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The Effect of Subsidizing Supermarkets to Enter Food Deserts on Welfare

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Recent research has found that in the United States, limited access to healthy food is associated with a lower consumption of fruits and vegetables (Bodor et al. 2008; Zenk et al. 2009; Michimi and Wimberly 2010), and a higher probability of obesity and other dietary related health problems (Morland, Wing and Roux 2002; Carroll-Scott, 2013; Thomsen et al. 2015). Areas with limited food access and low average incomes are often referred to as food deserts. Several federal, state, and local activities have emerged in response to the challenge of food deserts including encouraging large grocery retailers to move into underserved areas, improving food options in corner stores, encouraging mobile grocery vendors and making Supplemental Nutrition Assistance Program (SNAP) Electronic Benefit Transfer (EBT) available at farmers' markets. Since 2001, California, Nevada, New Mexico, Texas, Oklahoma, Louisiana, Illinois, New York, Pennsylvania, D.C., and Maryland have enacted legislations aimed at increasing the number of healthy food retailers or have subsidized local stores to provide fresh fruits and vegetables.

Although various policy interventions have been implemented to eradicate food deserts, concerns have been raised on whether such policies are effective and welfare improving. Estimating the impact of the policies to subsidize supermarkets to enter food deserts on households' welfare is challenging for several reasons. First, the intervention policies and programs are not randomly assigned or exogenously determined. Thus it is hard to separate the effect of improving food access from concurrent changes in other unobserved socioeconomic status. Second, data on households' food purchase, acquisition and consumption before and after the program intervention are not available. Thus, evaluating the welfare implications of intervention programs through reduced-form regressions is difficult.

In this article, I use structural estimation from industrial organization literature to estimate the consumer demand, firm supply and entry decisions of food stores and identify the welfare impact of subsidies for supermarkets to enter food deserts. My framework includes an explicit model of consumer demand with spatial differentiation, and a model of price and entry competition between multi-store retailers. This allows me to distinguish between demand, variable cost, fixed cost, and entry cost parameters. With specific knowledge of consumers' demand and food stores' profit functions, I can conduct counterfactual analysis and study the welfare implications of intervention policies on food deserts *ex ante*.

To evaluate the impact of the supermarket subsidies, I use a three-dimensional panel of store-level quantities and prices for 50 retail chains in 658 census tracts from Cook County over a period of 60 months, collected using scanning devices from Information Resources Inc. (IRI). The other store characteristics such as store size, whether it has a parking lot and number of checkouts are from TDLinx store directory data. The census-tract level socio-demographics are from 2008-2012 American Community Survey and the census-tract level food deserts definitions are from Food Access Research Altas (FARA) in 2010. I define food deserts and supermarkets following the FARA rules.[1]

With these data, I employ a model of an oligopoly industry characterized by spatial competition between multi-store firms to study the welfare implications of supermarket subsidies. There are three elements of the model, consumers' demand, firms' price competition

[1] In FARA, there are four definitions of food deserts. The definition I use is a low-income census tract where a significant portion of people live over 1 mile away from the nearest supermarket in urban areas and 10 miles away in rural areas. A supermarket is defined as a store which has over 2 million annual sales and has all major food departments such as fresh produce, fresh meat and poultry, dairy, dry and packaged foods and frozen foods.

and entry decisions. First, I use a random-coefficient discrete choice model (Berry, Levinsohn, and Pakes 1995; Nevo 2001) to estimate consumers' demand for a food store in each census tract in a county. The indirect utility of the consumer patronizing a store is a function of store characteristics, heterogeneous consumer preferences, and unknown parameters. The store characteristics include the store's prices, food options, store square footage, whether it has parking lot, the number of checkouts and the distance to consumers' home (spatial differentiation of stores). The BLP model allows consumer's valuation of the store's proximity to home to vary with whether the consumer owns a car and unobserved consumer characteristics. Furthermore, this model allows consumers with different income to have differential preferences towards store quality (e.g. food options). By exploiting the panel structure of my data, I control for retail chain[2] specific unobserved characteristics through retail chain fixed effects. The correlation between prices and unobserved demand shocks, which are included in the econometric error term makes prices endogenous in the demand estimation. As a result, I use observed variation in census-tract specific cost shifters such as the store's distance to the nearest the distribution center as the instrumental variable for prices.

Second, I specify the price competition between firms as a Nash-Bertrand pricing game. Given the demand and spatial market structure of stores, the incumbent firms set prices for each of their own stores to maximize firm-level variable profits. Therefore, firms can have different prices across their own stores in equilibrium. Thus this model recognizes the multi-store nature of retailers and incorporates spatial differentiation and the cannibalization effects on the demand.

Third, after observing consumer demand and setting optimal prices, each firm will simultaneously decide where to locate a store. Specifically, given that firm costs are hard to obtain, I use entry decisions to uncover the fixed costs and entry costs in the similar spirit as Bresnahan and Reiss (1990) and Berry and Waldfogel (1999). The entry model is based on the equilibrium condition that we will observe N firms in a market if and only if N firms are profitable while $N + 1$ firms are not. In contrast to earlier work, the fixed costs and entry costs estimates employ an explicit variable profit function that is identified through the BLP demand and Bertrand price competition framework as discussed above. Therefore, we relax the assumptions that firms are symmetric and allow firms to choose their characteristics (e.g. quality and locations), which significantly complicates the model.

Using the estimated demand, prices and cost distributions for each retail chain in each of the census tract, we can calculate the subsidies needed for supermarkets to have non-negative profits (entry) in each census tract including food deserts. In this paper, I assume governments subsidize supermarkets to enter food deserts in the form of lowering entry and fixed cost. Then we can evaluate how differ amounts of subsidies affect the consumer and producer surplus (social welfare) over the years and whether these subsidies are effective in eliminating the food deserts.

My paper has a number of contributions to the literature. First, to the best of our knowledge, my paper conducts the first welfare impact evaluation of intervention programs to eliminate food deserts. It provides important policy implications as to whether large-scale healthy financing initiatives targeting food deserts areas are effective and justified. Second, I estimate separately the demand, prices and costs for different retail chains in various locations, which is helpful for policymakers to conduct cost-and-benefit analysis of different policies other than subsidies to improve food access in low-income areas. Third, I contribute to the firm entry methods literature

[2] From now on, I use firms and retail chains interchangeably.

by allowing the retail chains to be asymmetric and choose their own characteristics after recognizing the spatial competition and multi-store nature of food retail chains industry.

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