The Preferences Behind Produce: Investigating the Effects of a Massachusetts Food Access Policy

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INTRODUCTION

On December 10th, 1948, Eleanor Roosevelt and the United Nations General Assembly convened in Paris, France to adopt the Universal Declaration of Human Rights. The document would set forth a global standard of achievement to secure fundamental living-conditions for all people. Nevertheless, among the many rights that constituted the document, Article 25 section 1, "the right to adequate food and the right to be free from hunger" still carries significant weight in the present day. The declaration was drafted in response to the tragedies of WWII, in which deaths due to famine matched or outnumbered military deaths. Thus, after the international community had witnessed widespread hunger in regions such as the Soviet Union, Bengal, Henan, and Java, Article 25's right to "adequate food" may have originally meant a simple minimum-calorie designation. But, with a growing body of knowledge in food science, the right to "adequate food" evolved greatly over the last half-century. In fact, the 1996 United Nations Human Rights fact sheet states "[food] adequacy means that the food must satisfy dietary needs, taking into account the individual's age, living conditions, health, occupation, sex, etc."

In the present time of calorie surplus, adequate food intake is much more nuanced than the quantity of calories that an individual consumes. The relationship between the amount of food an individual eats and their wellbeing isn't linear. In fact, not all foods are created equal-some foods offer very little nourishment per calorie compared to others. The complete consideration of a diet, as is widely recognized in food science, includes the quality and nutritional value of the food (USDA, 2020). The right to adequate food, as stipulated in the Universal Declaration of Human Rights, is the right to nutritious food. But, in the midst of a national nutritional crisis, the United States is falling short of this basic benchmark.

In the United States, almost 46% of adults and 56% of children have a poor-quality diet. Additionally, over the past half-century, federal healthcare expenditure has grown from 5% to

28% of the federal budget, with 85% of healthcare spending being devoted to treating diet-related, chronic disease (Fleischhacker, 2020). The health effects of the American diet are far reaching and leading to malnutrition on a large scale. In 2020 over 42% of the United States population, nearly half the country, was classified as obese (CDC, 2017).

For many Americans, lack of nutritional value in their diet is caused by inaccessibility to healthy foods (Corterill, 1995; Horowitz, 2004). Improving access to healthy food is not only a commitment to upholding basic human rights, but carries with it the potential to increase welfare for millions of Americans. And, while the landscape of food access is nuanced and many solutions for food access have been ineffective, demand-side policies show promising results in the economic literature (Allcott, 2018; Afshin, 2017). There is potential for policies centered around price reductions for healthy foods to improve the nutritional value of American diets and, thus, increase the proportion of the American population that is exercising their human right to nutritious food. In this light, my thesis will study the effect of the Massachusetts Healthy Incentives Program (HIP)-a demand-side policy targeted at reducing prices of healthy food products-on the rates of obesity in Massachusetts food deserts.

LITERATURE REVIEW

In the 21st century, Americans consume an unprecedented proportion of commercially produced, ultra-processed foods. An 18-year study of 41,000 adults by the American Journal of Clinical Nutrition found that from 2001 to 2018 ultra-processed food consumption grew from 53.5 percent to 57 percent (Juul, 2021). Processed foods such as packaged baked goods, snacks, soft drinks, and sugary cereals are abundant, but due to their high levels of sugar and low-levels of vitamins and fiber, have been linked to chronic disease (Srour, 2019; Rico-Campa, 2019). Obviously, American diets may be trending unfavorably away from sources of calories that are necessary for optimal health, such as fruits and vegetables, towards ultra-processed foods that are associated with negative health outcomes.

Sufficient consumption of fruits and vegetables has been associated with reduced risk of chronic disease and obesity (Dhandevi, 2015) and the United States Department of Agriculture's (USDA) Dietary Guidelines for 2020 - 2025 maintain that fruits and vegetables of all types are "core elements" of a healthy dietary pattern (United States Department of Agriculture, 2020). One commonly cited reason that many Americans may not be consuming healthy foods is that groups in low socio-economic classes may face environmental or financial barriers to accessing these foods. In the United States, urban neighborhoods and rural towns without access to fresh, healthy, and affordable food are called "food deserts" (USDA). In these communities, supermarkets or grocery stores may not be accessible and, instead, individuals must shop at convenience stores or fast-food restaurants that have little or no affordable healthy food options.

In 2011, a White House Task force was created targeted at reducing childhood obesity and a major part of their plan focused on food access. On the topic of food deserts, Michelle Obama stated that "we can give people all of the information in the world about healthy eating...if their only options for groceries are in the corner gas station or the local mini mart, then all of that is just talk" (NPR, 2011). Accordingly, Michelle Obama announced a $400MM Healthy Food Financing Initiative with the aim of eliminating food deserts nationwide by the year 2017 (The Economist, 2011). The discussion of Food Deserts and their impact is still relevant today. Just last year in February 2021, the Healthy Food Access for All Americans (HFAAA) was brought to congress, seeking to set up a system of tax credits and grants for businesses that served low-income and low-access areas (McEachin, 2021).

The policies mentioned above are founded on the idea that implementing healthy food retailers in food deserts solves problems of healthy food access. A large body of literature is focused on studying supply-side variables in food access-or an individual's literal, physical access to healthy foods. Since the 1990s, researchers have investigated the "Urban Grocery Store Gap," using ZIP code-level demographic information and found that in the largest 21 metropolitan centers of the United States, ZIP codes with higher levels of individuals on public assistance, when compared to middle-income ZIP codes, had fewer supermarkets that offer healthy foods (Corterill, 1995). In some ways, food access seems to be infrastructural-residents of low-income areas cannot access food retailers, but they also cannot access many other amenities that are prevalent in more affluent neighborhoods. Residents of poor neighborhoods in urban centers, as shown in New York City, may need to travel significant distances in order to access the same variety of supermarkets, banks, and other stores that are accessible in more affluent communities (Horowitz, 2004). Food pantries in these communities do not provide sustainable or even healthy solutions to food access because client visits are limited, and these services usually do not provide fresh produce because of spoilage concerns (Algert, 2006).

Nevertheless, accessibility to supermarkets or grocery stores may not be the answer to eradicating food deserts. Historically, access to superstores is not an indication of healthy eating. It has been seen that a consequence of superstore entry, such as Walmart Supercenters, is accessibility of foods and products that promote sedentary lifestyles and, thus, increase the incidence of obesity. Evidence from a study in Arkansas, a state that ranks among the highest in food inaccessibility, suggests that the entry of an additional Walmart supercenters per 100,000 residents increased an individual's probability of being obese by 10.8% of the sample obesity rate (Courtemanche, 2011). Supercenters can lead to cheap unhealthy food and consuming large quantities of unhealthy foods leads to weight gain (Philipson and Posner, 2003; Hausman and Leibtag, 2009). Ultimately, supermarket entries into communities that have, by definition, limited food-access have economically small outcomes in the short and long term (Allcott, 2018).

These findings hold true when investigating supply-side interventions. In the Bronx, New York City, a difference-in-difference study was conducted on two neighborhoods identified as high-need areas. The treatment group received a government-sponsored supermarket, as part of a program to increase food-accessibility, which greatly decreased distances needed to travel for healthy food options. No appreciable differences were found in availability of healthful or unhealthful foods at home or in the children's diets between the treatment and control group. Evidence suggests that whether one has a car is a greater determining factor in food access than whether a supercenter exists in your community (Wright, 2016). Some suggest this is because less than one in five individuals shop for their sources of calories within their own census tract, which define the perimeters of food deserts (Drewnowski, 2010; The economist, 2011). These findings suggest that environmental policy solutions to food deserts such as supermarket entries only provide little or negligible results.

Instead, consumer preference and food pricing does seem to play a more significant role in determining access to healthy foods. Higher income households are usually willing to spend a larger proportion of income on healthy foods (French et al., 2019; Dhakal and Khadka, 2021). The same study that determined supermarket entry to have negligible economic effects on healthy food-access, found there to be a striking and systematic relationship between the same household's income and preferences for healthy food intake (Allcott, 2018). In fact, the inherent definition of "food desert" may present challenges in understanding whether individuals that live in food deserts face supply-side food access issues. In focusing on traditional food retailers (such as grocery stores and supermarkets) the USDA definition of "food desert" often ignores tens of thousands of larger and smaller food retailers such as farmers' markets and roadside greengrocers—these alternative sources of healthy foods account for more than half of the United States' trillion-dollar retail food market (Wright, 2016). A 2011 article in The Economist titled "If you build it, they may not come," illustrates this effect with the depressed town of Renton. Just outside of Seattle, Renton is considered a food-desert for lack of traditional supermarkets, but its abundance of roadside greengrocers can attract consumers from outside of city limits. Situations like this are making researchers consider estimations of supply-side variables in determining food access.

In Detroit, one of the United States' oldest and largest food deserts (Gray, 2008), the non profit Central Detroit Christian Community Development Corporation (CDC) opened a retail outlet selling nutritious foods, specializing in fruits and vegetables. The retailer was studied to determine the factors that contributed to consumers purchasing healthy foods and results showed that expenditures played a significant role in determining the purchasing behavior of consumers. Demand for fruits and vegetables was, consequently, extremely elastic and researchers stated that increasing income or decreasing food prices could increase the amount of food consumption (Weatherspoon, 2012). The observation that decreases in food prices have positive benefits is widely supported and certain meta-analyses show that a price reduction in fruits and vegetables by 10% increases consumption by 14% (Afshin, 2017). The significance of consumer preference and price elasticity in consumption of fruits and vegetables, in addition to the apparent ineffectiveness of supply-side solutions, suggests that policies focused on reducing costs and incentivizing consumers to purchase healthy foods may be the most effective in eradicating food deserts.

The Supplemental Nutrition Assistance Program (SNAP) is the largest federal nutrition assistance program and is a successful example of a demand-side solution to food access. SNAP provides benefits to low-income individuals–to qualify an individual's gross monthly income must be at or below 130% of the poverty line (with some qualifications for families, etc.). The program targets food pricing by providing benefits to users through an Electronic Benefits Transfer (EBT) card, which can be used like a debit card to purchase food from eligible retailers. Though SNAP allows for users to purchase unhealthy foods, such as snack foods, candies, and bakery items, those who participate in the SNAP program are, on average, less likely to be in a position of food insecurity (Yen et al. 2008). SNAP effectiveness data shows that, although outcomes are heterogeneous across the treatment population, those groups with diets that can be disrupted (or those who can change their preferences) as a result of the benefits, gain the most economically (Deb, 2016). Thus, while food price changes, such as the increased level of disposable income provided by snap benefits, help significantly with food access, the most effective solutions require individuals to change consumer preferences towards healthy options.

Perhaps one of the most beneficial traits of the SNAP program is the foundation and infrastructure that it provides for healthy food programs-programs that specifically target price reduction in fruits and vegetables. The National Resources Defense Council (NRDC) stated that "States have the opportunity to act affirmatively by investing in SNAP incentive programs and leveraging existing federal dollars to make sure their residents can meaningfully access sufficient and healthy food, while simultaneously supporting local farms, which are an essential part of a thriving regional economy" (NRDC, 2020). SNAP has been used to create what are known as

"Healthy Incentive Programs" (HIP), which provided SNAP participants with a 30% incentive for specifically purchasing fruits and vegetables. After purchase, the 30% incentive would be added back onto the individual's EBT card for use at any SNAP-eligible food retailer. Essentially, what the HIP does is reduce fruit and vegetable prices by 30% and because the incentive is limited to fruits and vegetables, the program also incentivizes consumers to change preferences towards these products to gain the 30% benefit. In a HIP pilot program in Hampden County, MA, the healthy incentives program's 30% reduction in fruits and vegetables yielded a 20% increase in consumption of those products within four to six months for snap users in the treatment population (Klerman, 2014). This result is strikingly dissimilar to outcomes observed through supply-side supermarket entries or environmentally based policies.

Other programs similar to the HIP have been implemented with success across the United States. In New York City, a farmers' market incentive program called "Health Bucks" was implemented that provided a $2 Health Bucks coupon to every $5 spent on an individual's EBT card, with no ceiling amount. Consequently, in 2011, $90,000 worth of Health Bucks were distributed to New York City participants, with a 93% redemption rate (Olsho, 2015). Ultimately, the Health Bucks price reductions produced greater awareness of farmers' markets, increased frequency and amount of farmers' market purchases, and increased self-reported fruit and vegetable consumption (Olsho, 2015; Baronberg, 2013). Similar results have been witnessed in farmers' market incentive programs across the United States (Cole, 2013; Freedman, 2014).

While many states have versions of the HIP, Massachusetts's program is the oldest of its kind and, as of 2022, is still operating across the state. While much research has been done on the Massachusetts HIP Pilot Program conducted in Hampden County (Olsho, 2015; Klerman 2014), little research has been on the program within the last four years with the exception of a master's program thesis researching effects in Lawrence, MA (Huang, 2020). Additionally, seemingly no research has been published on how the Massachusetts HIP impacted food access in Massachusetts food deserts.

The Massachusetts HIP provides a significant case study for the effect of demand-side solutions on food deserts. Because SNAP benefits target food prices and seek to change consumer food preferences for individuals with income-levels common in food deserts, understanding how the decade-old program has affected healthy food consumption in Massachusetts food deserts would be an important contribution to the existing literature. My paper will empirically examine the impact that the Massachusetts Healthy Incentives Program (HIP) has had on the composition of Massachussett's food deserts and provide a theoretical model in behavioral economics that investigates why consumer preferences may pose significant barriers to policies targeted at improving food access.

THEORETICAL MODEL

In the literature for both the supply and demand side solutions to food access, our agent is the individual who lives in a food desert and is a rational utility-maximizing consumer. The obvious assumption, drawn from the definition of a food desert, is that this consumer does not purchase a diet of healthy foods for a variety of possible reasons. The consumer chooses a bundle of unhealthy foods (U) and healthy foods (H) when purchasing foods. There are three possible "scenarios" for the utility-maximizing consumer in a food desert.

1) **The consumer encounters inefficiency by facing supply side barriers to healthy foods:**

$$U(\mathrm{U, H}), \text{ where } y = P_H(0) + P_U(U)$$

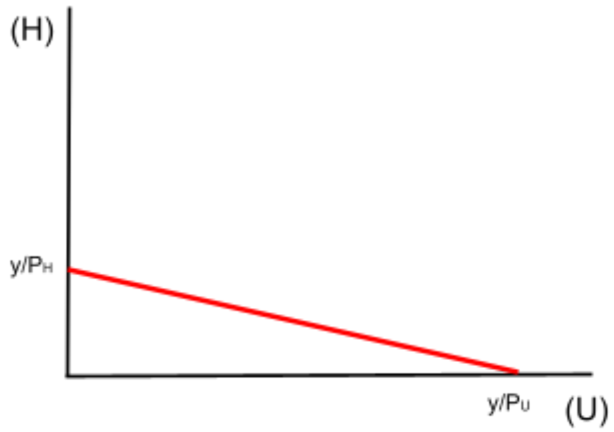
This consumer, while having some preference for healthy food (H), does not have access to a venue to express that preference, thus H must equal zero. Another way to understand this consumer's geographical barrier is an infinite price (P_H = oo), because no matter how high their income (y) is, there is an unattainably high price associated with accessing (H). If this is the case, where (P_H = oo), then H must be equal to zero because their income (y) is finite.

In this scenario, there is an environmental constraint that is creating inefficiency for the consumer. Michelle Obama's quote, "If a parent wants to pack a piece of fruit in a child's lunch... they shouldn't have to take three city buses," provides an accurate representation of this consumer; an individual whose preference is for healthy foods, but faces an environmental constraint (NPR, 2011). To solve this inefficiency, supply side interventions simply connect this consumer-and their assumed preference for healthy foods-with a venue (grocery store, supermarket, etc.). This theoretical scenario is improbable because the body of evidence shows that even as the utility-maximizing consumer in the food desert is exposed to healthy foods and has the venues to purchase those foods, they do not (Allcott, 2018). This is because either prices are creating the inefficiency-the prices they face in the produce aisle may be higher than the prices of unhealthy foods-or the preferences of the food desert consumer are for unhealthy foods.

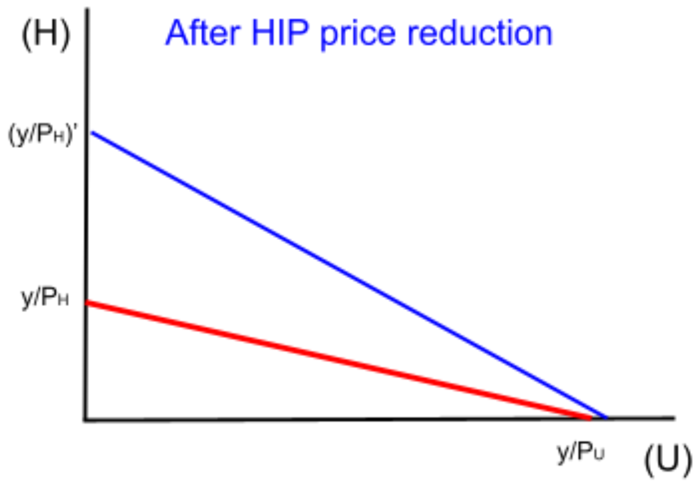
2) **The consumer encounters inefficiency by facing high prices for healthy foods.**

$$U(\text{U, H}) \text{ and } y = P_U(U) + P_H(H), \text{ where } (P_H) \text{ is } large.$$

This individual, while having some preference for healthy food (H), faces a price (P_H) that is really high. This is reflected in a budget constraint line that's flat and depicts a smaller proportion of (H), compared to every additional (U).



Demand-side solutions, like the Massachusetts Healthy Incentives Program (HIP), seek to solve the second scenario's inefficiency of differential food prices by specifically targeting and lowering the prices of healthy foods. Because of the reduction in price, the consumer with a preference for healthy food is not hindered by their budget constraint and chooses a more optimal bundle. Under this policy, even the consumer with mild preferences for unhealthy foods may be nudged to purchase healthier options.



In a basic scenario where the consumer chooses a bundle of unhealthy and healthy foods, the targeted lowered prices change the slope of the consumer's budget constraint line, such that their optimal bundle has a higher proportion of healthy foods. Depending on the magnitude of the preference for unhealthy food (a), the consumer may need a larger price reduction to be incentivized to purchase healthier options. This is because the amount of healthy food that a consumer purchases in scenario two is a function of healthy food prices and the preference for healthy food.

$$H^* = (P_H, 1 - a)$$

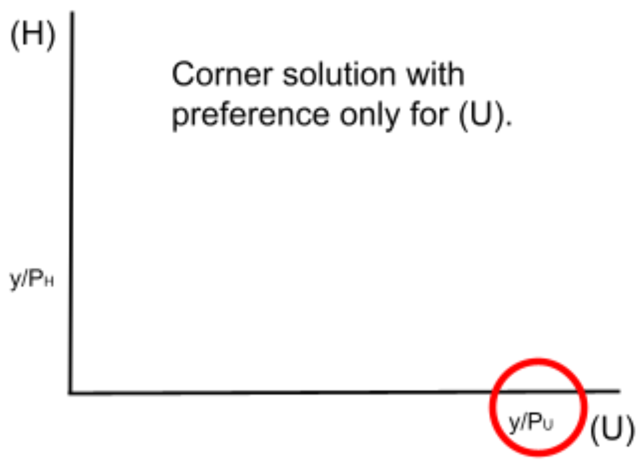
The two variables, preferences and prices, have opposite slopes. As P_H decreases, the proportion of H increases – this is a demand function. And, as $(1 - a)$ increases, the proportion of H increases.

3) The consumer only has a preference for unhealthy foods.

$$U(\mathrm{U}), \text{ where } y = P_U(U)$$

If, in the last scenario, price reductions and supply side accessibility solutions both do not have an effect on the consumers perceived access to healthy foods, the consumer prefers unhealthy foods and they are choosing their optimal bundle-utility-maximizing. With all of the resources in the world, this consumer would eat a diet of unhealthy food. This is reflected in a corner solution in their budget constraint line, where all of their income (y) is spent on (U).

Therefore, $U = \frac{y}{P_U}$



Assuming that the food desert consumer is sophisticated, meaning that they've been educated on food choices and understand the implications of their choices, the third food desert consumer is most likely a hyperbolic discounter. Hyperbolic discounting is a time inconsistent model of discounting future streams of utility. Individuals who discount hyperbolically will underestimate their future discount rate when compared to their present discount rate. Hyperbolic discounters value present satisfaction more than increased future utility. In the case of consumers whose preferences are for unhealthy food, they value the present satisfaction of taste more than the future health benefits of a less appetizing, but healthy diet. This poses a difficult issue for policymakers because, as stated before, if given all the resources in the world, these utility-maximizing consumers would choose the unhealthy bundle. For these individuals, there may be no policy solution.

Depending on the results of the empirical analysis, I hope to produce a theoretical model expanding upon how the individuals who hyperbolically discount may not be optimizing their potential stream of utility.

HYPOTHESIS

Hyperbolic discounting is implicit in human nature and it should be expected that some of the treated population, for this reason, will prefer unhealthy bundles regardless of the price associated with them. Ultimately, The effectiveness of the HIP's targeted price reduction will depend on the preferences of the individuals within each Massachusetts food desert. Those with preferences towards healthy eating will utilize the HIP price reduction and their diets will subsequently increase in nutritional value. Those consumers whose preferences are strongly unhealthy or, in other words, those who may be hyperbolically discounting will not utilize the price reduction to its full capacity, if at all. Therefore, while I do think targeted price reduction will positively affect the nutritional value of the average consumer's diet, there should be a subsection of the treated population who remains unaffected by the policy. Thus, the following will be the null and alternative hypothesis of this empirical analysis.

Ho: The Massachusetts Healthy Incentive Program's price reduction on healthy foods has a negative, significant relationship on the rates of obesity for residents of Massachusetts food deserts.

Ha: The Massachusetts Healthy Incentive Program's price reduction on healthy foods does not have a negative, significant effect on the rates of obesity for residents of Massachusetts food deserts.

The outcome of the empirical study may help explain the landscape of preferences within Massachusetts food deserts, which is information that informs policy makers what approach to take when generating solutions for food access. If there is a economically significant improvement in quality of diet in communities who-before the introduction of HIP-had physical access to healthy food (which rules out scenario one), we can determine that individuals in those communities are scenario two utility-maximizing consumers: individuals whose preferences are for healthy foods, but face higher prices for healthy foods. In those same areas, if there isn't an economically significant effect, then individuals may be scenario three utility maximizing consumers, whose preferences are for unhealthy foods With this being said, the results of the empirical analysis may also yield information as to whether healthy food prices, pre-HIP, were creating inefficient outcomes.

If price reduction policies work, this can open a conversation as to whether the nutritional value of the American diet is directly associated with income or wealth. This is because price reductions ultimately increase an individual's income-the individual in question is richer by 30% of the amount they normally spend on healthy foods. And if so, whether long-term solutions for food access could be directly tied to community programs, affirmative action measures, and other policies for economic mobility.

DATA SOURCES

I will be using two main sources of data for my empirical analysis of the Massachusetts HIP. These are the USDA Food Access Research Atlas (FARA) and the County Health Rankings and Roadmaps data set. The FARA is an interactive atlas that illustrates food-access indicators at the census-tract-level for every state, across the United States. These food access indicators include distance to supermarkets or grocery stores at half-mile, one, ten, and twenty mile distances; car ownership; family income; number of grocery stores in a given census-tract; and many more relevant variables. The data in FARA tracts with the Economic Census conducted every five years, which means that food access data is available for Massachusetts in bi-decade intervals (2015, 2020, etc). Because I'm doing a difference-in-differences regression, I'm using this data-set primarily to identify which census tracts are categorized as low-access tracts before and after the implementation of the program. Each census-tract includes a variable for its respective county and, ultimately, I am collapsing these census tracts into counties because finding health data at the county-level is significantly easier. Because of the FARA dataset's ability to identify low-income census tracts, I can run a triple regression where my interaction term is (treat*post*low-income_tract) and ensure that I am not capturing census tracts where

SNAP use is unlikely. Descriptive statistics are unavailable for this data-set because I was only interested in the dummy variable "lowincometract" to census tracts where SNAP/HIP users were likely to live.

The second data set is called the County Health Rankings and Roadmaps data set, which is a project from the University of Wisconsin Population Health Institute. This data-set includes health, economic, and social panel data for nearly every county in the United States for more than a decade. I used the variables and data from this data-set for the substantive amount of data in the regression, including my dependent variable, obesity. As stated on the County Health Rankings data description, "The County Health Rankings measure of obesity serves as a proxy metric for poor diet and limited physical activity and has been shown to have very high reliability" (County Health Rankings, 2022). The breadth of County Rankings data is important in this project because to investigate whether eating habits were responsible for a county's health outcomes, other confounding variables such as rates of exercise, income, smoking habits, and environmental conditions need to be taken into context. For example, two individuals that eat similar diets may not have similar health outcomes because one exercises and the other doesn't. The following are my variables of interest and their respective units:

Variable	Units
Diabetes Prevalence	Percent pop. Diagnosed w/ Diabetes
Excessive Drinking	Percent adults reporting heavy or binge drinking
Insurance Coverage	Percent pop. Under 65 w/out health insurance
Median Household Income	Dollars
Mental Health Providers	Ratio population : mental health providers
Obesity	Percent pop. with BMI > 30
Physical Activity	Percent pop. Reporting no leisure time activity
Smoking	Percent adults, current smokers
Unemployment	Percent pop. Unemployed, seeking work

For the purposes of the difference-in-differences regression, I am pulling data from 2016 as my pre-period and 2022 as my post-period. As stated before, my regression dependent variable will be obesity rates for each county, which will act as a proxy variable for whether individuals are eating healthier diets. The County Health Rankings dataset pulls from many data sources, which means each variable is sourced from different seminal sources such as the Behavioral Risk Factor Surveillance System, National Center for Health Statistics, and many more.

Below are the summary statistics for the County Health Rankings variables of interest from the years 2016 and 2022:

Summary Statistics for County Health Rankings Data

Variable	Year	Obs	Mean	Std. Dev.	Min	Max
Obesity	2016	3192	0.30901	0.04467	0.107	0.466
	2022	3193	0.35667	0.04327	0.164	0.51
Physical Inactivity	2016	3192	0.27297	0.05419	0.091	0.417
	2022	3193	0.30283	0.05829	0.129	0.518
Excessive Drinking	2016	3191	0.16593	0.03347	0.084	0.273
	2022	3193	0.19080	0.033510	0.06741	0.2989
Unemployment	2016	3190	0.06258	0.02287	0.011885	0.23668
	2022	3192	0.06754	0.02278	0.016949	0.22489
Smoking	2016	3191	0.18399	0.03783	0.069	0.412
	2022	3193	0.20308	0.04210	0.065	0.43
Mental Health Providers	2016	2882	0.00123	0.001349	0	0.01399
	2022	2989	0.00183	0.002013	0	0.02764
Diabetes Prevalence	2016	3191	0.11115	0.02277	0.051	0.228

	2022	3193	0.10770	0.02331	0.055	0.21
Median Household Income	2016	3191	47236.81	12094.23	21658	125635
	2022	3192	57613.41	14585.15	22901	160305
Uninsured	2016	3191	0.17440	0.05448	0.03010	0.40460
	2022	3192	0.11910	0.05104	0.02354	0.35753

EMPIRICAL APPROACH

I will be conducting a difference-in-differences regression in Stata for the empirical analysis. This method works well for the HIP because it creates an exogenous change in food prices based on the time it was implemented (2017) and the geographical area in which it was implemented (Massachusetts). This creates two periods, pre and post intervention, and the control can be generated with counties outside of Massachusetts. Ultimately, I have conducted two regressions for this project, my initial regression where I did not create a dummy variable for low-income census tracts and a triple-difference-in-differences model where I include low-income tracts into my regression.

Initial regression:

$$Obesity = p_o + p_1(HIP) + p_2(Post) + p_3(HIP * Post) + X + E$$

For the initial regression, the HIP variable represents a dummy variable that will be equal to one when a county is located in Massachusetts (and therefore is affected by HIP and receives price reduction) and zero when it is not. Post denotes whether the data is from the second, post-intervention period which means the population will be considered treated. Most importantly, the coefficient on the interaction term in our first regression (HIP * Post) is what

Stata will calculate to determine the treatment effect of the HIP price reductions on obesity inthe treated census tracts. This is also known as the Average Treatment Effect on the Treated (ATT) The syntax of this interaction term is denoting that the existence of the data in the post period and the existence of the data in Massachusetts (thus, eligible for HIP) is generating the treatment effect.

The X variable is a conglomerate of confounding variables, or variables that may affect the food purchasing decisions or health of individuals outside of the HIP. These include physical inactivity, unemployment, smoking, number of mental health providers, diabetes, and median household income. The goal of these confounding variables is to take the diet outside of the lifestyle–it has been shown that consumers in higher income groups, consumers with children, and consumers with health insurance coverage all purchase bundles with higher proportions of healthy food, these are factors that need to be accounted for such that any differences can be attributed to the HIP policy.

Triple-Difference-in-Differences regression:

$$Obesity = p_o + p_1 (HIP) + p_2 (Post) + p_3 (Low) + p_4 (HIP * Post) + p_5 (HIP * Low) + p_6 (Low * Post) + p_7 (HIP * Post * Low) + X + E$$

The Massachusetts HIP specifically targets SNAP users, which means that being able to isolate possible SNAP users (low-income individuals) and exclude individuals with relatively high median household incomes is important for understanding the full effect of the policy. The difference between these two regression is the inclusion of a dummy variable "Low" into the interaction term. To create "Low," we collapsed each census tract in FARA into its respective county and weighted each census tract by its population. Then, we found the mean percent of the population of each county who live in low-income tracts across all counties. The "Low" dummy variable is equal to one if the percent of the population living in low-income tracts in the county is above this mean (signifying a significant population of low-income households). The other terms in the regression, including the confounding variables, are identical to the initial regression.

RESULTS: INITIAL REGRESSION

Below is the Stata output for the *initial regression*:

Source	SS	df	MS			
				Number of obs	=	5,766
				F(10, 5755)	=	1586.54
Model	10.7627247	10	1.07627247	Prob > F	=	0.0000
Residual	3.90406975	5,755	.000678379	R-squared	=	0.7338
				Adj R-squared	=	0.7334
Total	14.6667945	5,765	.00254411	Root MSE	=	.02605

adult_obesity	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
treat	-.0525468	.0070793	-7.42	0.000	-.0664249	-.0386688
post	.0221168	.00095	23.28	0.000	.0202545	.023979
treat_post	-.0022852	.0099357	-0.23	0.818	-.021763	.0171925
phys_activity	.3968689	.01083	36.65	0.000	.375638	.4180998
exc_drinking	.1949522	.0143951	13.54	0.000	.1667324	.223172
unemployed	-.0372469	.0183369	-2.03	0.042	-.0731941	-.0012997
smoking	.2168145	.0121532	17.84	0.000	.1929896	.2406394
mentalhealth_prov	-1.869752	.21462	-8.71	0.000	-2.290488	-1.449016
diabetes	.6484042	.0288192	22.50	0.000	.5919078	.7049007
insurance	-.1386457	.007913	-17.52	0.000	-.1541581	-.1231333
_cons	.0858983	.0047431	18.11	0.000	.0766	.0951967

As we can see from this regression output, there is a negative coefficient on the interaction term, but very little statistical significance with a t-value of -0.23. This illustrates that, while there was a minor effect of the policy in reducing obesity rates in the treatment population or no economic significance (to be exact, the percent of individuals with a BMI above 30 decreased 0.2%). Considering the amount of resources devoted to providing a 30% rebate for healthy food purchases for hundreds of thousands of people, a policy maker would probably desire a higher coefficient to justify the program. Additionally, we can see that there is an R-squared value of 0.7338, which is a relatively high level of correlation.

Ultimately, based on our regression output we see no statistically or economically significant effect of the HIP on obesity rates in the treatment population. Thus, we would fail to reject the null hypothesis.

RESULTS: SECONDARY REGRESSION

Stata output for the Triple Difference-In-Differences regression *without confounding variables*:

adult_obesity	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
treat	-.0701454	.0083928	-8.36	0.000	-.0865981	-.0536926
post	.0449125	.0014	32.08	0.000	.042168	.047657
low_income_d	.0228697	.0015515	14.74	0.000	.0198282	.0259113
treat_post	-.0090943	.0123051	-0.74	0.460	-.0332166	.0150279
treat_low	-.0121425	.0209565	-0.58	0.562	-.0532245	.0289395
low_post	.0063236	.0021188	2.98	0.003	.0021701	.0104771
treat_post_low	-.0128084	.0261114	-0.49	0.624	-.0639956	.0383788
_cons	.2994181	.0010132	295.52	0.000	.2974319	.3014043

The above regression is for the triple-difference-in-difference regressions which utilize a low-income dummy variable ("low_income_d") which was constructed by identifying low-income census tracts through the USDA FARA database. In this first regression, confounding variables are not included to generate a baseline regression. In the baseline regression, we have an R-squared value of 0.30 which means the simple triple-difference-in-difference variables do a moderate job in explaining variation in the dependent variable. The ATT or coefficient on the interaction term is negative, but not statistically significant at a t-value of only -0.49 and p-value of 0.624. This would mean that we would fail to reject the null hypothesis that the HIP had an effect on obesity in Massachusetts food deserts. Additionally, we see very little economic significance as the treatment population only experienced a 1.3% decrease in percent of the population with a BMI over 30. There was a significant effect on obesity rates in the treatment population, Massachusetts, as seen on the coefficient of "treat" with a t-value of -12.61 and coefficient of -0.052 (5.2% reduction). Nevertheless, this group includes high-income individuals (who weren't targeted by the policy) and they cannot be determined to have occurred in the post period after the HIP was implemented. The reason this second regression was conducted was because of the presumption that the reduction in obesity was probably concentrated in the low-income cohort of the population. But unfortunately, the regression shows low-income individuals in Massachusetts ("treat_low") actually experience a positive, but insignificant coefficient. This combined with the large effect on "post" could show that most of the reduction in obesity is actually coming from high-income individuals and not those directly impacted by HIP.

Stata output for the Triple-Difference-in-Difference regression *with confounding variables*:

adult_obesity	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
treat	-.0528882	.0041938	-12.61	0.000	-.0611096	-.0446667
post	.0246683	.001128	21.87	0.000	.0224571	.0268796
low_income_d	.0004947	.0011499	0.43	0.667	-.0017595	.002749
treat_post	-.0005098	.0080172	-0.06	0.949	-.0162265	.015207
treat_low	.0035593	.009636	0.37	0.712	-.015331	.0224495
low_post	-.0060558	.0014115	-4.29	0.000	-.008823	-.0032887
treat_post_low	-.0137864	.0146171	-0.94	0.346	-.0424414	.0148686
phys_activity	.399437	.0125126	31.92	0.000	.3749076	.4239663
exc_drinking	.1977695	.0167553	11.80	0.000	.1649228	.2306162
unemployed	-.0412883	.0210679	-1.96	0.050	-.0825892	.0000127
smoking	.2240113	.0139142	16.10	0.000	.1967343	.2512884
mentalhealth_prov	-1.778467	.222295	-8.00	0.000	-2.214249	-1.342686
diabetes	.6730515	.0323585	20.80	0.000	.6096166	.7364864
insurance	-.1391565	.0086422	-16.10	0.000	-.1560984	-.1222147
_cons	.0806489	.0058663	13.75	0.000	.0691489	.092149

The above regression is the triple-difference-in-difference regression (which includes the low-income dummy variable), but with confounding variables added to the regression.

In this regression, we witness a much higher R-squared value of 0.735, which evinces that the added control variables contributed to mitigating some of the omitted variable bias that occurred in the last regression. The variables that are included in this, much more substantive, regression do a good job in explaining the variation that occurs in the dependent variable, obesity. The ATT or coefficient on the interaction term is negative at -0.0137, but slightly more significant than the baseline regression but still insignificant at -0.94. This shows that the HIP had a slight effect on obesity for low-income individuals in Massachusetts after the policy had been implemented, but we would fail to reject our null hypothesis. Similar to the baseline regression, there is very little economic significance as well—the treatment population experienced a 1.3% reduction in population over 30 BMI. For a policy maker who is reading this regression output, this may not be significant enough to justify the policy. We see similar results for low-income individuals in Massachusetts who experience a statistically insignificant, but slightly positive effect on obesity.

CONCLUSION AND FURTHER THOUGHTS

The Massachusetts Healthy Incentives Program provides an important, exogenous price reduction for healthy foods that has not been witnessed on a state-level anywhere else in the country. Understanding the impact of this program on consumers with various degrees of preference for healthy foods not only informs us about the landscape of preferences within food deserts, but about where price reduction policies may be effective in general.

Based on an empirical study into these preferences, we can conclude that the Massachusetts HIP did not have an economically or statistically significant impact on the obesity rates (and thus, nutritional value of diets) for SNAP users within Massachusetts. Thus, it is likely that the consumers who live in food deserts may be hyperbolic discounters with no preference for healthy foods. Ultimately, this would mean that no food-access solution policy would be effective in these communities. Nevertheless with certain improvements made to the regressions such as a dependent variable without lagged effects, I believe that a clearer and more confident answer can be reached in future regressions.

Understanding the behavioral economics behind people's purchasing decisions is integral to generating effective policy for food access. At the end of the day, there is no blanket approach to issues as complex as food consumption. People's food decisions are formed by cultural, familial, financial, and many more kinds of factors that vary by the individual. In some way or another, these considerations are reflected in the consumer's preferences and revealed when that consumer makes purchasing decisions. By understanding how consumers of different backgrounds (and thus, preferences) react to food access policies, policymakers can take this into consideration as a demographic when developing solutions. Perhaps certain demographics or cultures are more prone to hyperbolic discounting-a.k.a they prefer unhealthy bundles-and therefore policies that don't directly take the discount rate as a variable may be ineffective or inelastic. For other areas, price reductions may work because individuals have healthy preferences and actually experience inefficiency due to prices.

While certain individuals, as discussed above, may not be affected by policy, we have an obligation to maximize the welfare of those we can. An overarching take-away from this project may be that those who take responsibility for their own health, will be healthy. This research intends on contributing to a body of literature that aims to give those individuals who decided to be healthy, the tools to do so.

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