Corporate Social Responsibility for Kids' Sake: A Dynamic Model of Firm Participation *

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Abstract

This paper develops a dynamic oligopoly model of participation in a corporate social responsibility marketing initiative that defines quality standards for products advertised to children. Participation requires that firms either adopt initiative standards by investing in product quality or stop advertising products categorized as substandard quality. To test the model we estimate consumer demand for breakfast cereal using a panel of household purchase and television advertising data, then use it to investigate the incentives to participate in a costly initiative that improves the health quality of kids' cereals. Model predictions demonstrate the conditions under which firms are incentivized to choose participation and to reformulate their product to meet the quality standard. The application also forecasts market evolution and investigates the impact of the kids' health initiative on demand for calories, as well as firm profitability and consumer economic welfare. We compare these results to a mandatory quality compliance policy, and to business without an initiative, thus illustrating the costs and benefits of the three policy approaches.

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1 Introduction

The Federal Trade Commission (FTC) approached the Council of Better Business Bureaus (BBB) early in 2006 about a self-regulatory program designed to shift the mix of food and beverage products advertised to children to encourage healthy dietary choices.[1] Later that year the BBB launched the Children's Food and Beverage Advertising Initiative (CFBAI). CFBAI's participants include many of today's largest food and beverage companies, such as McDonald's, Burger King, Coca-cola, PepsiCo, Kraft, and ConAgra. Until recently, CFBAI firms set their own nutrition criteria. In July 2011, CFBAI released uniform nutrition criteria for foods advertised to children. The new agreement requires partner firms to meet these criteria by the end of 2013. A second initiative intended to limit child exposure to unhealthy foods, was developed by an interagency working group (IWG) under U.S. Congress's 2009 Omnibus Appropriations Act. The IWG recommends the voluntary adoption of nutrition principles for foods advertised to children by 2016. The IWG guidelines impose nutrition criteria viewed as overly strict by the food and beverage industry, and the guidelines have sparked heated debate. Complying with either marketing initiative means firms must decide on participation, which implies that they either invest to reformulate their products to meet well-defined nutritional standards, or discontinue advertising for kids products that fail to meet the nutritional standards.

These food and beverage marketing initiatives establish a set of transparent standards and serve as a clearing house through which brand managers and public policy makers passively monitor the quality of food marketed to children; consumers ensure the health quality of processed foods; and brands enhance their image by signaling themselves as socially responsible marketers. The marketing initiative membership provides an informative signal to policy makers, consumers, and competitors that products marketed by member firms are healthy according to the standards set forth under the doctrine of a particular initiative. For example, the CFBAI charter establishes core principles and uniform nutrition standards that participating firms comply with to present themselves as socially responsible marketers of better-for-you products for kids.

Marketing initiatives, and more generally corporate social responsibility (CSR), is a strategic imperative for firms and understanding its impact leads to adoption of CSR as an element of strategy rather than an act of faith (Raghubir et al., 2010). Consumers generally respond positively to CSR (Sen & Bhattacharya,

[1] As a result of caloric imbalance caused by a sedentary lifestyle and the excessive intake of food high in calories, sugar, and saturated fat childhood obesity has spread and become a health issue of supreme importance (CDC).

2001), and firms can use CSR initiatives to signal their commitment to societal or environmental wellbeing, and position themselves for long-term profitability, at least when consumer participation is required (Du, Bhattacharya, & Sen, 2011). Kotler & Lee (2005) point out the potential for marketing initiatives to improve consumer wellbeing and help firms to achieve profit and brand objectives simultaneously, affording firms and policy makers the opportunity to fulfill their objectives simultaneously. CSR strategy builds shared value, and presents opportunity for innovation and competitive advantage, and should not be viewed as a constraint on the firm (Porter & Kramer, 2006).

Brand managers want to know the impact that a particular initiative has on the preference consumers extend toward their brands as a result of participation, and how that translates into profit. Public policy makers on the other hand want to know the impact that a voluntary marketing initiative has on the consumption of calories and particular nutrients, the economic welfare of consumers, and the economic performance of the food and beverage industry. They are also interested in how voluntary initiatives as a policy alternative compare to a legislative mandate, or to having no marketing initiative at all. The key research questions are then: What are the incentives for the brands to participate; what exactly does that participation look like; is there economic value for customers and firms; and to what extent does each policy shift consumer purchases toward healthier product bundles?

A profit seeking firm will participate in a CSR initiative when the expected profit flow from participation exceeds the option value of not participating. Participation impacts profitability through revenues and through costs. Firm revenues are tied to participation though the positive CSR brand image which is a complement to the consumer experience (Gardener & Levy, 1955). Firm revenues are also tied to consumer tastes for physical product attributes, and consumers may or may not prefer a product reformulated to satisfy the marketing initiative's nutritional criteria. Participation is also tied to advertising which drives firm revenue and enhances the consumer experience (Nerlove & Arrow, 1962; Becker & Murphy, 1993).

If a firm chooses to improve the quality of its product so it may continue advertising, its profit flow is reduced by reformulation costs. Reformulation incurs a development investment as well as a change in variable costs. The development investment covers the creation of a new recipe and retooling of the production process. The incremental change in variable costs results from a change in the input levels required to produce the reformulated product, which may increase or decrease the marginal cost of production. The participation decision also impacts the amount of advertising which has a direct effect on the total costs of advertising. Altogether, the participation strategy has a complex interaction with other elements of brand

management.

The decision to participate in the CFBAI or the IWG initiative is inherently a dynamic one because both the decision to invest in product reformulation and the decision to advertise has an effect on future profitability. Sweeting (2011) asserts that if firms incur costs to improve their products,"accurately predicting a policy's effects will require a dynamic model because firms will typically expect to sell products for several years" and in oligopolistic markets "their incentives to develop particular types of products may depend on how their competitors might change their assortment decisions in response." In addition to this fact, marketing initiatives restrict advertising for products that don't meet nutritional standards and therefore the decision to participate in the initiative from one period to the next depends on the value of maintaining a media presence.

Our approach is to expand the Ericson and Pakes (1995) framework for dynamic oligopoly to develop a model of strategic health quality investment and CSR initiative participation. To begin we specify a heterogeneous consumer logit demand model and then develop a dynamic oligopoly model of health quality investment and marketing initiative participation that incorporates optimal pricing and advertising. Our model is used to investigate the incentives for participation in a voluntary initiative, the incentives for reformulating products, and to predict profitability, consumer welfare, and product demand as the market evolves. Our analysis demonstrates the conditions under which participation in the voluntary initiative is optimal, and illustrates the potential impact of a voluntary initiative on both producer and consumer economic value, as well as consumption. As an empirical exploration of our model we calibrate it to analyze the children's ready to eat (RTE) breakfast cereal market using scanner and advertising exposure data from eight major U.S. television markets between February 2006 and December 2008. The breakfast cereals are identified as a category of direct concern to policy makers in the debate that surrounds the marketing of food to children (Schwartz et al., 2008).

We continue the introduction with a discussion of some related literature. The rest of the paper is organized as follows: Section 2 provides background on the children's RTE cereal industry, the history of voluntary marketing initiatives, and the data used for the study. Next, we present our model of demand and our dynamic model of voluntary marketing initiative participation. Then, section 4 exhibits the demand estimation results. Finally, we use the demand estimates to calibrate the model and simulate participation strategies, results are presented and the implications for marketing and policy practitioners are discussed.

1.1 Discussion of Related Literature

Our empirical approach distinguishes the current study from a strand of existing research that assesses the effects of taxation designed to limit consumption of unhealthy food and beverages (Wang, 2012), or of advertising restrictions on competition or consumption. Much of this research deals with advertising restrictions in the cigarette and alcoholic beverage industry (e.g., Sass & Saurman, 1995; Gallet, 2003; Qi, 2011). Clark (2007) examines the effect of Quebec's mandatory ban on child-directed advertising on the market structure in the children's cereal market, whereas Dhar and Baylis (2011) investigate the effect of this same ban on fast-food purchases. These lines of research generally uses quasi-experimental designs to evaluate the short- or medium-term effects of implemented advertising restrictions on pricing, concentration, or consumption. Except for Huang and Yang (2011), all these studies examine mandatory advertising restrictions, which are exogenous to firm strategy. Huang and Yang (2011) investigate the effect of a voluntary advertising restriction on consumer's choices under the assumption that the restriction is exogenous to the consumers. In contrast, we use a market model and endogenize the firms' participation decisions to study the incentives for participation as well as the market surplus that results under voluntary versus mandatory compliance with a marketing initiative.

There has been an increasing reliance on voluntary agreements for achieving environmental objectives since the 1990s (Dawson & Segerson, 2008) and recently for mitigating childhood obesity. Some studies investigate observed participation (Delmas & Montes-Sancho, 2012) yet only few studies have examined the enforceability of voluntary agreements, however they are not empirical and they do not consider the dynamic nature of participation. For instance, Brau and Carraro (2011) and Dawson and Segerson (2008) both consider a policy environment in which a group of firms must decide whether to sign a voluntary agreement on abating pollution with an industry-wide target. Their research showed that there are different conditions under which voluntary agreements could be an equilibrium strategy for some but not other firms.

This research explores competing firms' decisions to enter into or exit from a marketing initiative, relating it to a number of articles that investigate the incentives behind entry into and exit from a market. Hitsch (2006) develops a model of product launch and exit that correlates a firms uncertainty about the demand for a prospective product to optimal entry and exit decisions. Rossi (2012) studies product entry and exit in the ready to eat cereal market with multi-product firms to investigate the incentives for engaging in product proliferation to deter entry of new firms.

A number of studies also investigate investment in product positioning or quality. Conducting an empirical analysis of the radio industry, Sweeting (2011) investigates how the incentives for product positioning are tied to fees firms pay for rights to play songs and the nature of the market. Goettler & Gordon (2011) analyze the computer processor industry to better understand the relationship between market structure and innovation, and Goettler & Gordon (2012) research innovation in a dynamic model where firms improve quality, investing to fend off competition.

2 Food Marketing to Children

This section explains the institutional backdrop against which our model is motivated and empirical application is conducted. It starts with a summary of the policy environment. Next, it discusses the actions of the major firms marketing kids' cereal. Then, it overlays the brands and market data we analyze, as well as the simulations we conduct, on the institutional backdrop.

2.1 Policy Environment

Figure 1 chronicles the "Marketing Healthier Foods to Kids" story timeline. Against the backdrop of increasing public concern over childhood obesity issues, congress enlisted The Institute of Medicine (IOM) to compile a report entitled, "Preventing Childhood Obesity: Health in the Balance" in 2004. The same year Congress directed the CDC to undertake a study of the role of food and beverage marketing on nutrition status of children and teens, and topically, how marketing approaches might be used to remedy the emerging epidemic. The CDC turned to the IOM in 2005 for a report on the "Food Marketing to Children and Youth: Threat or Opportunities," an influential report that serves as a comprehensive review of scientific studies assessing the influence of marketing on nutritional beliefs, choices, practices, and outcomes for children and youth. The IOM study notes that the majority of food and beverage products marketed to kids is high in total calories, sugar, salt, and fat, and low in nutrients. The study's major conclusion is that "TV advertising influences the food preferences, purchase requests, and diets, at least of children under the age of 12 years, and is associated with the increased rates of obesity among children and youth." The IOM subsequently called for "substantially more industry and government attention, action, and cooperation on an agenda to turn food and beverage marketing forces toward better diets for American children and youth."

In April 2006, the Federal Trade Commission (FTC) recommended that the Better Business Bureaus (BBB) consider possible actions to address the concerns over childhood obesity and food marketing to children. In response the BBB launched the Children's Food and Beverage Advertising Initiative (CFBAI) in November 2006 to change the nutritional profile of food and beverage products marketed to children. Shortly thereafter, Congress's 2009 Omnibus Appropriations Act formed an interagency working group (IWG) composed of the FTC, CDC, Food and Drug Administration (FDA), and the U.S. Department of Agriculture (USDA) to work on a proposal for voluntary principles and nutritional standards to guide industry self-regulation. When the IWG released its proposed guidelines in April 2011 calling for all food marketers to expand voluntary regulation, it was met with resistance from the food and beverage industry lobby. In response, in July 2011, the CFBAI released category-specific uniform nutrition criteria for foods advertised to children. The agreement requires partner firms to meet these new "tough but realistic" criteria by the close of 2013 (BBB,2011). The IWG recommends the voluntary adoption of nutrition principles for foods advertised to children by 2016. After hearing rebuttal from the food and beverage industry lobby, the IWG included a provision stipulating that the focus be on marketing directed to children 12 or younger (as opposed to 2-17), will not limit marketing that is family-oriented or to a general audience, and will not limit the use of established brand characters such as Toucan Sam (the Froot Loops cereal spokes-cartoon), or other elements of packaging that is "inextricably tied to the food's brand identity"(Vladeck, 2011). In addition, the Consolidated Appropriations Act of 2012 has a provision requiring the IWG to conduct a benefit-cost analysis before the proposed guidelines be adopted.

2.2 Ready-To-Eat Cereal

RTE breakfast cereals are marketed directly to children and adolescents (children brands), to family (family brands) for family's consumption, and to adults (adult brands) to satisfy adults' dietary needs and taste preferences. The kid cereal segment consists of brands that possess strong interactions with each other. Including category segments developed for adults into the evaluation dilutes the switching patterns observed in the data because these are usually complementary products at the household level. For example, a household may always purchase a kid cereal and an adult cereal for different members of their household. However, the data does not reflect the intended user of each product, and in effect may falsely indicate a switch form a kid cereal to an adult cereal. Children's RTE breakfast cereals are the largest category of packaged foods directly marketed to children. Harris et al. (2009) summarizes some industry facts: The

industry spends $229 million on advertising for these kids brands; children's exposure to cereal advertising represents a quarter of all food and beverage product television commercials viewed by children; children's cereal brands are usually the least healthy cereals, in fact, on the average, child RTE cereals contain 85% more sugar, 65% less fiber, and 60% more sodium compared to adult cereals; and cereal companies also advertise more intensively to children relative to any other age group, and on average, children see twice as much cereal advertisements on television compared to adults. The top four manufacturers, Kellogg's, General Mills, Post, and PepsiCo, who together accounted for more than 80% of children cereal sales in the U.S. market between 2006 and 2008, with the two largest firms, Kellogg's and General Mills, accounting for 60% of market sales.

Kellogg's, General Mills, and PepsiCo (under the Quaker brand banner) joined CFBAI in 2006 and pledged to devote 100% of their children-directed advertising to healthier, "better-for-you" products. Post became a signatory in 2009 and began to implement its own pledge by 2010. In July 2011, CFBAI released its category-specific uniform nutrition criteria (CFBAI, 2011a), which all participants must comply with by the close of 2013. CFBAI has spurred product improvement research, and development teams have worked since 2005 to improve the health profile of existing products; General Mills and Kellogg's rolled out improved products in 2009 after the end of our data sample. According to CFBAI's latest news release, before the start of CFBAI, some children's cereal contains as much as 16 grams of sugar per serving. As of 2011, 86% of children's cereal contain fewer than 10 grams of sugar per serving (CFBAI, 2011b).

2.3 Market Data

The data we use to calibrate our demand model comes from three sources: The MINTEL Global New Products Database, the A.C. Nielsen HomeScan panel, and the Nielsen Media Research advertising database. All the data we analyze are from eight designated marketing areas (DMAs) (Atlanta, Boston, Chicago, Houston, Los Angeles, New York, Philadelphia, and Seattle-Tacoma) from February 2006 through December 2008. This period corresponds to the years prior to release of either the CFBAI's or the IWG's nutritional guidelines. The period is several months prior to the passing of the Omnibus Appropriations Act. It is also important to note that brand manufacturer web sites, as well as the MINTEL nutrition facts database, documents that none of the cereal products we analyze were reformulated during the study period. We will now describe each database in turn.

We focus on twenty-one cereal brands. There are sixteen top-selling children's brands and five leading

family brands which are close substitutes for children's brands. These brands belong to General Mills, Kellogg's, Quaker, and Post. These brands represent an important dietary component for U.S. children. Households with any child under 12 accounted for 29% sales in volume for all RTE breakfast cereals in our data, and these twenty-one brands accounted for 41% sales in volume purchased by these households. Moreover, 93% of households with any child under 12 purchased at least one of the twenty-one brands in our sample period. Table 1 lists the twenty-one brands and the summary statistics on their nutritional contents. The children's brands generally have high sugar levels. The sugar levels of the children's brands ranges from 9 grams per serving (General Mills' Honey Nut Cheerios) to 14.6 grams per serving (Kellogg's Apple Jacks), both with a serving size around 30 grams. On the other hand, the sugar levels of the family brands are less concentrated. At the lower end, Kellogg's Rice Krispies has only 3 grams of sugar, and Quaker's Life has 6 grams for a serving size around 30 grams. At the higher end, Kellogg's Raisin Brans has 18 grams for a 60-gram serving size, and Kellogg's Raisin Brans Crunch contains 20 grams for a 53-gram serving (more than half of the sugar contained in these two brands is added sugar, and the remainder from raisins). Although there is a considerable sodium range across all twenty-one brands, the children's brands and the family brands are quite similar on the average in sodium content, with one exception being Kellogg's Frosted Mini-wheat which contains almost negligible sodium. The saturated fat levels range from 0.13 (Kellogg's Frosted Flake) to 3.50 (General Mills' Reese Puffs). Table 1 also reports the mean and standard deviations of the price, GRP and market share of each brand. Except for Quaker's brands, the children's brands generally have much higher GRPs than the family brands on average.

CFBAI standards are based on serving size. Both Kellogg's and General Mills pledged to advertise to children only products containing 12 grams of sugar or fewer per serving by 2009 when they joined CFBAI. Post promised to advertise only products containing 12 grams of added sugar or fewer per serving when it signed on the initiative in 2009. PepsiCo, the parent company of Quaker's pledged to limit its child-directed advertising to products in which sugar account for less than 10% of total calories of product. The CFBAI uniform standards released in 2011 further pushed sugar content to 10 grams or fewer per serving for the cereal category. Eight out of the sixteen children's brands contain more than 12 grams of sugar per ounce of cereal, and the remainder generally have sugar just below this threshold. Across the brands we study, the typical serving size is 30 grams, since 1 ounce is equal to 28.35 grams, this standard is roughly 12 grams of sugar per ounce. Sugar level is measured as total sugar, the sum of added sugar and naturally occurring sugar. On the other hand, IWG standards are based on Reference Amount

Customarily Consumed (RACC) and there are small and large RACC. The small RACC is 30 grams and the IWG standard is to reduce *added* sugar content to fewer than 7.8 grams per small RACC. Strictly speaking, this comes out to 7.37 grams per ounce and combined with naturally occurring sugar levels in kids cereal puts total acceptable sugar under the IWG standard of fewer than 8 grams per ounce for the cereals we consider.

The Nielsen HomeScan data we study tracks the purchases of children's RTE breakfast cereal for a panel of 13,985 households across the eight DMAs. These data include purchases made at big box retailers, grocery stores, convenience stores, and on-line retailers for at-home consumption. For each purchase, we know time and location of the purchase, price, and quantity, and other product characteristics such as brand and package size. Columns 6 and 7 record average price and observed price variance for the eight brands in our study. The prices across brands are generally comparable, with Frosted Flake and Cap'n Crunch having lower price per ounce or equivalently per serving lower than others. To reduce the panel selection bias households are aggregated to the DMA level using projection factors computed by Nielsen based on the DMA's demographic composition and we find that our aggregate market shares closely approximate those reported by IRI's Market Scope publication, which are based on store sales.

The Nielsen Media Research data provide brand level television advertising exposure on a weekly basis for the same DMAs during the same weeks. Advertising exposure is measured in gross rating points (GRPs). GRP measures the reach and frequency of commercials for a particular product during a specified week. For example, if a commercial is aired on TV in a market twice in a same week, with the proportion of audience in the market reached each time being 5% and 8%, then GRP is 13%. We also use advertising expenditure data at the same level of aggregation to compute the average price of advertising per GRP. Using firm-specific measures of advertising controls for the observed heterogeneity in advertising spot selection, because the price of advertising spots vary across television listings according to the market for television advertising spots. During our sample period, each of the eight brands on the average delivered 16,997 GRPs for children under 12, whereas the average brand-level GRP for children under 12 for the remaining 116 adult and family cereal brands is only 2,604. These eight brands also were marketed primarily to children, with GRPs for children under 12 accounting for about 73% of total GRP on the average, whereas for the other 116 adult and family brands, children under 12 only received about half of the overall advertising exposure. Table 1 summarizes biweekly GRPs and expenditure levels of the eight brands in our study. Except for Quaker Cap'n Crunch, all brands have relatively high levels of GRPs and

expenditures.

3 Model of Consumer Demand

We start with a standard random utility model. Here we outline the general model, the impacts of CSR participation on demand are described in more detail in section 4. The utility of consumer i derives from purchasing a product $j = 0, ..., J$ in market t is given by:

$$u_{ijt} = v_{ijt} - \alpha_i p_{jt} + \epsilon_{ijt}, \tag{1}$$

where $v_{ijt} = x_{ijt} + \gamma_i \Gamma(g^a_{jt}) + \xi_{jt}$ is the utility consumers derive from product j in the market t, where x_{ijt} is the direct observable preference for the product, γ_i is the marginal utility of goodwill, $\Gamma(g_{jt})$, and ξ_{jt} is an unobserved market level demand shock. $\Gamma(\cdot)$ exhibits satiation in goodwill stock g^a_{jt}, specifically $\Gamma(\cdot) = log(1 + g_{jt})$ for $g_{jt} > 0$ and is equal to 0 otherwise. The reason we specify advertising as a complementary product attribute (Becker & Murphy, 1993), as opposed to an awareness augmenting instrument (Grossman & Shapiro, 1984), is because kids cereals are an established category with well known products identified by beloved spokes cartoons featured in entertaining advertisements that are effectively designed to enhance the consumption value of the products they endorse. The α_i parameter is the marginal disutility of price. The consumer can choose an outside option we call 0. ϵ_{ijt} is a mean zero idiosyncratic taste shock distributed independently and identically as a type I extreme value random variable. Normalizing v_{0t} to zero, the indirect utility from the no purchase option is:

$$u_{i0t} = \xi_{0t} + \epsilon_{i0t}. \tag{2}$$

Integrating out ϵ_{ijm} derives the consumer demand share for product j in market t, which is then given by:

$$s_{ijt} = \frac{exp(v_{ijt} - \alpha_i p_{jt})}{1 + \sum_{k=1}^{J} exp(v_{ikt} - \alpha_i p_{kt})}.$$

Integrating over the consumers in the market, gives market demand share, $s_{jt} = \int s_{ijt} dP$.

3.1 Model of Advertising Carryover

As in a model that closes follows that of Dubé et al. (2005), advertising goodwill stock, g_{jt} captures the carry-over effects of advertising on demand, which is modeled as a distributed lag of advertising:

$$g_{j,t} = \sum_{s=1}^{\infty} \lambda^k \Psi(A_{j,t-s}), \tag{3}$$

where $\Psi(\cdot)$ is a nonlinear goodwill production function, t and s are time periods. We assume $\Psi(0) = 0$ and is a nondecreasing function of advertising proliferation, $A_{j,t}$. Firms produce goodwill by adding to the existing stock to generate an augmented goodwill stock,

$$g^a_{j,t} = g_{j,t} + \Psi(A_{j,t}). \tag{4}$$

which generates consumer demand at time t. The augmented goodwill stochastically depreciates over time according to the following law of motion:

$$\begin{aligned} g_{jm,t+1} &= \lambda g^a_{jm,t} + \nu_{jm,t+1} \\ &= \lambda(g_{jm,t} + \Psi(A_{jm,t})) + \nu_{jm,t+1}. \end{aligned} \tag{5}$$

$\lambda \in (0, 1)$ is a geometric decay factor. $A_{j,t}$ measures the reach and frequency of advertising for a particular product in a market as captured by GRPs in period t. An expansion of equation (5) yields:

$$g_{jm,t} = \sum_{k=1}^{\infty} \lambda^k \Psi(A_{jm,t-k}) + \omega_{jm,t}, \tag{6}$$

where $\omega_{jm,t} = \sum_{k=0}^{\infty} \lambda^k \nu_{jm,t-k}$. We apply a goodwill production function that exhibits decreasing returns to adverting effectively capturing market satiation, as suggested by Dubé, Hitsch, and Manchanda (2005), $\Psi(A) = log(1 + A)$, we also test this specification at the stage of estimation.

4 Model of Quality Investment & CSR Participation

This section describes the dynamic oligopoly model of investment in health quality and voluntary marketing initiative participation. This section also describes the equilibrium concept applied to explore participation

strategies. The market consists of F firms that manage their own portfolios of branded products. Time, t, is discrete and firms compete in participation, health quality, prices, and advertising. We first explain how firms earn profits in each period and how investment in health quality and participation in the marketing initiative influence product revenues and production costs. Next we describe the participation game and introduce the equilibrium concept applied to investigate participation in a CSR marketing initiative.

4.1 Profit Model

In each period, a firm, f, recruits profits jointly over all the products, j, in its category portfolio G_f, given, the market state $w = [g, \omega_M, x]$ (goodwill, previous maximum health quality, and product attributes), current health quality, ω, price, p, and augmented goodwill, g^a. Time subscripts are dropped to simplify notation. Firm profit in any period in which the firm operates is expressed as:

$$\Pi_f(w, g^a, p, \omega) = \sum_{j \in G_f} \pi_j(w, g^a, p, \omega) \tag{7}$$

where product cash flow is the difference between revenues, R_j, and costs, C_j:

$$\pi_j(w, g^a, p, \omega) = R_j(w, g^a, p, \omega) - C_j(w, g^a, p, \omega). \tag{8}$$

Revenues, R_j, are given by,

$$R_j(w, g^a, p, \omega) = p_j * Q_j(w, g^a, p, \omega), \tag{9}$$

This expression indicates that health quality, ω, and augmented goodwill, g^a, have direct impacts on firm revenues. We model two direct impacts on revenues for each, through the utility function, u_{ij}.

$$u_{ij} = x_j + \underbrace{\delta_i \omega_j + \zeta_i * I(\omega_j \geq \bar{\omega} \vee A = 0)}_{CSR\ impact} - \alpha_i p_j + \gamma_i \Gamma(g_j^a) + \xi_j + \epsilon_{ij}, \tag{10}$$

This expression indicates that consumer utility is a function of the firm's choice for the health quality, ω, and may positively ($\delta_i > 0$) or negatively ($\delta_i < 0$) impact consumer utility, depending on the consumer's preference for healthy quality. The expression also indicates that the consumer receives additional brand image utility, ζ_i, if the product reaches the health quality standard, $\bar{\omega}$, or ($\vee$) if the firm suspends advertising, but not if the firm advertises ($A > 0$) an unhealthy product ($\omega_{jt} < \bar{\omega}$). Note that the extreme value

utility shock, ϵ_{ijt}, assumption implicitly models and interaction in the reformulation and participation effects, which implies that the demand response of either effect is in fact changing in the other despite the fact that they are specified linearly in the utility function. Integrating out the error and averaging consumer demand share over the consumers in the market gives market demand,

$$Q_j = Ms_j, \tag{11}$$

where, M parameterizes the size of the market in total serving sales.

Marketing costs, C_j, are given by,

$$C_j(w, g^a, p, \omega) = (c_j + r_j(\omega))Q_j(w, g^a, p, \omega) + kA_j + \eta f(\omega, \omega^M)$$

The cost function includes several components: c_j, the marginal cost of producing the existing product; r_j, the incremental difference in the marginal cost of producing the product with health quality ω; k, the cost per advertising GRP, A_j; and $f(\omega, \omega^M)$, is the reformulation investment to scale the quality ladder from ω^M to ω, recall that ω^M is an element of the state vector, w. Finally, η is the price of the investment. The decision to reformulate has two distinct impacts on costs. The first cost change results from the change in variable inputs required to produce the reformulated product, r_j, hence reformulation has the potential to change the marginal cost of production. The second set of costs, $f(\omega, \omega^M)$, is the investment required to develop the higher health quality product and to retool the production technology. $f(\omega, \omega^M)$ has the following properties:

$f(\omega, \omega^M) = 0$	for $\omega \leq \omega^M$	Free maintenance, reduction, or reinstitution of quality
$f(\omega, \omega^M) > 0$	for $\omega > \omega^M$	Increasing quality is costly
$\frac{\partial f}{\partial \omega} > 0$	for $\omega > \omega^M$	Required investment increases in quality leap
$\frac{\partial^2 f}{\partial^2 \omega} > 0$	for $\omega > \omega^M$	Required investment increases in quality level

in practice we apply the following,

$$f(\omega, \omega^M) = \max\{\omega(\omega - \omega^M), 0\}^\theta, \tag{12}$$

where the cost-to-scale-quality parameter $\theta > 1$ reflects increasing cost of quality.

4.2 Firm Social Responsibility Game

The firms play the following game. At the start of a period, firms observe the state of the market, w, where $w = (w_1, .., w_J)$ is a vector that contains: advertising goodwill stock, and product health quality. Firms then make pricing, advertising, and quality decisions for each product $\sigma_j(w) = (p_j, A_j, \omega_j)$. If the firm participates in the initiative and the health quality of the products do not exceed the threshold stipulated by the initiative it suspends advertising for the product. If the firm participates in the initiative and its healthy quality exceeds the threshold stipulated by the voluntary initiative, then it is free to choose the advertising for its product. If the firm decides not to participate in the voluntary agreement, it is free to choose any level of advertising for products of any healthy quality. If a firm selects itself into a state in which it can advertise, they set their advertising plan to maximize the present value of profits. Prices are set to maximize profits each period. After firms set their strategy, $\sigma_j(w)$, demand is realized and current profits are determined prior to the start of the next period. Finally, a firm cannot select subsets of products that adhere to the voluntary initiative, if a firm chooses to join the initiative, then all products in the category that they market must serve the initiative, which implies that if a firm chooses to participate in the initiative it must either suspend advertising for unhealthy products or reformulate a product to continue advertising it.

The strategy profile vector $\sigma = (\sigma_1, ..., \sigma_J)$ contains the price, advertising, and quality decisions of all firms and their products. Each firm's value function is the expected discounted profits for firm f in state w under strategy σ, given by:

$$V_f(w_t|\sigma) = \max\Big\{\Phi_j, \mathbb{E}\Big(\sum_{s=t}^{\infty} \beta^{s-t} \Pi_f(w_s, \sigma_f(w_s))|w_t\Big)\Big\} \tag{13}$$

Firms maximize the stream of expected profits by choosing a strategy profile σ_f. Φ is the option value of exiting the market, which is a permanent decision.

4.2.1 Equilibrium

To investigate firm participation incentives we apply the Markov Perfect Equilibrium (MPE) concept to the dynamic game explained above.[2] We focus on the MPE in participation, pricing, and advertising. The MPE is characterized by a list of participation and pricing strategies $\tau_j^* = (\tau_1^*, ..., \tau_N^*)$, where $\tau_j^* = (d_{jt}, p_{jt}, A_{jt})$, such that no firm can profit by deviating from its strategy in any subgame starting at state w_t. Each firm's equilibrium strategy satisfies the Bellman Equation:

$$V_f(w_t|\tau^*) = \max\Big\{\Phi_j, \sup_{\kappa}\Big\{\mathbb{E}[\Pi_f(w_t, \kappa, \tau_{-j}^*(w_t)) + \beta V_f(w_{t+1}|\tau^*)]\Big\}\Big\} \tag{14}$$

The supremum is taken with respect to $\kappa = (p_f, A_f, \omega_f)$, the set of pricing, advertising, health quality strategies for each firm's portfolio. Equilibrium in this game reflects a dynamic and strategically optimal participation, advertising, health quality, and static optimality for pricing. The computation approach we apply is described in appendix A. We establish the existence of the MPE by numerically solving for equilibrium, for given demand parameterizations, there is no guarantee that the equilibrium is unique. In our simulations we also consider the equilibria that corresponds to the nested games, mandatory participation and no marketing initiative.

5 Demand Model Estimates

In this section, we present the results from the demand model estimation. We use standard estimation methods to identify and to estimate the demand model described in section 3 using the data described in section 2.

We aggregate the sample to four-week periods in estimating the demand. Table 2 shows the estimation results for four specifications. In all four specifications, we include price and brand fixed effects in consumers utility. We instrument prices with prices in other DMAs. For these price instruments to be valid, it is necessary that unobserved demand shocks are uncorrelated across different DMAs. A common violation of this requirement occurs if the econometricians do not observe national advertising. In our case, we control for advertising in each DMAs. The results of Hansen's J tests suggest that our instruments are valid, and the large F-stat values suggest that the instruments are relevant. The price coefficient, is around

[2] See Maskin & Tirole (2001) for a detailed treatment of the MPE concept and Ericson & Pakes (1995) and Pakes & McGuire (1994) for a detailed explanation of the general framework we apply and the numerical approach for obtaining MPE.

-10.5, and is negative and significant in all specifications. In the first two, only current period advertising exposure, as measured by GRPs, is included. In the last two specifications, we instead include accumulative advertising goodwill. λ and σ define the dynamic process of advertising goodwill as described in the model of advertising carryover section. The Advertising effect, both in the static models and the accumulated goodwill models, is positive and significant in all specifications. In the second and the fourth column, we also add an indicator variable "participation". The variable is one for products managed by a firm when they become a CFBAI signatory in a given period, and zero otherwise. We use this variable to capture the potential image-enhancing effect of participating in the CFBAI. We observe little reformulation during our sample period, therefore, the nutritional characteristics such as sugar, sodium, and saturated fat are fixed during out sample. We recover consumers preferences for these nutritional characteristics from the brand fixed effects using the two-step GLS method described in Nevo (2000). The coefficients on sugar, sodium, and saturated fat levels are all negative and significant, indicating that consumers dislike products containing higher level of these negative nutrients. This general distaste for sugar is consistent with the results from existing empirical and experimental research on the cereal market.

6 Participation Model Predictions

Differentiated products, such as RTE cereals, have asymmetric incentives to participate in CSR that are not a priori predictable. Moreover, the nature of that participation affects consumers' utility and hence their choices. Therefore we conduct a series of simulations using the market model with demand parameter estimates recovered using the RTE cereal data. These simulations predict the participation and investment strategies along with equilibrium profits, consumer welfare, and purchases for the two most popular kids cereals at the DMA level.

The simulations we present examine the two leading products in the kids RTE cereal subcategory, Frosted Flakes and Cinnamon Toast Crunch. The Frosted Flakes brand is managed by Kellogg, it is the market share leader, and Cinnamon Toast Crunch is managed by General Mills. The simulations provide insights into the participation incentives for these firms and their brands. They also reveal how the market evolves and which participation strategies firms use on their way to the market's steady states. The results also provide a prediction of the present value of brand profit flow, consumer economic welfare, and consumer purchase levels. We compare the results predicted by the CSR model to results from a non

image-enhancing participation mandate, as well as a market without an image-enhancing initiative.

To calibrate the revenue component of the model we specify the demand parameter estimates presented in the previous section in the revenue function. We recover the consumer response to changes in the nutrient mix due to reformulation directly from demand model estimates. We recover the response to marketing initiative membership directly from the data since we observe firms join CFBAI during the data period. We also check the robustness of our results to the magnitude of this parameter because consumer may respond differently to initiatives that have well defined nutritional standards, or initiatives sponsored by government such as the IWG initiative.

To calibrate the marginal cost component of the model we estimate a marginal cost model. We begin by backing out the implied markup under a Nash-Bertrand pricing assumption:

$$margin(p|A,d) = -(O \times_{elt} \Omega(p|A,d))^{-1} s(p|A,d) \tag{15}$$

where Ω has common element $\partial s_j / \partial p_k$, and O is an ownership matrix whose common element equals 1 if the firm manages both brand j and k and 0 otherwise. We then use these implied markups to back out marginal cost:

$$mc_{jt} = p_{jt} - margin_{jt} \tag{16}$$

Then regress the predicted marginal costs on product ingredients, x_j:

$$mc_{jt} = x_j' \kappa^x + \varepsilon_{jt} \tag{17}$$

We then use this model to predict changes in marginal cost of producing reformulated products. While this approach captures changes in the principle ingredients in breakfast cereal it may neglect new additives require to maintain the product experience with the new formulation, for now we acknowledge this limitation.

The costs of developing the reformulated product is not shared by food and beverage manufacturers due to its strategically important nature. That said a range of reformulation costs have been reported in a BBB CFBAI presentation at the Wellness 10 conference on March 25, 2010. Their presentation reports that reformulation cost would be in the range of \$100,000 to \$1,000,000 or more for one particular product or flavor. The investment price solves, reformulation cost $= \eta\bar{\omega}(\bar{\omega} - \omega^M)^{1.2}$, for η, here we set $\theta = 1.2$ and

ω^M is equal to the cereal's initial level; other values are checked to verify robustness of our results. The average cost for a GRP is computed directly from the advertising data by dividing quarterly expenditure by total GRPs to get an estimate for the cost of advertising, k. The discount factor is not observed and it is not estimated, we set the monthly discount factor based on the yearly interest rate of 12% which corresponds to a $\beta \approx 0.99$.

6.1 Firm Value, Optimal Investment, Advertising, and Pricing

Figure 3 illustrates the value and policy functions which are included to provide a sense of the firms joint policy function, it is however important to note that the surfaces pictured do vary off the limited dimensions portrayed. A more complete picture of each firms policy function is provided in the next section on the evolution of the market. The top row plots the value function, pricing function, advertising function, and investment function against various levels of own and competitor health quality, given an industry average goodwill. The bottom row plots the same functions against various levels of own and competitor goodwill, given an industry average health quality.

The value function appears in the first column, some properties of the firm value function, $V_f(w_t|\sigma)$, that are obvious: it is increasing in brand quality and goodwill, and decreasing in the competitor's brand quality and goodwill. Some properties of the value function that are not apparent in the figure depicted are that it decreases in reformulation investment price, advertising price, and marginal cost of production; and it increases in exit option value, Φ. The value function also decreases in the health target, $\bar{\omega}$, between the level that would be naturally optimal without the presence of an image boost and the level at which the health target becomes too costly to reach. It is also interesting to note that in unreported results we find that if firms are uncertain about the image demand shock, ζ, the value function increases in uncertainty because the option value of not participating increases as the firm learns more about the image demand effect. This finding is attributable to Hitsch (2006) in the context of product launch under demand uncertainty.

The second column of Figure 3 reveals that price closely contours the value function due to their close relation to quantity demanded. The third column of Figure 3 displays the advertising policy. Advertising is decreasing in own goodwill since the returns to advertising decrease as consumers become satiated on advertising. Advertising increases in competitor's goodwill, reflecting the marginal gain in sales generated by advertising as the competition captures market share. The forth column of Figure 3 displays the

investment policy. The function on top pictures a steady flow of investment in health quality up to the point at which the health quality standard is reached, beyond which a firm will not invest in further quality. The bottom panel of the forth column in this figure illustrates that the investment policy (one level) does not vary with respect to own or competitor goodwill at this particular quality level. To get a more complete picture of how firm competition plays out in this game we now analyze the path to the steady state.

6.2 Market Evolution

Table 3 details one particular path to the steady state that begins with goodwill levels and health quality levels equal to those observed at the end of the data period. Looking at the first period Kellogg has a healthier cereal to begin with as well as higher goodwill stock and price per serving. As time moves forward the model predicts that the two firms would apply different strategies. GM takes a "high-road" to full reformulation, placing their advertising program in a state of abeyance while they develop the healthier product, this gives GM the socially responsible marketer boost, which implies that for GM, the high-road is more profitable than advertising the unhealthy cereal.

On the other hand the model predicts that for Kellogg it would be best to take a "low-road" to full reformulation, continue advertising unhealthy products, which implies that Kellogg should hold off joining the initiative, or at least not implement the initiative standards on advertising yet. This is an optimal strategy because the marginal profitability of advertising out performs the social responsibility boost that suspending advertising would afford. While on the low-road Kellogg continues to improve the health quality of their product and ultimately benefits in two parts. First Kellogg's improvements immediately appeal to consumers tastes for a healthier product, enhancing demand for their cereal in the short-run. The second benefit to improvement comes further down the road when Kellogg finally reaps the social responsibility awards that accrue when their product finally meets the health standard.

Both firms have the incentive to reformulate the cereal to a point at which it complies with initiative standards, which implies that the CFBAI target is not too costly to obtain. It is also the case that when the market leader firm finally jumps into the full compliance state, it forces the lower equity brand to go all-in on reformulation with a large increase in healthy quality investment and goodwill investment at the moment that Kellogg reaches full compliance. This result testifies that competition in both health quality and social responsibility play a key role in mediating full reformulation, One without the other does not guarantee this parieto optimal dominant strategy. A result that is missed by models without competition

and models without incremental quality improvement. Once firms reach the participation threshold they cease further improvement in health quality because it becomes too costly. Finally the game enters a steady state with higher prices and similar goodwill levels.

Figure 4 plots Kellogg and GM's path to the steady state over goodwill levels for each firm. Arrows indicate the direction of the traveled path and the dots indicate each decision making period. The size (or diameter) of the dot indicates the health quality, one can think of the dot size as being proportional to the calories from sugar and saturated fat, as the dot shrinks so do the calories from sugar and saturated fat. The color of the dot indicates the participation policy applied by the firm. The line segments are color coded as black and red to indicate the paths of Kellogg and GM respectively. Figure 4 indicates the high-road path of GM versus the low-road path of Kellogg in the stretch of months leading up to full reformulation. The price is plotted on the vertical axis so dispite taking a low-road strategy Kellogg actually charges a higher price for their advertised cereal.

Figures 5 and 6 document the robustness of the steady state result by showing that the paths to the steady state enter the same channel, using the same high-road and low-road strategies for GM and Kellogg respectively, before hitting reformulation targets. One other result these figure show is that when a Kellogg begins in a high goodwill state they join the initiative by not advertising, riding goodwill until it dwindles and the profitability of advertising dominates the CSR image boost. The figures also indicate that when GM begins the game in a low goodwill state they spend the first period or so building up goodwill to ride out the no advertising CSR strategy, until they reformulate the product to meet the target health quality. One equilibrium that isn't admitted by this parametrization of the model is one in which a firm moves in in between the no advertising state and the no participation state, seemingly pulsing their way to profits, never improving their product quality to the level a particular initiative may require to be a signatory to their initiative. While this equilibrium isn't reveal under this parameterizations of the model it is possible within the modeling framework. This isn't a very practical strategy as it may confuse consumers and may not be allowed under the dictates of an initiative governed outside the firm. Another equilibrium not reveal under this parameterization of the model is one in which the reformulation is canceled, or never pursued, in favor of reducing product health quality in an attempt to serve a consumer segment of the market with tastes for calories from sugar and saturated fat. In order for such and equilibrium to emerge a critical mass of consumers would require such a preference. As an alternative strategy not captured by the model unhealthy products may enter the market to meet demand for unhealthy products.

Figures 7 and 8 show the differences in the strategies that firms use depending on the policy paradigm. One key difference under the mandatory compliance is that Kellogg is forced into taking the high-road strategy. Under this restriction Kellogg is incentivized to reach the quality threshold quicker which enables them to rebuild goodwill sooner. Or in other words, it is crucial for Kellogg to advance to a quality state in which they can advertise, because of the returns that advertising provides their brand. Figures 7 and 8 also show that when there is no well-defined threshold for brand image advancement firms loose incentive to invest in quality levels as high as those reached under an image enhancing initiative with well-defined quality standards or a mandate restricting the firms ability to advertise.

6.3 Returns to Industry, Consumers, & Policy Targets

This subsection explores the long-run implications of each policy alternative. To accomplish this we compute the present value of firm profit, consumer welfare, and a five year horizon of combined Frosted Flakes and Cinnamon Toast Crunch calorie consumption. The current value of firm profits are simply the value function at the outset of the game given the initial health quality conditions. The consumer welfare function, otherwise known as consumer surplus, is computed using the expression,

$$CS_i(p_t) = \frac{1}{|\alpha_i|}\mathbb{E}[\max_j V_{ijt}(p_t)] = \frac{1}{|\alpha_i|} ln\Big(\sum_{j=1}^{J} exp[V_{ijt}(p_t)]\Big) \tag{18}$$

where $V_{ijt} = v_{ijt} - \alpha_i p_{jt}$ is the consumers indirect utility for product j introduced in section 3 in equation (1).

Table 4 records the present value of firm profits and consumer welfare as well as caloric demand for the two product featured over a five year horizon. These computations are based on the starting value for goodwill and health quality observed at the beginning of the game. These results indicate that both consumers and firms are better off in terms of economic welfare under the CSR initiative compared to a mandate or business as usual. The results also indicate a net increase in calories

Figures 9 and 10 show the profit levels for the two firms under the CSR initiative compared to the mandate and to business without an image enhancing initiative. Each subplot shows firm profits for various starting values of goodwill, given the health quality of each cereal during the data period. The top line in both figures plots the profits under the CSR initiative. In Figure 9 the second line plots the profits under the mandate and in Figure 10 the second line plots the profits under a no image enhancing initiative

scenario. The third line in both figures plots the percentage difference between the two. In almost all cases both firms make more profits under the CSR initiative. The exception takes place for the challenger firm when goodwill levels are low. This testifies that reformulation was strategically necessary yet it is not in the best interest of the challenger to be forced into playing the CSR game.

The right hand side of Figures 9 and 10 plot consumer welfare and caloric demand against goodwill. Again we are comparing the CSR initiative against the mandate and the no initiative scenarios. Figure 9 indicates that consumers enjoy more welfare under the CSR initiative than under the mandate. This result isn't to surprising because the mandate does not award consumers with the enhancement in utility accrued from buying products from socially responsible marketers. This is also true for the second comparison between CSR and no initiative pictured in Figure 10.

Comparing the caloric demand under the CSR initiative to the mandate and to the business as usual scenarios we see that consumers demand more calories from the focal products under the CSR initiative. At first thought it may seem like this is not a positive finding from the perspective of the policy maker. However it is the case that the health quality enhancement reduces calories from sugar and saturated fat which implies that the calories consumed are healthier calories; a nutritional goal outlined dietary guidelines proposed by the USDA (USDA, 2010).

Figure 11 compares the mandate to no initiative. While it clear that firms prefer not to be subject to a mandate it is interesting to see that consumer welfare is actual higher under the mandate. This is because under the mandate they actually enjoy more desirable products and consequently a high level of goodwill (pictured in Figures 7 and 8). It is also true that people consume more calories from these two products under the mandate for the same reason.

7 Summary, Implications, & Concluding Remarks

In summary this paper explored the incentives for participation in a marketing initiative that had the potential to enhance a firms image as a socially responsible marketer. The direct incentives for firms are that social responsibility improves products and enhances demand in the process yielding higher returns to the firm. The social responsibility image boost also increases sales and firm profitability in line with the previous corporate social responsibility literature (Sen & Battacharya, 2001; Du, Battacharya, & Sen, 2011). The reformulation also has the potential for long-run production efficiency if the marginal cost of

producing the reformulated products is smaller, although, if the unit production costs are higher it might be a disincentive to participate in a socially responsible marketing program. As an added promotional spillover the greater utility consumers extent towards healthier and socially responsible brands leads to greater returns to media spend. It is also found that investment in the socially responsible reformulation is a key competitive instrument and the goal health quality provides firms with the incentive to reach the health quality threshold and do so in stride with their competition.

The analysis also provides predictions about the way the market evolves. It is found that full reformulation is a dominant steady state strategy if the target health quality isn't too costly to achieve. However their are to distinct strategies for reaching this steady state. First the high-road strategy followed by the market share leader which was followed due to the relative benefit of continuing their advertising program. Second the low-road strategy followed by the challenging firm which is to suspend the adverting program in favor of the social responsibility boost that being a signatory to the initiative provides. The model predicts that the game evolves to a steady state in about three years, but that firms reach the reformulation goal in about half that time. And full reformulation by the leadership firm may force challengers to catch-up fast, ponying up most of the required quality investment to reach the threshold during the period that the leadership firm enters the initiative. We also found that where mandatory compliance is concerned, firms may speed up reformulation to enable firms to advertise.

Comparing social responsibility initiatives to a mandate and to a market without an image enhancing initiative we found that CSR marketing initiatives are preferred to the other policies for firm profitability and consumer economic welfare. This enhancements also results in increased category consumption for healthier calories. While this does not answer how demand for a healthy diet shifts within and across consumers, it does indicate a strong incentive for firms to improve the quality of the calories consumed, an important aspect of nutrition according to government dietary guidelines. One interesting result the analysis reveals is that challenger firms may prefer no CSR initiative when the leading firm's goodwill is low because social responsibility provides and additional dimension to competition which moderates the gains of being socially responsible – due to its costly nature. It is also found that consumers enjoy greater long-term economic welfare under mandatory participation compared to business as usual. This result is supported by a heritage of literature that documents conditions under which a mandate lifts the market out of an inefficient equilibrium (see Akerloff (1970) for example).

As a practical matter CSR marketing initiatives present managers with the opportunity to provide

consumers with additional value generated by enhanced image and enhanced product quality. On the side of firm operations not only do the product improvements have the potential to make production more efficient they also directly reduce administrative managerial costs for shaping government legislation through lobbying efforts, and eliminate the need to hire resources for overseeing compliance with government mandates.

From the managerial perspective of the policy maker CSR marketing initiatives present the opportunity to improve the health qualities of the products their constituents value without restricting consumers from purchasing the products they enjoy. Alike the marketer, for the policy maker too there is also no need for administrative oversight required to monitor compliance in the form of government agency. Finally from the perspective of the political agent charged with reducing the externality caused by consumption of the legacy product: Industry organized CSR initiatives improve health quality without the need for the politician to spend political capital or other taxpayer resources in legislative planning.

Improving the healthy quality of the mix of food and beverage products marketed to children, and more generally everyone, is a priority for policy makers. Voluntary agreements that take this aim are viewed as a viable solution to make such an improvement. This research introduces a model to analyze a series of interlinked managerial decisions related to: participating in a CSR marketing initiative; investing in product reformulation; and pricing and advertising the products. Positioned at the intersection of public policy and marketing, the research promises to appeal to a wide audience and provides a framework which is generally applicable to a wide range of CSR initiatives. To our knowledge it is the first study that models the strategic decisions of firms faced with a CSR initiative as well as predict the impact on key market outcomes such as firm profitability, consumer welfare, and consumption of the product attribute generating the negative externality of concern.

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Table 1: Summary Statistics

Product	Category	Serving (g)	Sugar (g)	Sodium (mg)	Sat. Fat (g)	Price ($): Mean	Price: s.d.	GRP: Mean	GRP: s.d.	Share (%): Mean	Share: s.d.
Post Cocoa Pebbles	kids	30	11.00	190	1.000	0.177	0.047	0.186	0.136	1.937	0.852
Post Fruity Pebbles	kids	30	11.00	190	1.000	0.180	0.050	0.148	0.131	2.142	0.874
Post Honey-Comb	kids	32	10.00	180	1.000	0.185	0.067	0.238	0.169	1.754	0.851
GM Cinnamon Toast Crn	kids	30	9.97	209	3.107	0.170	0.032	0.386	0.168	6.795	2.108
GM Cocoa Puff	kids	30	13.94	167	1.373	0.194	0.061	0.215	0.176	2.377	1.171
GM Cookie-Crisp	kids	30	13.00	170	1.500	0.229	0.069	0.271	0.202	1.578	0.858
GM Honey Nut Cheerios	kids	28	9.00	190	1.501	0.165	0.022	0.491	0.253	14.225	3.437
GM Lucky Charms	kids	30	12.32	203	1.059	0.192	0.041	0.351	0.190	4.685	1.625
QKR Capn Crn	kids	27	11.82	204	1.580	0.138	0.043	0.037	0.076	2.408	1.075
QKR Capn Crn Crn Berry	kids	26	11.61	182	1.467	0.137	0.038	0.019	0.059	1.950	1.141
GM Reeses Puffs	kids	30	12.00	200	3.501	0.189	0.056	0.284	0.173	2.259	1.080
GM Trix	kids	30	13.00	187	1.425	0.218	0.060	0.256	0.167	1.604	0.850
Kel Apple Jacks	kids	33	14.55	150	0.517	0.201	0.047	0.143	0.159	3.099	1.138
Kel Corn Pops	kids	31	14.14	133	0.221	0.190	0.049	0.098	0.124	3.032	1.149
Kel Froot Loops	kids	30	13.05	137	0.901	0.183	0.042	0.137	0.175	4.177	1.393
Kel Frosted Flakes	kids	30	11.66	145	0.131	0.148	0.027	0.247	0.167	10.806	3.045
Kel Frosted Mini-wheats	family	51	10.23	5	0.816	0.248	0.038	0.113	0.138	13.725	4.524
Kel Raisin Bran	family	59	17.69	350	1.266	0.254	0.045	0.000	0.000	8.661	2.680
Kel Raisin Bran Crn	family	53	19.98	209	1.007	0.271	0.064	0.156	0.112	3.462	1.508
Kel Rice Krispies	family	33	3.11	319	0.300	0.235	0.052	0.134	0.108	4.892	1.628
QKR Life	family	32	6.20	165	1.517	0.156	0.053	0.058	0.079	4.432	2.201

Source: GRP data are from Nielsen Media Research. Price and share information from Nielsen Homescan. Nutrition data from Mintel GNPD.

Table 2: Demand Estimation Results

	(1)	(2)	(3)	(4)
Price	-10.532***	-10.246***	-10.704***	-10.891***
	(1.697)	(2.145)	(1.711)	(2.219)
log(1+GRP)	0.525***	0.525***		
	(0.071)	(0.072)		
Goodwill			0.567***	0.567***
			(0.100)	(0.101)
Lambda			0.665***	0.672***
			(0.143)	(0.149)
Sigma			0.365	0.402
			(1.150)	(1.138)
Sugar	-3.384***	-4.604***	-1.784***	-2.391***
	(0.037)	(0.043)	(0.018)	(0.022)
Sodium	-0.020***	-0.020***	-0.231***	-0.303***
	(0.002)	(0.002)	(0.022)	(0.025)
Sat. Fat	-3.710***	-5.496***	-0.757***	-0.958***
	(0.146)	(0.153)	(0.017)	(0.019)
kids*participation		-0.010		0.004
		(0.032)		(0.034)
Brand dummies	Y	Y	Y	Y
Observations	7,350	7,350	7,350	7,350
Partial-F	19.928	12.660	20.050	12.660
p-value	0.000	0.000	0.000	0.000
J-test	1.604	2.050	1.8205	1.8161
p-value	0.658	0.562	0.6104	0.6114

Source: Authors' calculations.

Table 3: Sample Path to Steady State

	Participation		Healthy Quality		Expected Goodwill		Price	
T	Low equity	Hi equity	Low equity	Hi equity	Low equity	Hi equity	Low equity	Hi equity
1	Par w/o Adv	Par w/o Adv	0.00	0.04	0.50	0.70	0.1610	0.1612
2	Par w/o Adv	No Par	0.01	0.05	0.25	0.35	0.1607	0.1612
5	Par w/o Adv	No Par	0.04	0.08	0.03	0.47	0.1609	0.1611
10	Par w/o Adv	No Par	0.09	0.13	0.00	0.59	0.1611	0.1614
15	Par w/o Adv	No Par	0.14	0.18	0.00	0.65	0.1613	0.1616
20	Par w Adv	Par w Adv	0.19	0.19	0.20	0.70	0.1616	0.1618
25	Par w Adv	Par w Adv	0.19	0.19	0.39	0.60	0.1616	0.1619
30	Par w Adv	Par w Adv	0.19	0.19	0.40	0.60	0.1616	0.1619
35	Par w Adv	Par w Adv	0.19	0.19	0.40	0.60	0.1616	0.1619
39 (SS)	Par w Adv	Par w Adv	0.19	0.19	0.40	0.60	0.1616	0.1619

Table 4: Present Value

Policy	Profit		Consumer	5 Year Caloric Demand (1,000s)		
	GM	KEL	Welfare	GM	KEL	Total
Voluntary	822,409	867,700		235,427	220,104	455,531
Mandatory	808,834	848,799		233,022	216,202	449,225
Difference	13,575	18,900	5.28%	2,405	3,902	6,306
Business as usual	810,903	855,704		233,708	216,051	449,760
Difference	11,505	11,995	5.79%	1,719	4,053	5,772

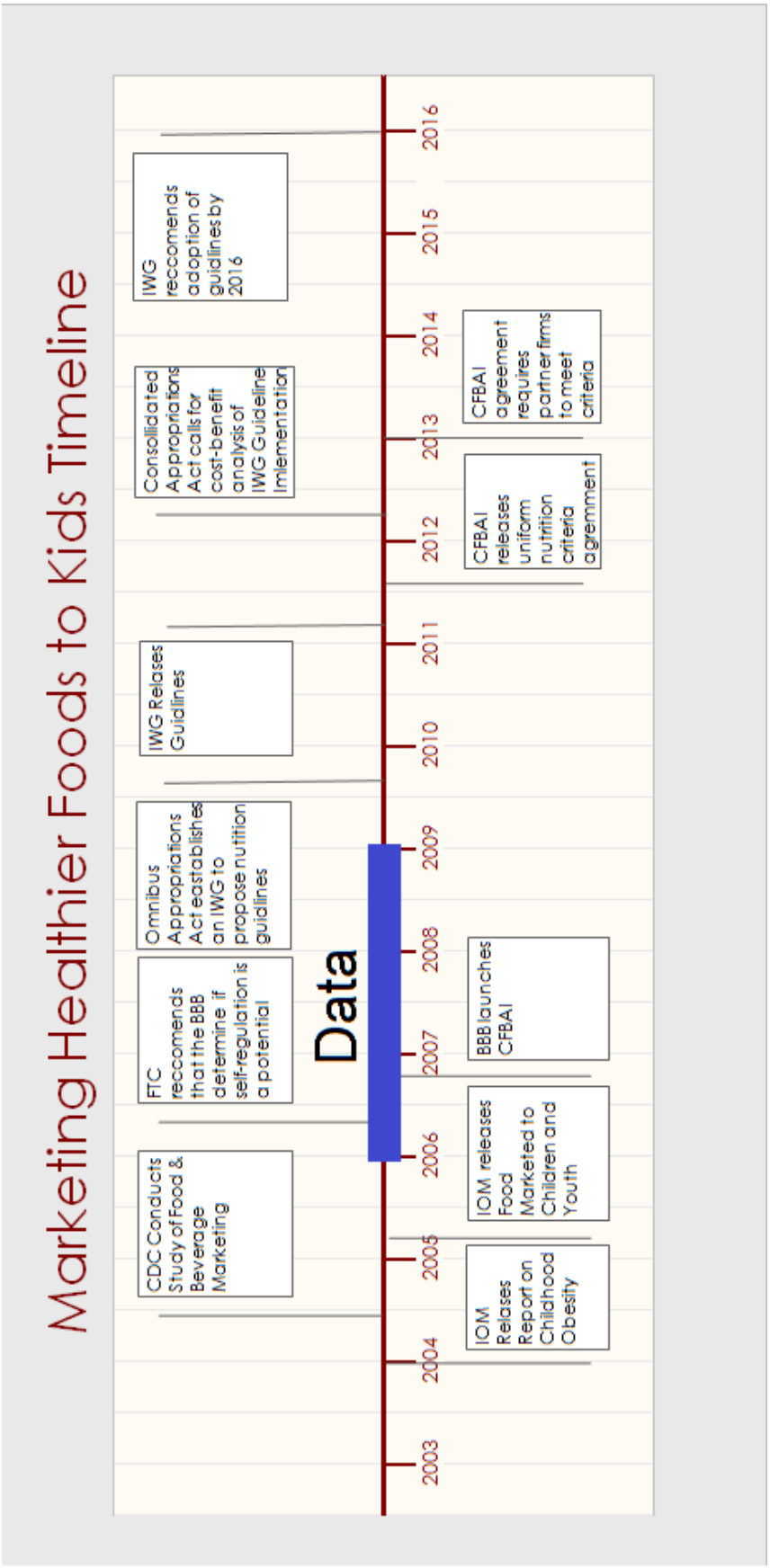

Figure 1: Time Line

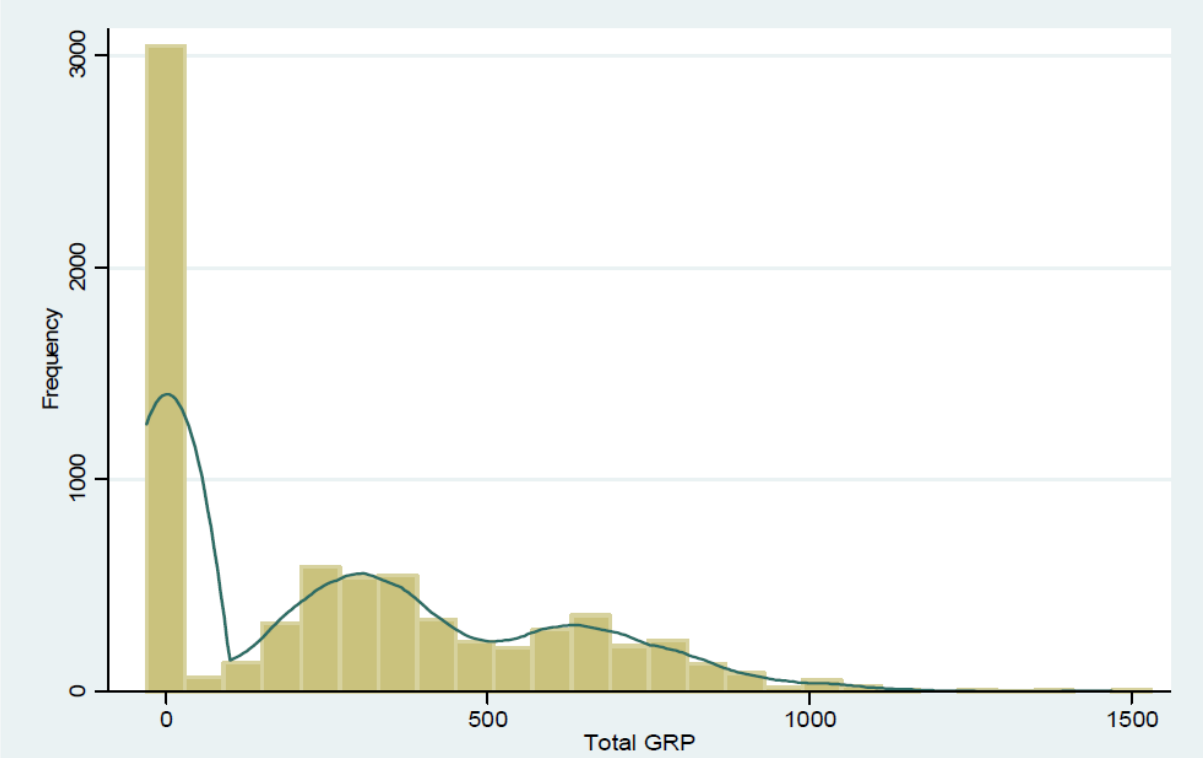

Figure 2: Distribution of Gross Rating Points (GRPs)

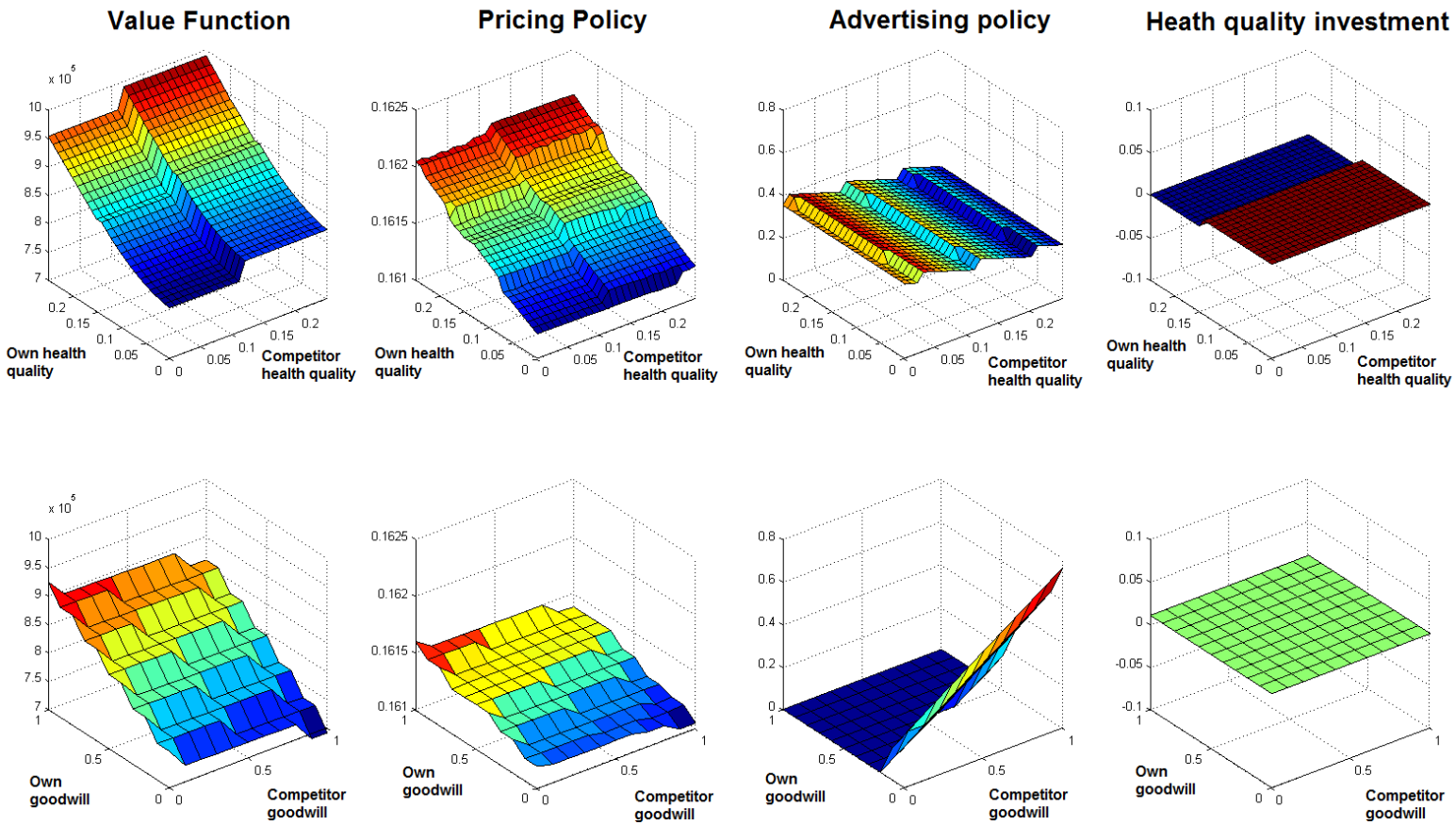

Figure 3: Value and Policy Functions

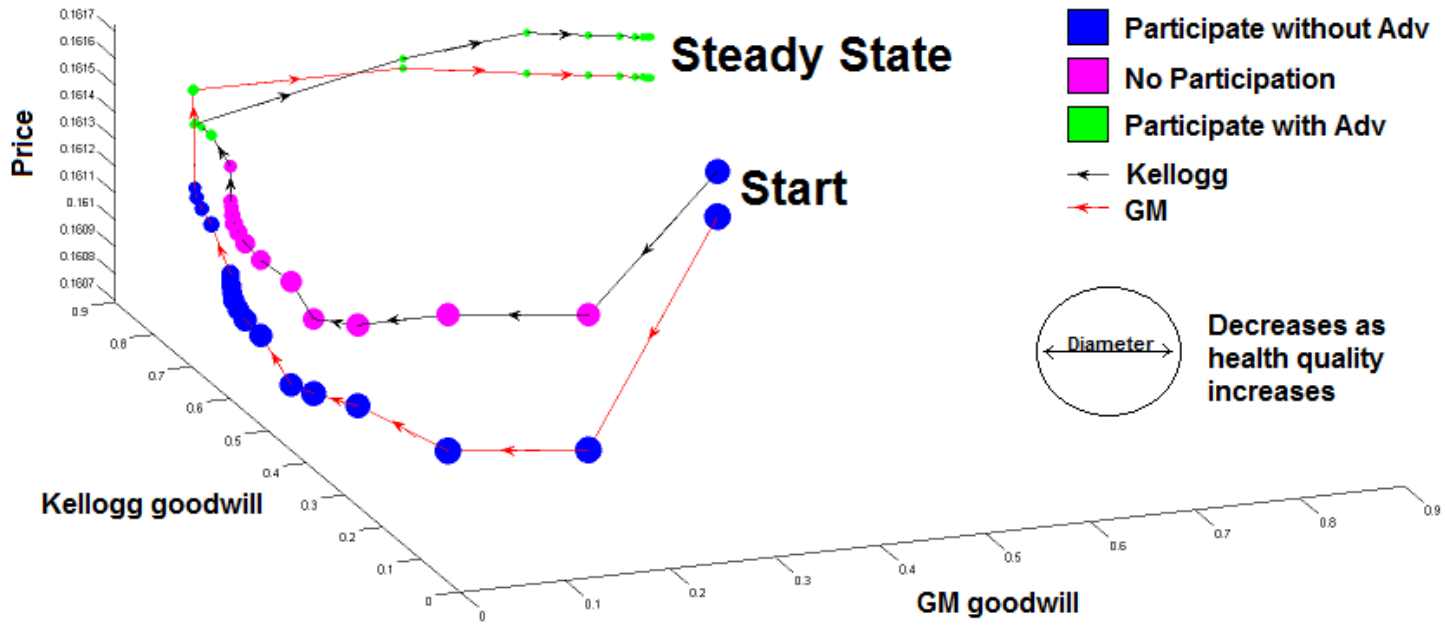

Figure 4: Kellogg Evolution to Steady State

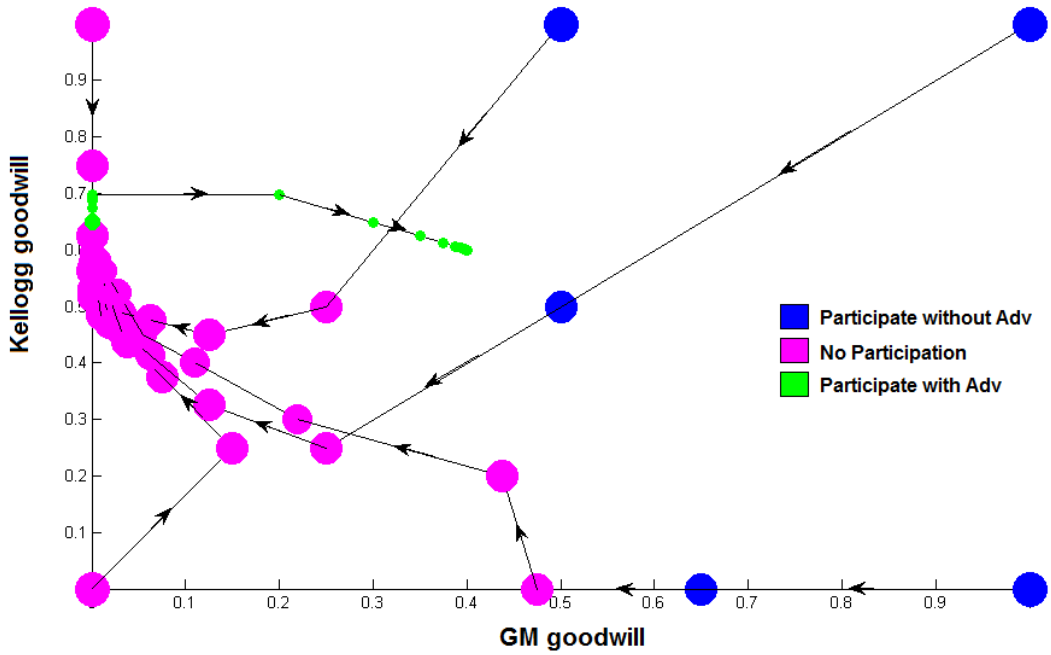

Figure 5: Paths to Steady State

A Computational Algorithm:

We start by taking an initial guess at the participation strategy profile $\sigma^0 = (p^0 = (p_1^0, \ldots, p_F^0), A^0 = (A_1^0, \ldots, A_F^0), \omega^0 = (\omega_1^0, \ldots, \omega_F^0),$.

1) For participation profile σ^n calculate the corresponding value functions V_f^n for each of the F firms. The value functions are calculated according to the Bellman equation (**??**). The maximization on the right hand side is not carried out, the current guess of the participation strategy σ^n is used

2) If $n > 0$, check to see if the value functions and policies meet the convergence criteria, $\|V_f^n - V_f^{n-1}\| < \epsilon_V$ and $\|\sigma_f^n - \sigma_f^{n-1}\| < \epsilon_d$ for all F firms. If they do, stop.

3) Update Each firm's strategy from the Bellman equation (**??**). This time the maximization on the right had side is carried out. for each participation strategy, σ_f^n, given then participation strategies of other firms, σ_{-f}^{n-1}, then choose the participation strategy that maximizes firm f's value function.

We compute all expectations with Monte Carlo simulation. In the simulation we assume a monthly discount factor $\beta = 0.9901$, or equivalently an annual interest rate of 12%.

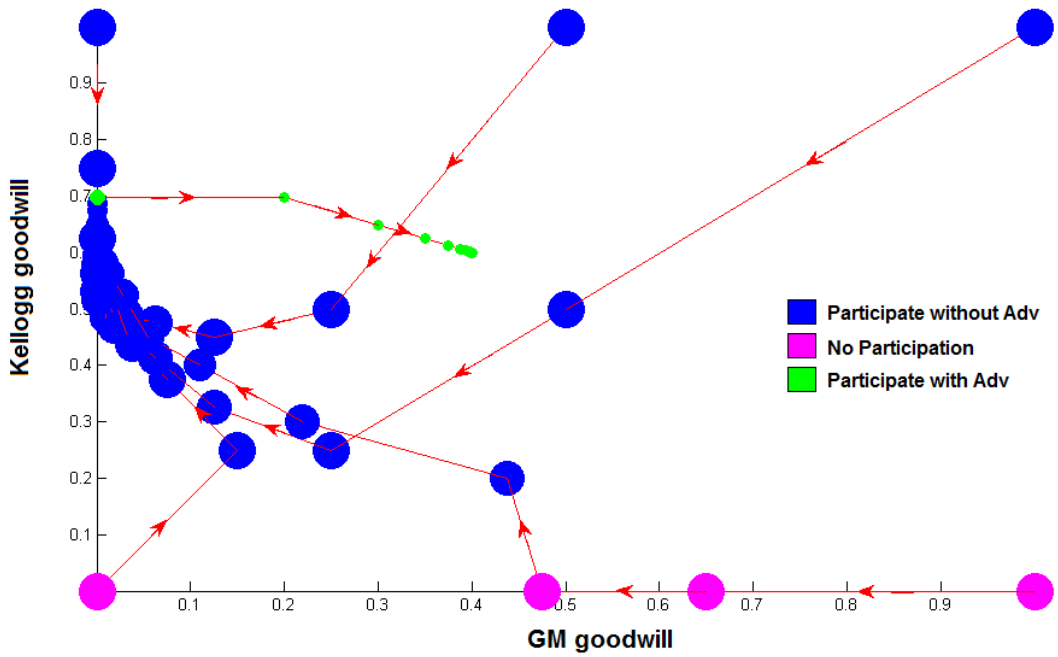

Figure 6: Paths to Steady State

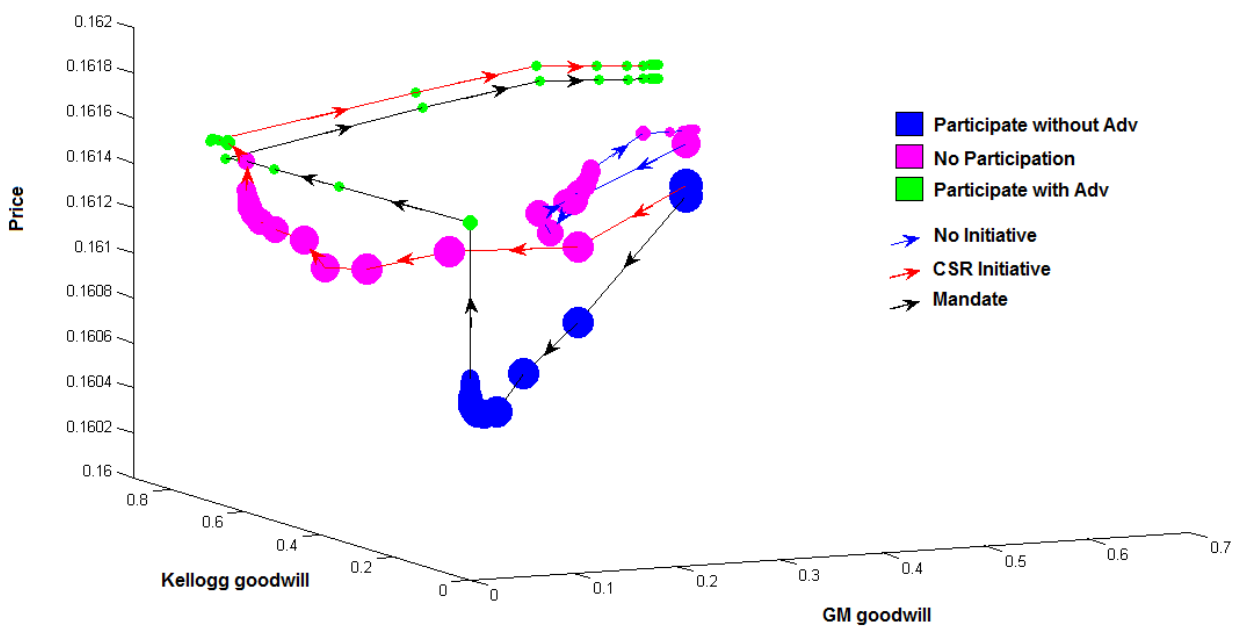

Figure 7: Comparison of Paths: Kellogg

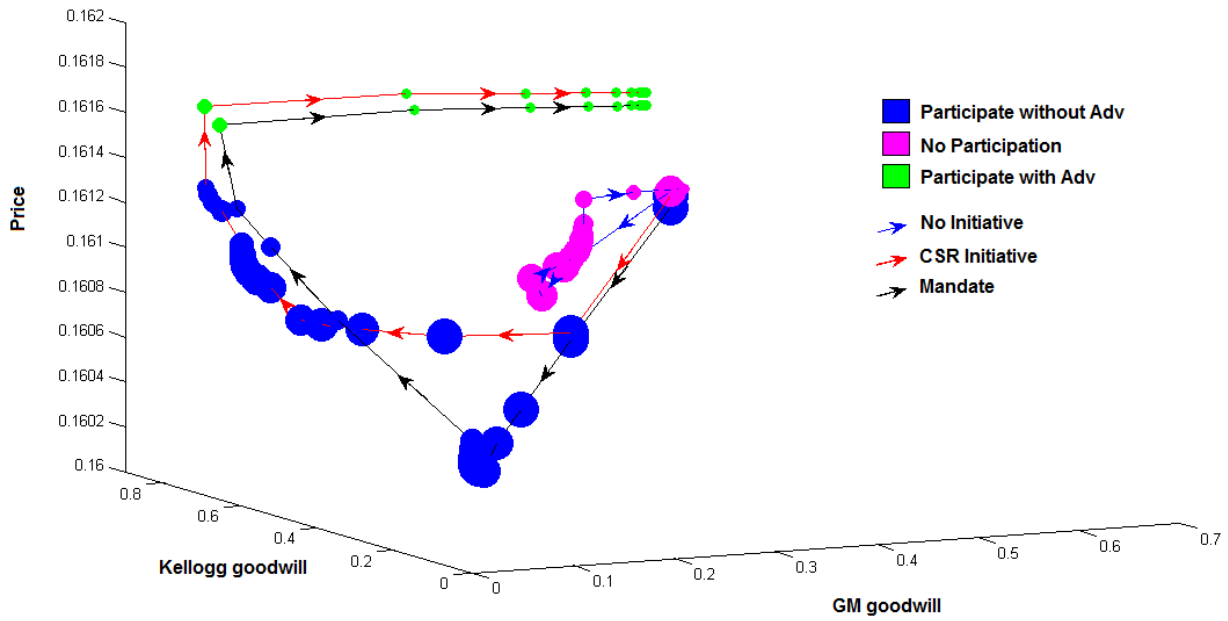

Figure 8: Comparison of Paths: GM

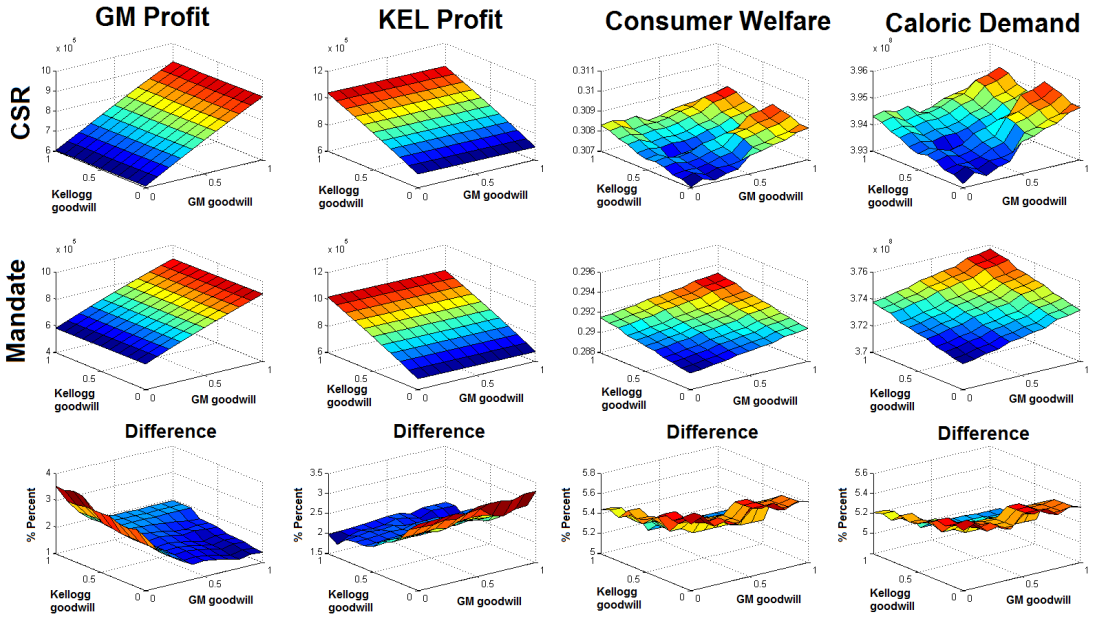

Figure 9: Comparison of Long-Run Outcomes: CSR vs Mandatory

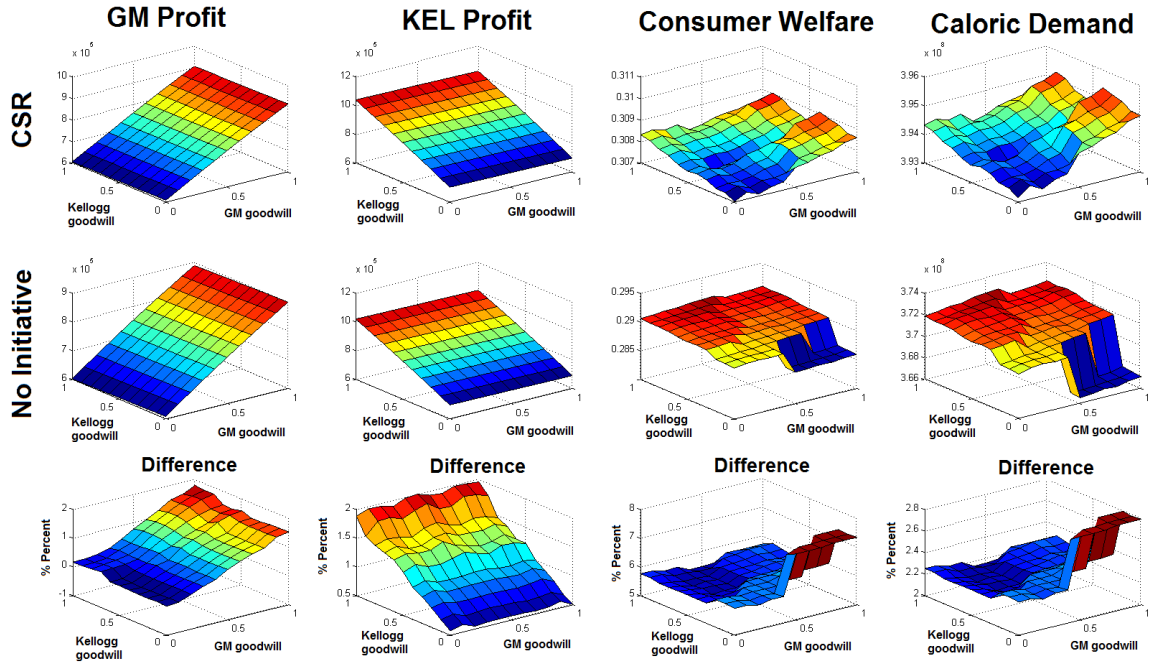

Figure 10: Comparison of Long-Run Outcomes: CSR vs No Initiative

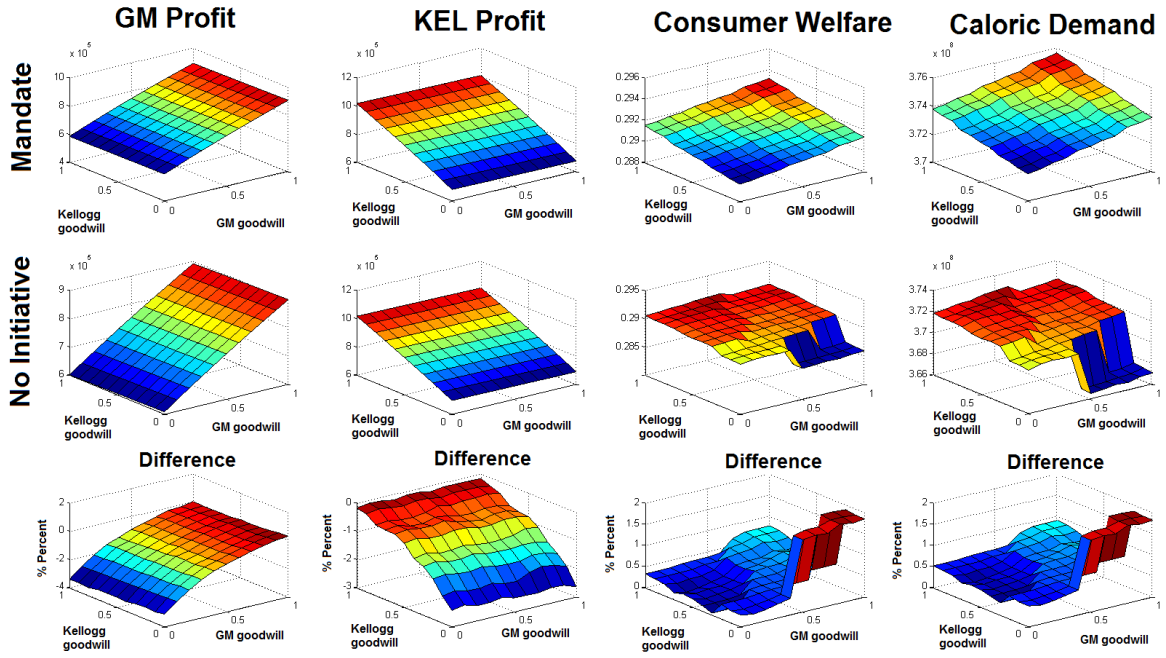

Figure 11: Comparison of Long-Run Outcomes: Mandatory vs No Initiative