|  |  |
| --- | --- |
|  | (1) |

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|  | (2) |

|  |  |
| --- | --- |
|  | (3) |

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| --- | --- |
|  | (4) |

|  |  |
| --- | --- |
|  | (5) |

|  |  |
| --- | --- |
|  | (6) |

|  |  |
| --- | --- |
|  | (7) |

|  |  |
| --- | --- |
|  | (8) |

|  |  |
| --- | --- |
|  | (9) |

|  |  |
| --- | --- |
|  | (10) |

# 3. CSR Marketing Signaling (CMS) Game

## 3.1 Game Preamble

The CSR market signaling (CMS) game is, as the name implies, a game of incomplete information (Harsanyi, 1967, 1968) and consumer signals of preference for corporate social responsibility, also known as “voting with the wallet” (Becchetti, 2012). The CMS game represents uncertainty about consumer willingness to pay for non-traditional product or brand attributes (i.e., CSR) in the form of private information (the buyer’s “type”) decided, through convention, by *nature*. The buyer’s own type is known to him- or herself, but neither by the other buyers in the market nor by platform operator. Here we make use of the common distinction between utilitarian and hedonic consumption (e.g., Babin, Darden, Griffin, & Darden, 1994; Batra & Ahtola, 1990; Childers, Carr, Peck, & Carson, 2001; Crowley, Spangenberg, & Hughes, 1992) for a simple dichotomy of buyer types. The former (utilitarian) only values product-specific attributes and is price sensitive. The latter (hedonic) values non-product-specific attributes and therefore possesses utility components that permit a higher willingness to pay for CSR, despite consuming less quantity under the same budget constraint. Each hedonic buyer hopes all firms use CSR; however, each hedonic buyer doesn’t wish to be required to choose the CSR-engaged platform before knowing the full details (e.g., charitable cause to be supported, responsible business practices to be enacted, etc.) and earnestness of the platform’s CSR policy. The buyer’s CSR signaling thus comes at a cost that reflects the sentiments of the skeptical CSR consumer (Skarmeas & Leonidou, 2013) and may also include related switching costs (Farrell & Klemperer, 2007), such as technological incompatibility; forfeited brand loyalty, either psychological or monetary, in the form of accrued loyalty points; onboarding fees; learning curve time, etc.

The strategic choice by the platform operator to engage in CSR when facing a market of unknown buyer types is therefore an investment under uncertainty, informed by prior knowledge of the marketplace and the observed buyers’ voting with the wallet as signals of responsible consumption. This setup differs from other signaling games (Spence, 1973) in the CSR literature (e.g., Fisman et al., 2006)**,** since those have represented the firm as the privately informed player, with the information deficit instead on the side of the buyer, who must decide whether or not to believe the firm’s CSR spending as a signal of altruism or opportunism. Here, instead, we turn the strategic focus to the firm (or in this case, the platform) as the uninformed player, while importantly also allowing for each buyer to be skeptical of and influenced by the unobserved types and strategies of the other buyers as well.

## 3.2. Game Explanation and Definitions

The CMS game models CSR as a strategic response to market demand signals when facing a preemptive CSR strategy introduced by a rival. The rival platform (platform 2) is at a size disadvantage vs. the larger focal platform (platform 1) in a market of buyers. The platforms are undifferentiated in terms of baseline (i.e., utilitarian) quality; however, platform 1 has more sellers, which augments its value to buyers.[[1]](#footnote-1) In an attempt to counter this size disadvantage, the rival platform 2 decides to engage in CSR in order to capitalize on its potential for “total quality” differentiation--that is, utilitarian plus hedonic quality--which exists if enough buyers in the market value CSR. The rival’s strategy choice causes an exogenous shock to the market. After observing the signals of responsible consumption from buyers voting with their wallets, the focal platform 1 then must choose whether or not to engage in CSR to negate its rival’s CSR-derived advantage. The profitability of that decision depends on the cost-benefit trade off of the CSR policy, which includes the proportion of hedonic buyers who value CSR in the market and their willingness to pay a CSR-related price premium versus the costs stemming from the CSR policy. These costs include both an initial investment toward responsible operations or donation to a charitable cause, and an increase in marginal cost related, for example, to sustainable raw materials and operations costs or increased training or organizational restructuring costs to ensure responsible practices, etc., which raise the prices of goods on a platform engaging in CSR.

***Game stages***. The CMS game proceeds dynamically as follows (Figure 1). In the first stage, *nature* chooses the type of the buyers in the market , for . A buyer is hedonic and values CSR with probability , or utilitarian and does not value CSR with probability (. Additionally, in this initial stage, the rival platform 2 has already introduced its preemptive CSR policy. Then, in the second stage, the buyers simultaneously signal their types, choosing either to vote with the wallet (*W*), , at cost or abstain (), , at zero cost. Finally, in the third stage, the focal platform chooses its strategy to engage in CSR or not, , after which, the buyers make their platform adoption decisions rationally according to their types and the platforms’ CSR strategies. In the short horizon (1-period) CMS game version, platform 1 does not consider future periods. Then we relax this restriction in the long horizon (multi-period) game and platform 1 considers the effect of its CSR policy through future periods in which a proportion of buyers and sellers may churn (i.e., leave their current platform) and adopt another platform probabilistically in proportion to their expected value from each platform.

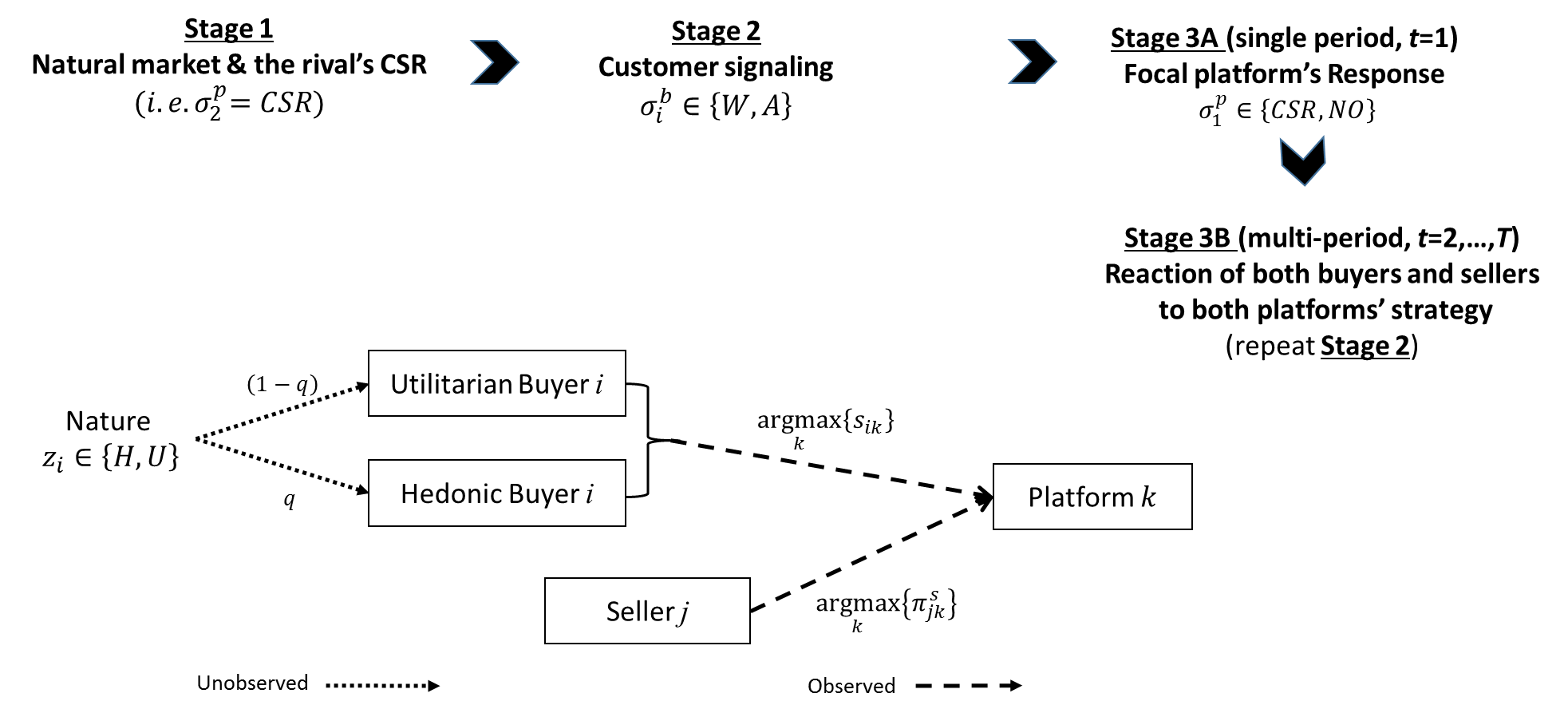


Fig. 1. CSR market signaling game (Stages 1-3) in short (3A) and long (3A-B) decision horizons.

***Representative buyer’s value*.**  To quantify a buyer’s demand for each platform, we derive a value (indirect utility) function following the constant elasticity of substitution form (Dixit & Stiglitz, 1977), which is common in platform competition literature models accounting for a cross-group network effect (e.g., Kang & Downing, 2015; Nair, Chintagunta, & Dube, 2004; Zhu & Iansiti, 2012), and we then solve the utility maximization problem (see Appendix XX) to yield the value buyer *i* would receive from platform *k* at time *t*, :

|  |  |
| --- | --- |
|  | (1) |

In Eq. (1), the constant ε is the cross-group network effect term (see Appendix XX for explanation), and the solution assume prices are equal for sellers on the same platform (). This expression captures the value buyers receive from consuming goods on either platform as a sum of (i) the quantity of goods one can afford, (ii) total quality of the platform and its goods, and (iii) the platform’s size, in terms of number of sellers scaled by the magnitude of cross-group network effect. The total quality term, , includes both baseline quality which is utilitarian, , and CSR-related quality, . The latter part, CSR-related quality, demonstrates the importance of the platform’s CSR policy-market fit, since the total quality increases by only when the platform uses CSR (i.e. ) *and* the buyer is hedonic (). No quality increase is experienced by the hedonic buyer if the platform doesn’t engage in CSR (), representing a lost opportunity for differentiation. Similarly no quality increase is experienced by a utilitarian buyer (), even when the platform engages in CSR, which makes any CSR investment financially unviable facing a utilitarian buyer. Interpreting the value of platform size for buyers depends upon the type of platform. On a ride sharing platform like Uber or Lyft, for example, size means *availability* of rides at low expected wait times; whereas, on an ecommerce or gaming platform, size means *variety* of products or game titles from which the buyer may choose. Finally, the buyer’s payoff () as a function of the choice to vote or abstain is:

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|  | (2) |

which is the value from Eq. (1) minus the signaling cost of his or her strategy ().

***CSR price premium***. Define the expected CSR price premium for platform 2, (), as the markup of platform 2’s price above platform 1’s price evaluated at the level where demand is equal if platform 1 decides not to engage in CSR despite that fact that platform 2 has already chosen to utilize a CSR strategy. Platform 1 must consider this amount in making its CSR strategy decision because by choosing not to engage in CSR it would be allowing platform 2 the opportunity to earn this premium. Expressed in terms of non-price value components, this is proportional to the product of the ratios of platform quality (total quality for platform 2 with CSR, only utilitarian quality for platform 1 without CSR) and platform size (number of sellers) (see Appendix XX):

|  |  |
| --- | --- |
|  | (3) |

The network effect term exponentially amplifies ( or dampens () the impact of size difference on the value experienced by the consumer. This must factor into platform 1’s strategy decision since an overwhelming size advantage in a market of high cross-group network effect magnitude might make the CSR price premium negligible, or vice versa. Additionally, platform 1 must consider the cost of the CSR policy with its resultant price markup (i.e., CSR-related marginal cost increases) and how that compares to the price premium, which is the additional value enjoyed by a hedonic buyer. This CSR cost-value tradeoff is illustrated in the dynamic simulations of price premiums presented in Section 4.2.2.

***Demand share***. To determine the expected share of demand for each platform, we make use of the discrete choice model form[[2]](#footnote-2) (McFadden, 1973), , which smooths the relative value of one platform to the total potential value among platforms into an s-shaped curve. Substituting in the value function from Eq. (1), we obtain the demand share for platform in period :

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| --- | --- |
|  | (4) |

where , , and . This form shows the interaction of the CSR strategy choice with the platform size and network effect variables. The ratio of expected platform total quality from equation (1) multiplied by the ratio of platform prices acts as a coefficient on the size of the platform (i.e., number of sellers , which is itself raised to the power of the market’s cross-group network effect (ε). The interconnectedness of supply and demand in any platform competition is thus evident in equation (4).

## 3.3 CSR Market Signaling (CMS) Game Solution

The lack of complete information makes the CMS game irreducible to subgames, so instead the perfect Bayesian equilibrium (PBE) concept extends the Nash equilibrium to dynamic (i.e., sequential move) Bayesian games. A PBE consists of a strategy profile for the players and a system of beliefs over the nodes at all information sets. This requires both s*equential rationality*, meaning that strategies specify optimal actions given one’s beliefs and the strategies of other players, and c*onsistency,* which entails that the beliefs remain consistent with Bayes rule. The steps to find the game’s PBE can be summarized as follows: (i) identify the buyer’s strategy profile (pooling vs separating); (ii) update the platform’s beliefs about the buyer type via Bayes rule; (iii) compute the platform’s optimal strategy, given updated beliefs; and (iv) check if the buyer’s strategy is a best response to the platform’s strategy. If yes, the strategy profile is a PBE.

***Buyer* s*trategy profiles****.* The two possible pooling strategies are (i) both buyer types abstain () and (ii) both types vote with the wallet (). In either case the platform cannot learn about the market’s distribution of buyer types. The two potential separating strategies are (iii) the hedonic type abstains while utilitarian type votes (), and lastly (iv) the hedonic type votes with the wallet while the utilitarian abstains (). Both of these would introduce the potential for the platform to learn about buyer types from market signals, though only one of these separating strategy profiles is rational, which is explained in more detail below.

***Updated Platform Beliefs via Bayes Rule****.* We first specify the simple hierarchical model that allows us to compute the firm’s updated beliefs similarly for each buyer strategy profile. The number of observed votes with the wallet in period *t*, given the hedonic probability, is assumed to be binomially distributed, , and the uncertainty over the hedonic probability is captured with a beta distribution, , for the analytical convenience of updating beliefs with conjugate priors. Importantly, though, the implications of the results derived from this model don’t depend upon these specifications.[[3]](#footnote-3) The posterior probability of nature’s hedonic buyer distribution given the observed voting with the wallet ( therefore follows a Beta-binomial distribution:

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| --- | --- |
|  | (5) |

where is the number of observed votes with the wallet, is the number of observed abstentions, and and are the platform’s prior beliefs of hedonic buyers and utilitarian buyers, respectively. This conjugate form allows for updating prior beliefs over time, thereby reducing uncertainty over time, for . This is done simply by defining the prior belief of hedonic buyers as the sum of *past* evidence of voting with the wallet, , and likewise for past evidence of abstaining, .

***Optimal platform strategy given updated beliefs.*** The optimal CSR strategy given the buyer strategy profiles and observed voting with the wallet can be derived from the platform’s profit function (see Appendix XX), updated according to posterior belief of the buyer distribution in Eq. (5):

|  |  |
| --- | --- |
|  | (6) |

where is the point estimate of the posterior distribution[[4]](#footnote-4) of buyer types. Note we include time indices (subscript *t*) on the platform strategies since platform 1 can choose both *if* and *when* it responds to platform 2’s CSR strategy. However, as this CMS game is not a repeated game for the platforms, each platform can only choose its CSR strategy once and then much stick with it once its implemented. The threshold value () of buyer hedonic proportion after observing buyers’ strategies to vote or abstain is the *minimum level of evidence* of buyer preference for CSR required for the platform to expect that engaging in CSR would be more profitable than not doing so. This of course depends on the buyer strategy profile. Of the four listed above, we may preclude two by the assumptions of the CMS game. Since utilitarian buyers gain no value from CSR, no rational utilitarian buyer would play strategy to vote with the wallet, thus removing strategy profiles and from consideration. This leaves only the strategy profiles where the utilitarian player abstains and the hedonic player either abstains or votes with the wallet, and , respectively. We can compute each of these thresholds (see Appendix XX):

|  |  |
| --- | --- |
|  | (7) |

Where we denote , which accounts for the marginal profit per price dollar in a market with network effects, together with the markets total purchasing power.

Where is platform *k*’s up-front cost of engaging in a new CSR policy, is the difference in demand shares between buyer types.

***Best response buyer strategies given optimal platform strategy****.*  Here we distinguish between the representative buyer () and all other buyers (). While knows her own type, she doesn’t know the types of any other buyer . Additionally, must decide her strategy before observing any other buyer’s strategies (i.e., considering only , not the updated belief ) and before the platform decides its strategy. Obviously the best response strategy for a utilitarian buyer is not to vote () in any circumstance, but for a hedonic buyer, determining ’s best response is equivalent to finding the strategy that maximizes the expected payoff:

|  |  |
| --- | --- |
|  | (8) |

Where where is the expected signaling cost threshold for a given hedonic proportion () (see Appendix XX):

|  |  |
| --- | --- |
|  | (9) |

where . Denote is the additional incremental value enjoyed by a hedonic buyer when a platform decides to engage in CSR, is the baseline probability of a buyer voting with the wallet for platform , and is the threshold level of voting with the wallet that the platform requires to expect CSR to be the optimal strategy, defined in Eq. (7) according to the buyer’s strategy profile.

Average/expected/baseline probability of a random buyer voiting with the wallet

|  |  |
| --- | --- |
|  | (10) |

Finally, plugging equation (14) into (16) yields the expression as a function of the representative buyer’s strategy profile, which is useful for determining potential separating and pooling equilibria. Thus expressions (13-16) provide the blueprint for solving the game, but such a CMS game must first be fully specified, with market size (), signaling cost (), nature’s distribution of hedonic buyers (), the platform’s prior beliefs about the buyer distribution (), and the revenue and expense parameters that define the platform threshold of required voting with the wallet in order to compute the BPE.

1. This size advantage impacts the value enjoyed by buyers through the extent of the platform’s variety of complementary goods and the strength of the market’s cross-group network effects (e.g., Gupta, Jain, & Sawhney, 1999; Katz & Shapiro, 1994; Nair et al., 2004). This is explored in more detail in Section 4. [↑](#footnote-ref-1)
2. This is preferable to other representations of product differentiation, e.g., Hotelling’s linear city (1929), for our demand-side examination of CSR for several reasons. Based on McFadden’s random utility model (RUM), the conditional logit is widely applied in marketing for discrete choice of qualitative attributes and hedonic consumption (e.g., Gretz, 2010; Guadagni & Little, 1983; Gupta, 1988) , and is therefore aptly suited for our consumer signaling. Additionally, it has the advantage of allowing for extensions to -product (-firm, -platform, etc.) choice scenarios through multinomial or nested logit (Hausman & Mcfadden, 1984), and following Berry’s (1994) empirical specifications, it has been widely applied in estimation of network effects in platform competition (e.g., Kang & Downing, 2015a; Nair, Chintagunta, & Dube, 2004; Zhu & Iansiti, 2012). [↑](#footnote-ref-2)
3. Besides the number of buyers voting with the wallet, different signals could be modelled differently. For example, buyers choosing between platforms could use a Dirichlet-multinomial distribution, or purchase quantities (i.e., count values) could be modelled with a Poisson-Gamma distribution, etc. [↑](#footnote-ref-3)
4. The posterior probability is a distribution capturing the platform’s remaining uncertainty of the market’s proportion of hedonic buyers after observing them vote with the wallet or abstain. To make a strategy decision, the platform needs a point estimate (), in this case a policy that maps from the space of probability distributions in the support of to the real numbers. In decision-theoretic policy selection, the agent would first determine its loss function -- that is, the cost of choosing its CSR strategy incorrectly -- and then choose the point estimate that minimizes the expected loss. Some point estimates to minimize common loss functions are the mean for squared loss, median for linear loss, and mode for binary loss. If we utilize the mean point estimate, then given that the posterior distribution of buyer types follows a beta-binomial distribution, this yields by definition , where again and are the prior beliefs about hedonic and utilitarian buyers, respectively. [↑](#footnote-ref-4)