Incentive contract design for food retailers to reduce food deserts in the US

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ABSTRACT

In the US, obesity affects over 37% of the adult population and over 16% of the child and adolescent population. Although not-for-profit agencies cannot directly control what a person eats, they can influence the supply side of the obesity epidemic by incentivizing food retailers to open stores in regions of the US where food deserts exist. An incentive contract design dependent upon performance and resulting health benefit is presented for food retailers to reduce food deserts in the US. A principal-agent framework is used to capture the competing interests and moral hazard from the contracting mechanism. Optimization models are developed to determine the most effective and equitable resource allocations from the initiative given a target reduction in obesity rate or a set budget, while determining the optimal subsidy these agencies should offer to food retailers to incentivize operation in certain counties. These subsidies are designed to create financially viable conditions for food retailers to offer high quality, healthy food alternatives. The impact of retailer location on obesity is based on estimates of marginal effect on obesity rate. Given an example initiative in metropolitan Atlanta, Georgia and surrounding counties, the overall county-wide obesity rate would decrease by 1.17% with a fixed budget of $400M. Sensitivity analysis on the reduction in obesity is performed for varying total budget amounts. This incentive contract design strategy is a positive step toward ensuring that the underserved US population has better access to healthy foods while helping solve the obesity epidemic.

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1. Introduction

In the US, obesity affects over 37% of the adult population and over 16% of the child and adolescent population [25]. It is the second leading cause of preventable death and is a significant factor in many severe health conditions such as chronic obstructive pulmonary disease, heart failure, diabetes, cancer, etc. (USDH, 1998). Although obesity is an individual problem, the societal costs of obesity are significant. In 2006, the average cost of healthcare for an obese person was nearly $1500 a year more than for a normal weight individual [14]. Obesity-related healthcare costs in the US equaled 21% of medical spending or $190.2B in 2011 [6], and the incremental lifetime medical cost of an obese child relative to a normal weight child is estimated to range between $16,310 and $19,350 [15]. For Medicare patients, over $600 of the additional annual medical costs attributed to obesity come from prescription medication [14]. That figure will continue to rise with the rising costs of prescription medication and the fact that in most drug categories obesity is driving the rise in prescription drug rates [18]. A factor that has been strongly associated with obesity is the food environment where an individual lives [5,9,12]. These geographic areas are commonly called food deserts, and defined as “areas with limited access to affordable and nutritious food, particularly such an area composed of predominantly lower income neighborhoods and communities” (H.R. Bill 6124, 2008). In the US, those with access to fresh fruits, vegetables, and healthy foods is based in part on socio-demographic factors such as income, geographic location, and population density [21,34]. Approximately 10% of the US population live more than 1 mile from the nearest
supermarket [26].

Several studies have examined how the presence or absence of types of food retailers (e.g., grocery stores, supermarkets, and convenience stores) in these geographic regions impact obesity. Morland et al. [22] showed that supermarket and grocery stores have a positive correlation with a healthy population, whereas Courtemanche and Carden [10] estimate that an addition of one supercenter (Walmart) per 100,000 residents increases BMI by 0.24 units. Jago et al. [20] showed that increased fruit and lower fat consumption is associated with lower density of small stores (convenience store and drug store) in the area. Boden et al. [4] estimated that in New England, each additional supermarket in a respondent’s neighborhood was associated with a reduced odd for obesity where fast food restaurants and convenience store were associated with an increased odd for obesity. These findings were consistent with those of Morland and Evanston [23]. In a randomized controlled trial [17], observed that an in-store marketing campaign in a low-income neighborhood significantly increased sales of healthier items. Wedick et al. [32] performed a prospective study and showed that shorter distances to a healthy food store positively impacted dietary behavior. Yan et al. [33] found that obesity rate increased in supercenters and convenience stores and decreased in grocery stores and specialized food stores for the US as a whole.

Numerous food distribution activities have been initiated as a response. The Healthy Food Financing Initiative is one such example. It is a partnership between the U.S. Departments of Treasury, Agriculture and Health and Human Services, which earmarked over $400 million to provide funding support for developing stores that sell fresh and healthy food in underserved areas. The initiative incentivizes healthy food retailers in the form of tax credits, grants or low-cost loans, and technical assistance. The rather ambitious goal of the initiative is to eliminate food deserts across the country within seven years [30].

The Healthy Food Financing Initiative was modeled after The Pennsylvania Fresh Food Financing Initiative (FFFI), which is one of the more successful programs [16]. FFFI provides financial support to food retailers to operate in underserved and low-income communities in order to increase the access to nutritious and affordable food. The incentives are designed to help the food retail enterprises overcome the barriers of higher infrastructure costs and credit risks in those economically distressed communities. Over the period of 2010—2014, FFFI committed $73.2 million in loans and $12.1 million in grants to 88 projects, which were expected to bring 1.67 million square feet of fresh food retail space across Pennsylvania. Moreover, thousands of job positions were created through the program. Several grant and loan products were available for the program, and the details varied based on project type, risk, loan terms and social impact. Rather than subsidizing stores that were otherwise economically unfeasible, the program only provided incentives to attract viable supermarkets into underserved areas. The Reinvestment Fund (TRF) was the administrator of the FFFI program [27].

It is important to mention that several studies have found no association between food retailers and obesity. For example, Elbel et al. [13] found that locating a government subsidized supermarket in an underserved neighborhood in the Bronx did not change the dietary intake of children living there. Further, Cummins et al. [11] found that opening a supermarket in a food desert in Philadelphia did not lead to significant dietary improvements or reduced BMI. Further, even if locating food retailers in food deserts had an impact on obesity, no studies have shown that such an intervention would be cost-effective.

We therefore present an incentive contract design dependent upon performance and resulting health benefit for food retailers to reduce food deserts in the US. In particular, we consider an initiative with a given budget operating in Atlanta, Georgia and surrounding counties. A principal-agent framework is used to capture the competing interests and moral hazard from the contracting mechanism. Optimization models are also developed to determine the most effective resource allocations from the initiative. The impact of retailer location on obesity is based on the estimates of marginal effect on obesity rate determined in Yan et al. [33]; which are the only estimates based on a national study to date.

2. Incentive contract design

We consider three contract types (or interventions) between a funding agency (principal) and food retailer (agent) based on the findings of Yan et al. [33]: 1) a subsidy to convert a convenience store with no gas pumps to a grocery store, 2) a subsidy to open a specialty food store, and 3) a subsidy to open a new grocery store. The agent devotes certain effort to the business (monetary equivalent $a). Whether or not the agent stocks and prices as desired is not necessarily directly observed. For example, a store could locate and not stock a wide variety of healthy foods (or price them high). Thus, one cannot observe the agent’s effort in terms of making fresh fruits and vegetables available in the store, for instance. Are they regularly stocking? Are they overcharging? These are some examples where the agent’s action may be hidden to the principal. For these reasons, the principal cannot directly observe the agent’s actions but only the outcomes, leading to moral hazard. Nonetheless, this effort will lead to an observable outcome of $x$, which has two components: an annual sales of $p(a) = a + \epsilon$, where $\epsilon$ is normally distributed with a mean of zero and a variance $\sigma^2_x$ and a monetary benefit from reduced obesity (expected reduced health costs related to obesity), $h(a)$, resulting from the increased community’s access to healthy and affordable foods, where $h(a)$ is a non-decreasing function of effort level. The monetary benefit from reduced obesity is of linear form: $h(a) = ma + \delta$, where $m$ is selected based on the marginal effect at the target area estimated from the obesity model presented by Yan et al. [33]; and $\delta$ is normally distributed with a mean of zero and a variance $\sigma^2_h$. These two components of the observable outcome can be summed because both $p(a)$ and $h(a)$ are functions of the monetary equivalent of effort (i.e., these components are in the same units). The first term is discounted to be a $/unit of time and the second term is directly in $/unit of time. Since both components are represented in terms of money (annual sales plus monetary benefit from reduced obesity), the output is defined as:

$$x(a) = p(a) + h(a) = a + ma + \epsilon + \delta$$

Several obstacles can prevent retailers from locating a new outlet in a food desert, such as higher distribution costs in low-income areas due to poor transportation infrastructure, additional training cost from an unskilled labor pool, and increased security cost in areas with higher crime rates [2,3]. These economic considerations make it more likely that food retailers will not choose to locate in those areas. We therefore assume that the food retailers are risk-averse with utility function:

$$U(w) = -e^{-rw}$$

where the coefficient $r$ is the measure of the agent’s level of risk aversion, and $w$ is the retailer’s profit. We use a performance-based linear contract of the form:

$$s(x) = \gamma + \beta x$$

where $\gamma$ is the subsidy paid to the agent, $\beta$ is the performance based...
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