)$	Undetermined

Second, if $\pi_2(c) \leq \pi_1(\underline{e})$, the boycott is not costly enough to induce the technology change. Indeed, if the decrease in the firm's profit is too small, the firm always chooses to keep the polluting technology whatever is the behavior of type-i consumers ($\overline{q} \leq 0$). In that case, if the opportunity cost is positive, type-i consumers know that their pressure is too weak to induce the technology change, and they never boycott. The outcome is therefore: $(q_i^*, p^*) = (1, 0)$.

Third, if $U_i(s; \underline{e}) > U_i(e_i; e)$, type-i consumers always boycott, whatever is the firm's strategy ($\overline{p} < 0$). In that case, the opportunity cost is negative, which means that type-i consumers derive positive net utility from boycotting. This case can explain why one may often witness unsuccessful boycotts that never end. If the boycott is costless for some potential consumers, they always will participate. But in that case, they are likely to have small amounts of consumption, which generate a too small decrease in the firm's profit to make it change its behavior. The outcome in this case is: $(q_i^*, p^*) = (0, 0)$.

For otherwise, i.e. for $\Delta U > 0$ and $\pi_1(\underline{e}) < \pi_2(c)$, the one-period payoffs cannot determine the outcome of the game. In that case, two Nash equilibria of the one-period game are possible: $(q_i^*, p^*) = (1, 0)$ and $(q_i^*, p^*) = (0, 1)$. We need therefore to consider the cumulative payoffs of both players.[2]

2.4.2 Selection among the two potential equilibria

We consider the case in which: $\Delta U > 0$ and $\pi_1(\underline{e}) < \pi_2(c)$. In that case, the one-period payoffs determine two potential Nash equilibria: $(q_i^*, p^*) = (1, 0)$ and $(q_i^*, p^*) = (0, 1)$. To choose between those two equilibria, we follow Roth (1996)'s application of Pearce (1984)'s "extensive form rationalizability". Applied to the war of attrition model, this solution concept predicts that the first player to withdraw is the one who will be the first to receive negative net benefits from winning an extended conflict (for another application of this concept to the war of attrition model, see Burton, 2004). In our case, the boycott will succeed if type-i consumers are able to remain longer in the conflict than the firm without making loss.

Consider first the net cumulative payoff received by the firm if it wins the conflict after T periods. The first part of the payoff is the discounted benefit from winning the conflict

[2]Note that we do not consider the case in which $\overline{p} > 1$. Indeed, this case implies a negative utility derived by the clean technology($U_i(c_i, 0) < 0$), which does not make much sense.

after T periods, while the second part is the net discounted cost of continuing the conflict for T periods. φ is the discounting factor.

$$B_T^f = \sum_{t=T}^{\infty} \varphi^t \pi_1(e) - \sum_{t=0}^{T} \varphi^t (\pi_2(c) - \pi_1(\underline{e})) \tag{9}$$

The net benefit of winning the conflict is zero for:

$$T^f = \frac{1}{\ln \varphi} \ln(\frac{\pi_2(c) - \pi_1(\underline{e})}{\pi_1(e) + \varphi(\pi_2(c) - \pi_1(\underline{e}))}) \tag{10}$$

Therefore, T^f is the maximum duration after which the firm would never plan on continuing the conflict. For T^f to be positive, the full profit under technology 1 must be sufficiently high:

$$\pi_1(e) \geq (1 - \varphi)(\pi_2(c) - \pi_1(\underline{e})) \tag{11}$$

Similarly, type-i consumers net payoff of winning the game after T periods consists of the discounted utility of winning the conflict after T periods, minus the discounted opportunity cost of continuing the boycott for T periods:

$$B_T^c = \sum_{t=T}^{\infty} \varphi^t U_i(c_i; 0) - \sum_{t=0}^{T} \varphi^t \Delta U \tag{12}$$

This net payoff is zero for:

$$T^c = \frac{1}{\ln \varphi} \ln(\frac{\Delta U}{U_i(c_i, 0) + \varphi \Delta U}) \tag{13}$$

Type-i consumers would never plan to boycott longer than T^c periods if the total opportunity cost equals the benefits of having the good produced with technology 2 forever ($B_T^c = 0$). T^c is positive if the opportunity cost is not too large:

$$\Delta U \leq \frac{U_i(c_i, 0)}{1 - \varphi} \tag{14}$$

The boycott is likely to succeed if the maximum duration for type-i consumers is larger than for the firm: $T^c > T^f$, which implies:

$$\frac{\pi_2(c) - \pi_1(\underline{e})}{\pi_1(e) + \varphi(\pi_2(c) - \pi_1(\underline{e}))} > \frac{\Delta U}{U_i(c_i, 0) + \varphi \Delta U} \tag{15}$$

We can now analyze which factors influence the two maximum lengths $T^f(\pi_2(c), \pi_1(e), \pi_1(\underline{e}), \varphi)$ (see Appendix A) and $T^c(U_i(c_i, 0), \Delta U, \varphi)$ (Appendix B).

First, it is easy to see that a more profitable clean technology decreases the maximum conflict duration of the firm T^f: $\frac{\partial T^f}{\partial \pi_2(c)} < 0$. Indeed, a more profitable clean technology increases the net cost of the boycott. Conversely, a more profitable dirty technology increases T^f: $\frac{\partial T^f}{\partial \pi_1(e)} > 0$, $\frac{\partial T^f}{\partial \pi_1(\underline{e})} > 0$. Considering type-i consumption, the share of environmentalists clearly decreases the maximum duration: $\frac{\partial T^f}{\partial \alpha} < 0$. In contrast, the amount consumed by type-i consumers has an ambiguous effect on T^f. Indeed, e_i decreases the profit from technology 1 under boycott (which has a negative impact on T^f), but it increases the full profit under technology 1 (which tends to increase T^f). Overall, the amount consumed by type-i consumers is likely to decrease the maximum duration of the firm because it increases the pressure of the boycott.

Second, a larger utility derived from the clean technology increases T^c: $\frac{\partial T^c}{\partial U_i(c_i,0)} > 0$. Moreover, a smaller opportunity cost also increases T^c: $\frac{\partial T^c}{\partial \Delta U} < 0$. Therefore, a better substitute increases the maximum boycott duration, by decreasing the boycott opportunity cost: $\frac{\partial T^c}{\partial U_i(s;\underline{e})} > 0$. The share of type-i consumers unambiguously increases T^c, because it decreases the opportunity cost of the boycott: $\frac{\partial T^c}{\partial \alpha} > 0$. The impact of the amount consumed by type-i consumers is less straightforward. On the one hand, a larger amount consumed decreases indirectly the residual pollution, which tends to decrease the opportunity cost: $\frac{\partial \Delta U}{\partial \underline{e}} \frac{\partial \underline{e}}{\partial e_i} < 0$. On the other hand, a larger e_i increases directly the opportunity cost, because it increases the amount consumption transfer for the substitute: $\frac{\partial \Delta U}{\partial e_i} > 0$. Overall, the direct consumption effect is likely to dominate the indirect pollution effect.

3 What make a boycott successful?

First, as shown earlier, the quality of the substitute increases the potential for success, by decreasing the opportunity cost of boycotting. An extreme case would be the entry in the market of a firm producing the good with technology 2. The exploitation of this niche would imply $U_i(s, \underline{e}) = U_i(c_i, \underline{e})$ and $\Delta U < 0$. Type-i consumers would always choose to boycott (which does not necessarily means that the firm would switch technology).

Moreover the chances of success of a consumer boycott depends on the ability to hurt the firm's profit enough. Thus the share of type-i consumption in the firm's profit $\pi_1(e)$ is a crucial element. The larger is this share, the smaller is the threshold under which the

firm never switch technology ($\overline{q} = 0$) and the shorter is the maximum conflict duration for the firm (T^f). Two elements determine this share. First, a large number of type-i consumers (α) unambiguously raises the boycott potential for success, because it increases the maximum boycott duration for the consumers (T^c) and decreases the maximum duration for the firm (T^f). Second, the amounts consumed by type-i consumers (e_i) also raises the boycott capacity to hurt the firm's profit, by decreasing T^f. However, with e_i increases also the consumption opportunity cost of boycotting and thus decreases T^cIts seems therefore interesting for an NGOs willing to implement an environmental boycott to work on the α, i.e. informing and educating the type-j consumers to increase their awareness of and sensitivity to their responsibility in the degradation of their environment.

It is easier to understand the existence of infinite consumer boycott that never succeed. Indeed, people participating to a boycott campaign are usually those who are the most aware of and highly sensitive to their own pollution. Therefore, they are likely to be in small number, because of their high sensibility to their environment, and to be relatively small consumers. Boycotting is costless for them, but their consumption only represents a marginal share of the targeted firm's profit, and thus do not hurt the firm's profit much.

Take the example of the boycott of a boycotted major oil company. The consumers that are the most likely to boycott this company are those who feel the larger negative utility from pollution. Even if no boycott is announced, these consumers are likely to prefer the use of their bicycles to the frequent use of their car, and their capacity to hurt the company's profit is small. Conversely, consumers the most able to hurt the firm's profit have large opportunity cost, which make their participation to the boycott unlikely.

Moreover, participation in a boycott campaign constitutes a prisoner dilemma, which decreases the potential for success. First, in the case of many consumers, the individual choice of boycotting only increase imperceptibly the probability of the firm to withdraw, while the opportunity cost may be quite large, which provide a weak incentive to boycott. Second, boycotting is not a visible action. Thus there cannot be any social control among environmentalists.

4 Conclusion

This paper explores the conditions under which a consumer boycott upon environmental considerations may be successful. A boycott is presented here as a war of attrition between a firm and a group of consumers, for the choice of the producing technology. The ability of the boycotting group to hurt the firm's profit enough is the main element determining the chance of success of such type of action. Thus the share of the boycotting group's demand in total demand is crucial. Nevertheless, this share is directly related to the boycott opportunity cost. Indeed, the boycotting group needs to be composed of large consumers to hurt the firm's profit (especially if the group is of small size). However, boycotting is more costly for a large consumer, who has to renounce to a higher utility of consumption.

Overall, it appears that this tradeoff makes a consumer boycott unlikely to succeed. This might explain why one can witness so few successful boycotts in real life: the boycotting groups are usually composed of consumers with small opportunity costs, whose boycott does not hurt the targeted firm's profit enough to make it change its behavior.

A potentially more efficient policy for NGOs would be to work on the share of the population sensitive to the quality of the environment. Indeed, the game presented here is static, but informing and educating consumers may increase their awareness of environmental degradation, especially the degradation they are responsible of. The objective of this policy would have two main consequences in the long run. First, it would induce a decrease in overall consumption, which would reduce environmental degradation. Second, this would increase the population likely to participate in the boycott. In the long run, the combination of education and boycott would increase the potential for environmentally friendly technology adoption.

Finally, although this model does not consider explicitly the market structure, it seems reasonable to assume that competition increases the chances for the clean technology to be present on the market. Indeed, if there is free entry, there is room for ecological certification and green labeling: a firm may choose to enter the market and to produce the good with the clean technology, if it is profitable. In that case, there is a perfect substitute on the market. In a monopoly case, the boycott is less likely to succeed, because there is no good substitute for which the environmentalists could switch their consumption.

Appendix A: factors influencing T^f

Note that φ is likely to be smaller than 1, thus $\frac{1}{\ln\varphi} < 0$.

$$\frac{\partial T^f}{\partial \pi_2(c)} = \frac{\pi_1(e)}{[\pi_1(e) + \varphi(\pi_2(c) - \pi_1(\underline{e}))][\pi_2(c) - \pi_1(\underline{e})]\ln\varphi} < 0 \tag{16}$$

$$\frac{\partial T^f}{\partial \pi_1(e)} = \frac{-1}{[\pi_1(e) + \varphi(\pi_2(c) - \pi_1(\underline{e}))]\ln\varphi} > 0 \tag{17}$$

$$\frac{\partial T^f}{\partial \pi_1(\underline{e})} = \frac{-\pi_1(e)}{[\pi_1(e) + \varphi(\pi_2(c) - \pi_1(\underline{e}))][\pi_2(c) - \pi_1(\underline{e})]\ln\varphi} > 0 \tag{18}$$

The impact of type-i consumption on T^f: α decreases the maximum conflict duration for the firm, and the opposite effects determine the impact of e_i.

$$\frac{\partial T^f}{\partial \alpha} = \underbrace{\frac{\partial T^f}{\partial \pi_1(e)}}_{>0}\underbrace{\frac{\partial \pi_1(e)}{\partial \alpha}}_{<0} + \underbrace{\frac{\partial T^f}{\partial \pi_1(\underline{e})}}_{>0}\underbrace{\frac{\partial \pi_1(\underline{e})}{\partial \alpha}}_{<0} < 0 \tag{19}$$

$$\frac{\partial T^f}{\partial e_i} = \underbrace{\frac{\partial T^f}{\partial \pi_1(e)}}_{>0}\underbrace{\frac{\partial \pi_1(e)}{\partial e_i}}_{?} + \underbrace{\frac{\partial T^f}{\partial \pi_1(\underline{e})}}_{>0}\underbrace{\frac{\partial \pi_1(\underline{e})}{\partial e_i}}_{?} \gtrless 0 \tag{20}$$

Appendix B: factors influencing T^c

$$\frac{\partial T^c}{\partial U_i(c_i, 0)} = \frac{-1}{[U_i(c_i, 0) + \varphi\Delta U]\ln\varphi} > 0 \tag{21}$$

$$\frac{\partial T^c}{\partial \Delta U} = \frac{U_i(c_i, 0)}{\Delta U[U_i(c_i, 0) + \varphi\Delta U]\ln\varphi} < 0 \tag{22}$$

$$\tag{23}$$

The quality of the substitute has a positive impact on T^c:

$$\frac{\partial T^c}{\partial U_i(s; \underline{e})} = \underbrace{\frac{\partial T^c}{\partial \Delta U}}_{<0}\underbrace{\frac{\partial \Delta U}{\partial U_i(s; \underline{e})}}_{<0} > 0 \tag{24}$$

The impact of type-i consumption on T^c: α increases the maximum boycott duration, while two opposite effects determine the impact of e_i.

$$\frac{\partial T^c}{\partial \alpha} = \underbrace{\frac{\partial T^c}{\partial \Delta U}}_{<0}\underbrace{\frac{\partial \Delta U}{\partial \alpha}}_{<0} > 0 \tag{25}$$

$$\frac{\partial T^c}{\partial e_i} = \underbrace{\frac{\partial T^c}{\partial \Delta U}}_{<0}\underbrace{\left[\underbrace{\frac{\partial \Delta U}{\partial \underline{e}}}_{<0}\underbrace{\frac{\partial \underline{e}}{\partial e_i}}_{<0} + \underbrace{\frac{\partial \Delta U}{\partial e_i}}_{>0}\right]}_{?} \gtrless 0 \tag{26}$$

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