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 nutr

28% of the federal budget, with 85% of healthcare spending being devoted to treating diet-

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 en cel or ficil ies to ccessin (ngo)] TJ ET Q q 0.24 0 0 0.24 3.3

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-incom

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

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

"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).

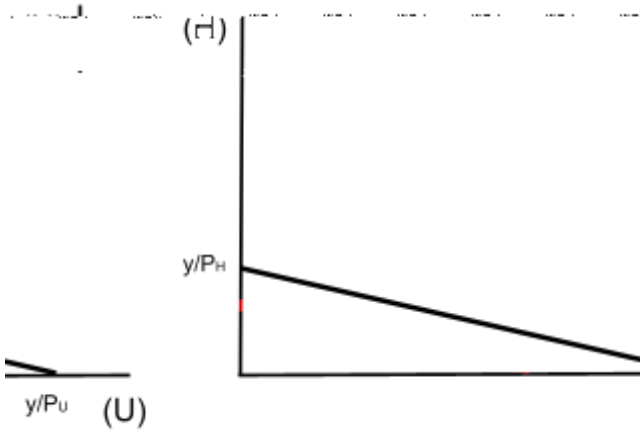
While many states have versions of the HIP, Massachusetts's program is the oldest of its kind and, as of 2022, is still operating across the state. While much research has been done on the Massachusetts HIP Pilot Program conducted in Hampden County (Olsho, 2015; Klerman 2014), little research has been on the program within the last four years with the exception of a

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(U, H) and $y = P_U(U) + P_H(H)$, where (P_H) is *large*.



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

P

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 macm BT 500 0 0 501 (t) -2250 (i) -2 (e) 4 3TT1 1 Tf [(unhe) 4 d-2 (y

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

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 eaiscounty's ounty' (

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						

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2022 18

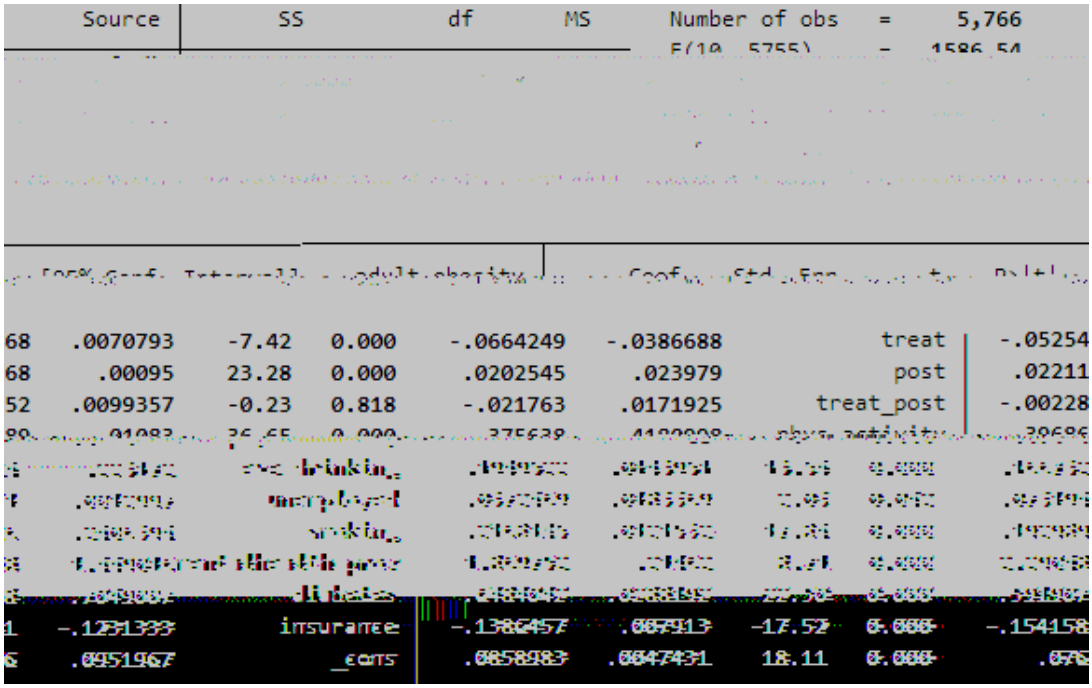
Stata will calculate to determine the treatment effect of the HIP price reductions on obesity inthe treated census tracts. This is also known as the Average Treatment Effect on the Treated (ATT) The syntax of this interaction term is denoting that the existence of the data in the post period and the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

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*:



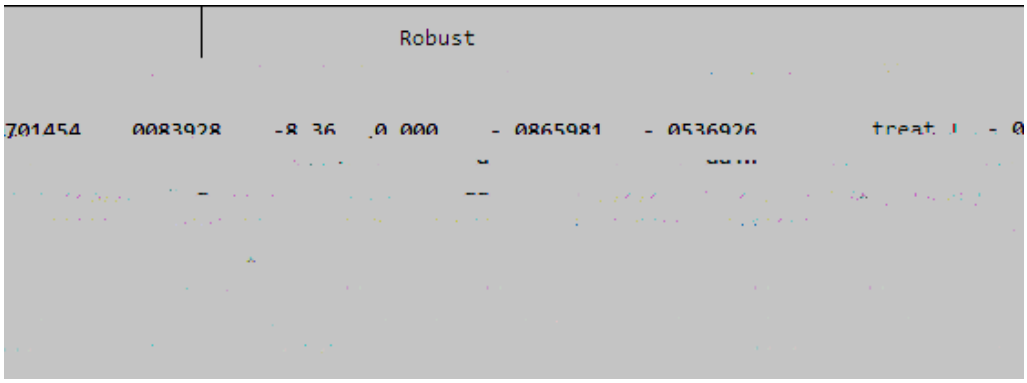
As we can see from this regression output, there is a negative coefficient on the interaction term, but very little statistical significance with a t-value of -0.23. This illustrates that, while there was a minor effect of the policy in reducing obesity rates in the treatment population or no economic 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*:



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 presu0.24 3.38

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

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