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Abstract

Grocery (food sales) taxes exist in over one-third of U.S. counties but do not apply to purchases made with the Supplemental Nutrition Assistance Program (SNAP). We examine the impact of grocery tax rates on food insecurity, and its differential impact on SNAP participants and non-participants. By using data from the Current Population Survey Food Security Supplement matched with county-level grocery tax rates, we found that grocery taxes had a positive impact on increasing only the probability of non-SNAP households being food insecure. Such result implies that the SNAP program also indirectly reduces food insecurity by shielding participants from the negative effects of grocery taxes. Policy makers should target eligibility of non-participating SNAP households in states that tax food in order to reduce food insecurity.

Keywords: food security, grocery food, sales tax, SNAP

JEL Codes: Q18, D12, H71

Do Grocery (Food Sales) Taxes Cause Food Insecurity?

Food insecurity is a significant problem in the United States, where it is estimated that 14% or 17.5 million households were food insecure in 2014. Because food insecurity is associated with serious negative social problems (particularly for children) such as health (Cook, et al., 2004, Dunifon and Kowaleski-Jones, 2003, Weinreb, et al., 2002), psychological (Alaimo, et al., 2001), and behavioral problems (Slack and Yoo, 2005, Whitaker, et al., 2006), policies thought to impact food insecurity have been extensively studied. Much of the past research conducted on food insecurity in the United States has focused on the most important federal program designed to lessen food insecurity, the Supplemental Nutrition Assistance Program (SNAP) (Alaimo, et al., 1998, Bartfeld and Dunifon, 2006, Borjas, 2004, Cohen, et al., 1999, DePolt, et al., 2009, Duffy and Zizza, Forthcoming, Gibson-Davis and Foster, 2006, Gundersen and Oliveira, 2001, Huffman and Jensen, 2008, Jensen, 2002, Nord and Golla, Ribar and Hamrick, 2003, Wilde and Nord, 2005, Yen, et al., 2008, Yen, et al., 2012). In addition, Gregory and Coleman-Jensen (2013) examined the impact of variations in regional food prices on food insecurity for SNAP participants. However, a glaring gap in this literature is the issue of how grocery taxes (sales taxes imposed on foods at retail outlets such as grocery stores, convenience stores, etc., not on restaurants) impact food insecurity.

While grocery food is exempted from sales tax in many states and counties in the United States, 16 states have tax grocery taxes at the state level, county level or both. Table 1 shows six ways that state and county governments impose grocery tax policies. In the first category, a state applies the full general sales tax rate to grocery and some

counties tax grocery as well, such as most counties in Alabama and Kansas. The second category differs from the first one in that only the state, and not the counties taxes grocery, such as those in Mississippi and South Dakota. In the third and fourth categories, states tax grocery at a reduced sales tax rate, and counties impose an additional tax rate on groceries (e.g., most counties in Arkansas and all counties in Tennessee most counties in Illinois do not impose an additional tax). In the fifth category, states exempt grocery from sales tax while counties may tax grocery (e.g., Georgia). In the last category, a state has no sales tax, but some counties tax grocery, which only occurs in Alaska.

Examining how grocery taxes affect food insecurity is important for at least two reasons. First, these taxes apply to over one-third of U.S. counties and can cost a family hundreds of dollars per year. Figure 1 displays a map of the grocery tax rates in all U.S. counties in 2014, which range from 0% in most counties to 9% (4% state plus 5% county) in Tuscaloosa County, Alabama. The average (combined) grocery tax rate for the places taxing grocery was 4.3%, which translates to more than $200 for a family with annual grocery bill of $5,000. Second, most of the counties that do not exempt grocery from the sales tax are located in the South such as Alabama, Mississippi, and Arkansas, where food insecurity tends to be the most severe. Consequently, examining whether there is a link between food insecurity and grocery taxes should be of particular interest to these states in dealing with this serious health and social problem.

Similar to Gregory and Coleman-Jensen (2013), who found that variations in regional food prices have a significant effect on food insecurity, we are interested in examining whether grocery taxes impact food insecurity. Our main hypothesis is that

households living in counties with a positive grocery tax rate have a higher probability of being food insecure than households living in exempt counties. Households living at or near the poverty level are the most vulnerable to the negative repercussions of the imposition of a grocery tax. One factor that complicates this hypothesis is that SNAP participants are exempt from sales taxes on food purchased with SNAP benefits even if they live in a locality that taxes food. However, this applies only on purchases made with SNAP benefits, which is often expended before the next benefit installment. Hence, even SNAP participants will be at least partially affected by the grocery tax. Moreover, not all food insecure households participate in SNAP, so non-participants would therefore be subject to the full tax. In fact, only 75% of eligible households in the United States participate in the SNAP program.

The main goal of the research reported here is to determine whether the grocery tax rate positively impacts food insecurity. Our fundamental interest is in determining how grocery taxes affect the food insecurity status of SNAP participants, who face only partial exposure, and SNAP non-participants who are fully exposed to the tax. The analysis is based on detailed household demographic and food security status data from the Current Population Survey Food Security Supplement (CPS-FSS). These cross-sectional data on households are merged with county-level grocery tax rates in the United States. These data are then used to estimate the impact of grocery tax rates on the probability of a household being food insecure with a probit model. The probit model is estimated separately for: (1) SNAP non-participants and (2) SNAP participants. Additional demographic and socioeconomic household variables are included in the

model to control for other factors hypothesized to effect food insecurity. By separating the sample between SNAP participants and non-participants, we obviate the issue of endogeneity of SNAP participation. Previous research suggests that the SNAP program has a significant impact on food insecurity (Gundersen, et al., 2011, Jolliffe, et al., 2005, Kreider, et al., 2012, Ratcliffe, et al., 2011, inter alia). However, since our focus is on how grocery tax rates differentially impact SNAP participants and non-participants, the issue of endogeneity between SNAP participation and food insecurity is not a concern.

The main contribution of this study is that it is the first, to our knowledge, to examine the impact of grocery tax rates on food insecurity, and its differential impact on SNAP participants and non-participants. We hypothesize that (1) taxing grocery increases food insecurity for SNAP non-participants but not for participants, and (2) taxing grocery increases food insecurity even consumers are not attentive to a sale tax. Our results will contribute to better understanding of the interactions of state/local policies (imposition of sales taxes) and federal policies (exempting SNAP purchase from a sales tax). In addition, our use of county-level tax data is an improvement over previous studies on sales tax impact, which largely relied on the use of state sales taxes (Goldin and Homonoff, 2013).

The rest of the paper is organized into six sections. In the next section, we examine previous studies on food taxes and food insecurity. This is followed by our theoretical model that conceptualizes how taxing groceries disproportionately impacts non-SNAP participants. A description of data used, the empirical model, and results are then presented and discussed, followed by conclusions of the study.

Literature Review

The economics literature has developed extensively in the area of the effect of taxes on various foods and beverages on consumption and health. One of the earliest works on food taxes debated the effects and propriety of oleomargarine taxation (Hardin, 1943, Ladd, 1960, Pabst, 1941). Several articles have addressed the issue of taxing specific foods or food constituents as a means to move consumers away from unhealthy to healthier food (Fletcher, et al., 2010, Freebairn, 2010, Miao, et al., 2013, Okrent and Alston, 2012, Rahkovsky and Gregory, 2013, Schroeter, et al., 2008). In their summary of the literature and assessment of the controversies therein, Okrent and Alston (2012) conclude from their equilibrium displacement model that a uniform tax [grocery tax] is more distortionary than taxes on sugar or calories, but less distortionary than fat taxes. Further they argue "…the most efficient policy would be a tax on food based on its caloric content…a calorie tax would be regressive, falling disproportionately heavily on the poor." (p. 634) By extension, the myriad attempts to prevent individuals from eating unhealthy foods through taxation may lead to the unintended consequence of food insecurity. However this literature, except for Okrent and Alston (2012), failed to consider the effects of sales taxes placed on all food (grocery taxes).

Miller (1951) argues, based on a budgeting framework, that the exemption of taxes on food will lower the regressivity of the sales tax. Johnson and Lav (1998) argue that grocery taxes are regressive and that because of the declining tax base food taxes are a poor source of state revenue. States that tax groceries, nevertheless, are reticent to remove them and some have credits and rebates, but these policies are often complicated,

manipulated in financial duress, and are only partial solutions (Johnson and Lav, 1998). In contrast, Viard (2011) argues against the grocery tax exemption on the grounds of optimal tax theory.

Walsh and Jones (1988) contend that the imposition of a three percent grocery tax in West Virginia lowered food sales by nearly six percent in border counties, but the tax had no effect on interior counties. Subsequently, Mehmet and Skidmore (2007) explore the effects of a six percent grocery tax in border counties in West Virginia. Based on a difference-in-difference model, they suggest that a one percentage point increase in the grocery tax would lead to decline in per capita food sales of 1.38 percent. The finding of both papers is that consumers in counties at the border will shift food purchases to non-taxed counties to avoid paying the grocery tax. None of these studies consider the implications of food taxes specifically on food access and food security in particular. Thus, the current paper adds to this literature of the effects of grocery taxes.

Problematizing the literature of the effects of taxes is the burgeoning literature on tax salience. Chetty et al. (2009) provide evidence that consumers underreact to sales taxes that are imposed at the cash register, which is common for grocery taxes, relative to excise taxes which are incorporated in the posted prices of products. In short, the salience of a tax affects consumer response to the tax. Following Chetty et al. (2015), Zheng et al. (2013) show that a sales tax does not change demand as much as an excise tax, which can have an effect nearly equivalent to a price change dependent on the tax pass through. Similarly, Chen, et al. (2015) find similar results of lower salience of a sales tax based on an economic experiment.

Goldin and Homonoff (2013) contend that taxes at the register are less regressive than excise taxes. Given data on cigarette sales, the researchers provide further support that for tax-attentive, low-income consumers, taxes at the register are less regressive. This body of work suggests that sales tax on groceries may have a limited effect on purchases, which is dependent on consumer awareness of the tax. This literature, however, does not look at how grocery taxes may have a net effect on total purchases of food and may influence food security. The intent of this paper is to fill this gap.

The literature on the determinants of food insecurity has not taken on the grocery tax issue, but has found multiple factors that contribute to food insecurity. Gundersen et al. (2011) find factors that influence food security such as income, race, marital status, etc. At the state and county level, Gundersen et al. (2014) find that poverty rates, unemployment rates, and percentage of homeownership are correlated with food insecurity. Beyond these socioeconomic factors, three stylized facts may influence food security: 1) probability of food insecurity declines with income; 2) poverty is not synonymous with food insecurity; and 3) a non-trivial percentage of households not in poverty are food insecure (Gundersen, et al., 2011).

In addition to the socioeconomic factors associated with food insecurity are food prices (Gregory and Coleman-Jensen, 2013). A $10 increase in the thrifty food plan basket of goods, which is used to set SNAP benefit levels, is predicted to increase food insecurity by 2.5 percentage points. This amount is less than a one standard deviation in food prices. On the margin, the increase in food prices would lead to 5.0%, 5.1% and 12.4% increase in the prevalence of food security for households, households of adults,

and households with children. Relative to the grocery tax issue, the average household pays a higher cost of based on taxes alone. Thus, we have reason to believe that areas with a grocery tax are more likely to have a higher prevalence of food insecurity than others.

An important branch of the food security literature has made efforts to understand the correlation of food insecurity to health outcomes such as obesity, diabetes, anemia, overall health, etc. (Baum, 2011, Ding, et al., 2014, Kalichman, et al., 2014, Nicholas, 2011, Shaefer and Gutierrez, 2013, Yen, 2010, inter alia). One potential challenge to the literature is the selection problem. Unobservable factors that contribute to food insecurity may also lead to the poor health outcomes. As a result, failure to deal appropriately with correlated unobservables could lead to spurious correlations (Gundersen, et al., 2011).

In a related issues, a core effort in much of recent food security work focuses on the proper estimation of the effect of SNAP participation on food security. What promoted this literature, at least in part, was an effort to unravel the counterintuitive result that Supplemental Nutrition Assistance Program (SNAP) participating households can have higher rates of food insecurity than nonparticipating, SNAP-eligible households (Gibson-Davis and Foster, 2006, Gundersen, et al., 2009, Gundersen and Kreider, 2008, Gundersen, et al., 2011, Jensen, 2002, Lin, et al., 2010, Mykerezi and Mills, 2010, Ratcliffe, et al., 2008, Ratcliffe, et al., 2011, Wilde and Nord, 2005, Yen, 2010, Yen, et al., 2012). Econometric questions of endogeneity of SNAP participation and the appropriate ways to assess the treatment effects of SNAP on food insecurity are at the core of this literature (Bollinger and Hagstrom, 2008, Gibson-Davis and Foster, 2006,

Gregory and Coleman-Jensen, 2013, Gundersen and Kreider, 2008, Huffman and Jensen, 2008, Kreider, et al., 2012). Another challenge of assessing the effects of SNAP is underreporting and measurement error in SNAP participation rates (Bollinger and David, 1997, Gundersen and Kreider, 2008). This previous literature has dealt with the endogeneity of SNAP participation and food insecurity. We assert that a model of grocery taxes are not affected by the correlated unobservable as grocery taxes are independent of household level factors that affect SNAP participation and food insecurity.

Grocery Tax Impact on Food Insecurity—A Simple Framework

By U.S. federal law and USDA regulations, SNAP purchases are exempt from a sales tax (whether state or local). Therefore, depending on the degree of dependence on SNAP for their food needs, SNAP participants may be less affected by a grocery tax than non-SNAP participants. Using a simple theoretical framework, we first show in this section how SNAP status affects the impact of grocery tax on food insecurity and then obtain the main hypothesis to be tested in our empirical section. Next, we examine the role of attentiveness on grocery tax's impact on food insecurity.

Let m be consumer income, p and x be the grocery food price a consumer faces and the quantity she consumes, and o be her consumption on all other goods combined (including restaurant food), which has a normalized price of one. The subscript denotes the scenarios to be discussed, with zero indicating the original or base scenario. For a SNAP non-participant, the original budget constraint without a grocery tax is shown in Figure (2a) as BC_0 (in bold) and expressed algebraically as:

1) $px_0 + o_0 = m.$ (SNAP non-participant)

When a grocery sales tax of *t* percent is imposed, the budget constraint becomes:

2) $p(1+t)x_1 + o_1 = m.$ (SNAP non-participant)

As a result, the budget constraint tilts from BC_0 to BC_1 (step 1 in Figure 2a) because grocery food becomes more expensive. Grocery food consumption under this scenario decreases compared with the original equilibrium.

For a SNAP participant, the original budget constraint without a grocery tax is shown in Figure (2b) as BC_0 as well and expressed algebraically as:

3) $px_0 + o_0 = m + B$ or equally $p(x_0 - \frac{B}{p}) + o_0 = m,\ o_0 \leq m$ (SNAP participant)

where *B* is the SNAP benefits (in dollars) the person receives. The $o_0 \leq m$ conditions is imposed because SNAP benefits do not increase the maximum purchasing power on the other goods, resulting in a kinked budget constraint as shown in Hoynes and Schanzenbach (2009).

When a grocery tax is imposed on the SNAP participant, it only applies to food purchases above the level of SNAP benefits. Accordingly, the new budget constraint becomes:

4) $p(1+t)(x_1 - \frac{B}{p}) + o_1 = m,\ o_1 \leq m,$ or equivalently

$p(1+t)x_1 + o_1 = m + B(1+t),\ o_1 \leq m.$ (SNAP participant)

A comparison of equations (3) and (4) yields an interesting finding. The new budget constraint now has an additional *Bt* term on the right-hand side, which indicates that the new budget constraint can be derived in two steps as shown in Figure (2b). In step 1, the

original budget constraint line $p\left(x_0 - \frac{\mathrm{B}}{p}\right) + \mathrm{o}_0 = \mathrm{m} + \mathrm{B}$ rotates clockwise around the *y*-intercept where $\mathrm{o}_0 = \mathrm{m}$ (no kink applies in this step). In step 2, this rotated budget constraint shifts outward by *Bt* because SNAP benefits have more purchasing power on food than equivalent amount of cash in the presence of a grocery tax. As a result, the new and old budget constraints intersect at the kink ($\frac{\mathrm{B}}{p}$, m), and share a common flat line of *o = m* up to the point the maximum SNAP benefits are used.

The following proposition follows naturally from the above derivations:

Proposition 1: *Taxing grocery food increases food insecurity for SNAP non-participants but not for participants.*

The extra outward shift of the budget constraint reflects how SNAP can attenuate food insecurity in the presence of a grocery tax. This proposition provides the central hypothesis in our empirical analysis.

The above analysis is based on the assumption that consumers are attentive to grocery taxes. We now show the impact of grocery tax in the case that consumers might not be attentive to grocery taxes, as argued by Chetty et al. (2015). To conserve space, we do this for the case of SNAP non-participants and the intuition directly carries over to the case of SNAP participants. When consumers ignored grocery tax during shopping, they will maximize utility subject to the perceived budget constraint Goldin and Homonoff (2013), which is the original budget constraint without the tax (shown in equation 1 and denoted as BC_0 in Figure 3). Therefore their intended consumption of grocery food will remain as if there were no grocery tax. To make the intended consumption of grocery food feasible, the consumption of the other good (including restaurant food) has to

decrease to account for the tax. In effect, the new budget constraint becomes

5) $px_0 + o_0 = m - ptx_0$ (SNAP non-participant)

which corresponds to BC_3 in Figure 3. Proposition 2 follows from the above discussion.

Proposition 2: *Taxing grocery food increases food insecurity no matter consumers are attentive to the tax or not.*

The intuition of Proposition 2 is straightforward. When consumers are attentive to a grocery tax, the impact of the grocery tax is mainly through a reduction of grocery food. When consumers ignore the grocery tax, then food insecurity still can rise because consumption of restaurant food has to decrease in order to keep their original consumption level of grocery food.

Data

Our sample is generated from the 2013 cycle of the CPS-FSS. The CPS is a large and nationally-representative survey of the civilian, non-institutionalized population conducted monthly and containing extensive labor-market and demographic information at the household level. The FSS is an annual supplement completed by a subsample of the CPS sample in December and is conducted to elicit household-level information on issues regarding food security, food expenditure, food consumption patterns, program participation, etc. For the 2013 cycle, the CPS contains data on 150,457 individuals out of which 103,533 individuals completed the FSS. From the FSS, for our sample we select households that we have complete information on the variables of interest such as tax rates and SNAP participation status. We segment this sample by SNAP participation status and exclude those households that are above 200 percent of Federal Poverty

Guidelines (FPG) and indicate that they are food insecure. This results in a subsample of 3,124 SNAP participants and a subsample of 8,703 SNAP non-participants. As discussed later in the paper, as a robustness check we also generate a sample that screens out households above 150% of FPG that claim to be food insecure. Table 2 provides a snapshot of summary statistics for the two subsamples with 200% FPG screen.

The CPS-FSS provides data on all household-level information needed to construct the model developed in this study. For our analysis, we use a measure of food security status provided in the survey which is based on the 12-month household-level food security scale generated through a series of 18 questions pertaining to child and adult's food security. This series includes questions regarding the household's ability to afford balanced meals, to afford enough food to last before next receipt of income, quality and variety of foods available for children, etc. Based on this classification, about 17.2% of SNAP non-participant households and 52% of SNAP participant households are identified as food insecure as shown in Table 2.

Grocery tax data are available at the county level for the year 2014 and are obtained mainly from Tax-Rates.org (Tax-Rates.org, 2015), augmented with data from Sale-tax.com (Sale-tax.com) and our own search on state and county departments of taxation web sites. Because historical grocery tax data are not available, we are relying on the cross sectional variation in tax rates to identify the impact of grocery tax. This approach is reasonable because tax rates generally do not change over a short time period, and there is substantial variation across grocery tax rates as they range from 9% in some counties to complete tax exemptions in some states (e.g. Kentucky). We use two

measures of tax rates. The effective tax rate is calculated as the average annual tax rate paid by the household on all food purchases (including SNAP purchases for SNAP participants) and the nominal tax rate is the tax rate paid on each additional dollar of food expenditure. These measures are discussed in more detail in the following section.

Empirical Model

We begin this section with a discussion of determinants of food security followed by an overview of the methodology used for empirical estimation.

Determinants of Food Security

We control for multiple determinants of food security that have been established in the literature. Food security is modeled as a function of demographics of the household and household head (such as income, age, race, and gender), household composition (e.g. number of children and presence of elderly), and state and county economic conditions. Among household demographics we include total household income, which is measured as the total income the household receives from all sources including welfare programs (such as SNAP and Temporary Assistance for Needy Families), wages and salaries, and returns on investment (e.g. dividends, interest). Households that fall into the first income quartile of the sample are more likely to be food insecure relative to households in higher income quartiles. In addition, we control for the household's citizenship status. This is an important determinant of food security as an immigrant household's SNAP eligibility is contingent on both federal and state eligibility requirements. Generally, immigrant households have to satisfy more stringent criteria to qualify for SNAP relative to non-immigrant households (USDA FNS, 2012, p. 14).

Demographics of the household head include age, gender, race, level of education, and marital status. We expect households with heads that are older, males, married, and have at least a college degree to be less likely to be food insecure while households with heads that are non-white tend to be more likely to be food insecure than their counterparts. Among factors that describe household composition, we hypothesize the presence of a non-working household member, such as a child or a disabled members, increases the probability of food insecurity. Intuitively, non-working members might qualify as dependents of working adults and will likely put a strain on household resources through their food needs. In addition, disabled individuals might decrease the working adult's labor force participation through their need for home-care (Ratcliffe, et al., 2011). The impact of the presence of elderly individuals in the household is ambiguous. It will depend on the elderly household member's employment status and food needs. Moreover, elderly members might hold liquid assets such as savings accounts or Individual Retirement Accounts (IRAs) that can be used for the household's food needs in times of financial distress.

Finally, state and county economic conditions include a measure of cost of living, state population, state unemployment rate, state poverty rate, and rate of college graduates in the state. To estimate cost of living, we use the Living Wage Calculator tool developed and administered at Massachusetts Institute of Technology (MIT) to obtain a "living wage" for each household in the sample. Living wage is defined as the wage rate households need to earn to meet the minimum standards of living in their locale. The living wage provides a more comprehensive measure of cost of living relative to the

federal poverty threshold as it incorporates myriad expenses not accounted for in the federal poverty threshold such as food, child care, health insurance, housing, transportation, and other basic necessities (e.g. clothing, personal care items, housekeeping supplies) (Nadeau and Schultheis, 2014). Living wage is hypothesized to have a positive effect on food insecurity. The higher the cost of living, the lower the purchasing power of household income and therefore the higher the likelihood of the household being food insecure. Note that while estimates from the Living Wage Calculator are available for each county in the U.S., the CPS does not disclose county information for all households in the sample. As a result, we apply state-level living wage estimates to households when county-level information is not available. Besides cost of living estimates, we include state population, unemployment rate, poverty rate, and rate of college graduates to control for economic conditions. Better state economic conditions are hypothesized to have a negative effect on household food insecurity.

Empirical Model

We use a probit model to determine the impact of grocery taxes and other determinants on the probability of food insecurity. We specify three separate models that capture the effect of the nominal and the effective tax rate for SNAP participants and non-participants. The models can be summarized using the following two equations:

(6) $\Pr(foodinsecurity_i = 1) = \mathbf{\Phi}(\alpha_0 + \alpha_1 nominaltax_{sc} + \alpha_2 X_i + \alpha_3 M_{sc})$

(7) $\Pr(foodinsecurity_i = 1) = \mathbf{\Phi}(\beta_0 + \beta_1 effectivetax_{sc} + \beta_2 X_i + \beta_3 M_{sc})$

where the food insecurity status of household i depends on the grocery tax rate in state s and county c where the household is located, household variables, and state and county

level explanatory variables and **Φ** is the cumulative normal distribution. These equations are estimated separately for both SNAP non-participants and SNAP participants.

The variable $foodinsecurity_i$ is derived from the CPS-FSS and is based on the 12-month food security status of the household. It is a binary variable which equals 1 if the household is classified as low or very low food secure and equals zero if the household is classified as high or marginally food secure. Two explanatory variables are of particular interest. The variable $nominaltax_{sc}$ in equation (6) is the county-level sales tax charged on grocery items and paid by the household on each additional dollar spent on food. In contrast, equation (7) uses the variable $effectivetax_{sc}$, which measures the average grocery tax paid by the household on all food purchases in a year. This variable is calculated as follows:

$$effectivetax_{sc} = \frac{nominaltax_{sc} * (totalfood_i - SNAPbenefits_i)}{totalfood_i}$$

where $totalfood_i$ represents household i's total annual expenditure on food and $SNAPbenefits_i$ is a measure of total dollar amount of SNAP benefits received by household i in the year. Total annual food expenditures are based on self-reported weekly values while SNAP benefits are calculated from self-reported monthly receipt. Data for both variables is obtained from the CPS-FSS. Note that for SNAP non-participants, the nominal grocery tax equals the effective grocery tax rate as the amount of SNAP benefits received is zero. As a result, while equation (6) is specified for both SNAP participants and non-participants, equation (7) is only specified for SNAP participants.

The variable X_i is a vector of household specific variables. It contains measures of the household head's demographics including a continuous variable for age, Age, a binary variable that equals 1 if the head is male, $Male$, a binary variable that equals 1 if the head identifies as being African American, $Black$, a binary variable that equals 1 if the head has attained a college degree, $College\ degree$, and a binary variable that equals 1 if the head is married, $Married$. In addition, X_i contains variables that reflect household composition including a binary variable that equals 1 if total household income falls into the first income quartile of the respective sample, $First\ income\ quartile$, a continuous measure of the number of children younger than 18 years in the household, $Number\ of\ children$, a binary variable that equals 1 if at least one household member is a senior 60 years of age or older, $Presence\ of\ elderly\ in\ HH$, a binary variable that equals 1 if at least one household member is disabled, $Presence\ of\ disabled\ in\ HH$, and a continuous variable measuring the total number of individuals residing in the household, $Number\ of\ HH\ members$.

The variable M_{sc} is a vector of state-specific and county-specific measures. Following the approach used by Ratcliffe, et al. (2011) and Gregory and Coleman-Jensen (2013), we include four measures of state-level economic conditions to capture unobservable factors that might affect a household's food security status. These measures include the state's total population in 2013, $State\ population$, the proportion of residents in the state who have completed college education in 2013, $State\ college\ degree\ rate$, the unemployment rate in the state in 2013, $State\ unemployment\ rate$, and the state's poverty rate in 2013, $State\ poverty\ rate$.

Finally, to estimate the direct effect of the grocery tax on food insecurity, it is important to control for the cost of living faced by each household as mentioned above. We include a continuous variable, $Living\ wage$, that represents living wage estimates for each state and/or county in the sample.

To capture the direct effect of the grocery tax on household food security, we restrict both samples (SNAP participants and non-participants) to households that are likely to be SNAP eligible by screening out households with income above 200 percent of Federal Poverty Guidelines that claim to be food insecure from the sample. We eliminate these outliers to avoid potential biases from unobservable characteristics of high income food insecure households. The CPS screens households by food security status for certain questions on the Food Security Supplement such that only households that are deemed food insecure complete the full supplement. Typically households with income above 185 percent of the poverty threshold that provide some additional indication of high food security are screened out (US Census Bureau, 2013, p. 17-3). Therefore, our screening is more generous relative to the CPS in that it eliminates only the most extreme outliers. As a test for sensitivity, we run our models using a more stringent screening using 150 percent of Federal Poverty Guidelines and find that the results are comparable to the baseline sample (cf., Mykerezi and Mills, 2010).

Results

The results of the probit model estimation are displayed in Table 3, which contains three columns of results based on screening out food insecure households who are above 200% of the poverty threshold: (1) SNAP non-participants, (2) SNAP participants, based on the

nominal tax rate, and (3) SNAP participants, based on the effective tax rate. The nominal tax rate is the actual rate charged by the locality that the household is located in, while the effective tax rate is computed as the overall average rate paid by the SNAP household (which includes tax exempt expenditures from SNAP purchases, and regular taxed expenditures from participants' own income). Table 4 gives the same information when we screen out food insecure households above 150% of the poverty level. The marginal results are presented in both of these tables, which means the coefficient gives the percentage change in the probability of food insecurity from a one-unit change in each independent variable.

With respect to SNAP non-participants and the 200% poverty level screening procedure, the results show that the grocery tax has a positive impact on food insecurity, and is statistically significant at the 5% level. Specifically, a 1-percentage point increase in the grocery tax increases the probability of households being food insecure by 0.60%. The tax rate has the highest marginal effects of all determinants of food insecurity in the model. This result also holds for the model where food insecure households above the 150% poverty level are screened out. In that case, the marginal effect of the grocery tax rate on food insecurity falls slightly from 0.60 to 0.56, and is still statistically significant at the 5% level (Table 4). Hence, the model provides empirical evidence that states taxing food are increasing the likelihood of food insecurity for non-SNAP households.

Many of the demographic and socioeconomic variables have a significant impact on non-SNAP household food insecurity, and all have the same directional effects as previous studies of food insecurity (e.g., Ratcliffe, et al., 2011) have found. Focusing on

the model that omits food insecure households over the 200% poverty level, we find that food and other living costs (living wage) have a positive and significant impact on food insecurity for non-SNAP participants. Consistent with Gregory and Coleman-Jensen (2013) regarding food prices, our results indicate that each additional dollar increase in living costs (measured by the living wage variable) raises the likelihood of being food insecure by 0.3% ($p<0.05$). Not surprisingly, the households with the lowest income in the sample among non-SNAP participants had a 10% ($p<0.01$) higher likelihood of being food insecure relative to households in higher quartiles. We also find that the probability of non-SNAP households being food insecure increases for African Americans (6.8%), immigrant households (5%), number of children in household (2.2%), and households with a disabled member (14.6). Significant factors of the head of the household that negatively impact the probability of non-SNAP households being food insecure include age (-0.1%), having a college degree (-6%), being married (-7.2%), having an elderly household member (-5.1%), living in a metropolitan area (-2.1%), and the percentage of population enrolled in state colleges and universities (-0.2%).

While the grocery tax has a significant positive impact on increasing the probability of non-SNAP households being food insecure, the same is not true for SNAP households. Our results show no statistically significant relationship between the grocery tax rate and food insecurity for SNAP households. This result is holds for both cases where food insecure households above the 200% and 150% poverty level are screened out. Further, this result holds for both the nominal and effective tax rates. Thus, it appears that SNAP not only reduces food insecurity by offering direct benefits (Gibson-Davis and

Foster, 2006, Gregory and Coleman-Jensen, 2013, Gundersen and Kreider, 2008, Gundersen, et al., 2011, Ratcliffe, et al., 2011, Yen, et al., 2012, inter alia), but also shields participants indirectly from food insecurity by exempting benefits from taxes, which cause food insecurity.

Unlike the SNAP non-participants models, far fewer socioeconomic and demographic variables are statistically significant in the SNAP participants' model. Focusing on the model that uses the effective tax rate and omits food insecure households over the 200% poverty level (Table 3), we find that households with the lowest income in the sample among SNAP participants had a 7.4% ($p<0.01$) higher likelihood of being food insecure. SNAP households having a disabled member had a 14.8% ($p<0.01$) higher probability of being food insecure. The only significant factors negatively impacting the probability of SNAP households being food insecure is the household having immigrant status (-7.4%) and marital status (-4.9%).

These results ignore the fact that three states in the data set also have various grocery tax credit features. For example, Kansas offers a credit of $125 per person under some fairly stringent conditions determining that the household is poor or is likely food insecure. Unfortunately, the CPS data do not have information on whether eligible households in these states receive such credits, and what the monetary value of the credit is. While we considered using a dummy variable for households in these states to determine whether the tax credit mitigated or partially mitigated the impact of the tax on food insecurity, we concluded that this would not be a good way to measure this as the dummy would be picking up a lot of other state-wide determinants of food insecurity.

Therefore, our results should be interpreted with a caveat that tax credits are not included. If tax credit reduces food insecurity and higher tax states are more (less) likely to issue a tax credit, then our estimated tax impact will be a lower (upper) bound of the true impact.

Summary and Implications

This research examined the issue of whether grocery taxes impact food insecurity. While grocery food is exempted from sales tax in the majority of states and counties in the United States, there are grocery taxes in 16 states in the form of a state tax, a county tax or both. These taxes apply to over one-third of U.S. counties and can cost a family hundreds of dollars per year. The average grocery tax rate for the places taxing grocery was 4.3%, which translates to more than $200 for a family with annual grocery bill of $5,000. Examining whether a link between food insecurity and grocery taxes exits is an important topic because these taxes effect many people and no previous study, to our knowledge, has examined the serious social and public health implications of these taxes.

Our main hypothesis is that households living in counties with a positive, non-zero grocery tax rate have a higher probability of being food insecure than households living in exempt counties. Households living at or near the poverty level are the most vulnerable to the negative repercussions of the imposition of a grocery tax. The analysis was based on detailed household demographic and food security status data from the Current Population Survey Food Security Supplement (CPS-FSS) merged with county-level grocery tax rates in the United States. These data were used to estimate the impact of grocery tax rates on the probability of a household being food insecure with a probit model. The probit model was estimated separately for: (1) SNAP non-participants and (2)

SNAP participants.

The main finding of the research was that the grocery tax significantly effects the food security status of SNAP non-participants. Specifically, a 1-percentage point increase in the grocery tax increases the probability of non-SNAP households being food insecure by 0.60%. However, the same was not true with respect to SNAP households. The grocery tax had no significant impact on food insecurity for SNAP participants because they were at least partially shielded from the tax due to SNAP benefits being exempted.

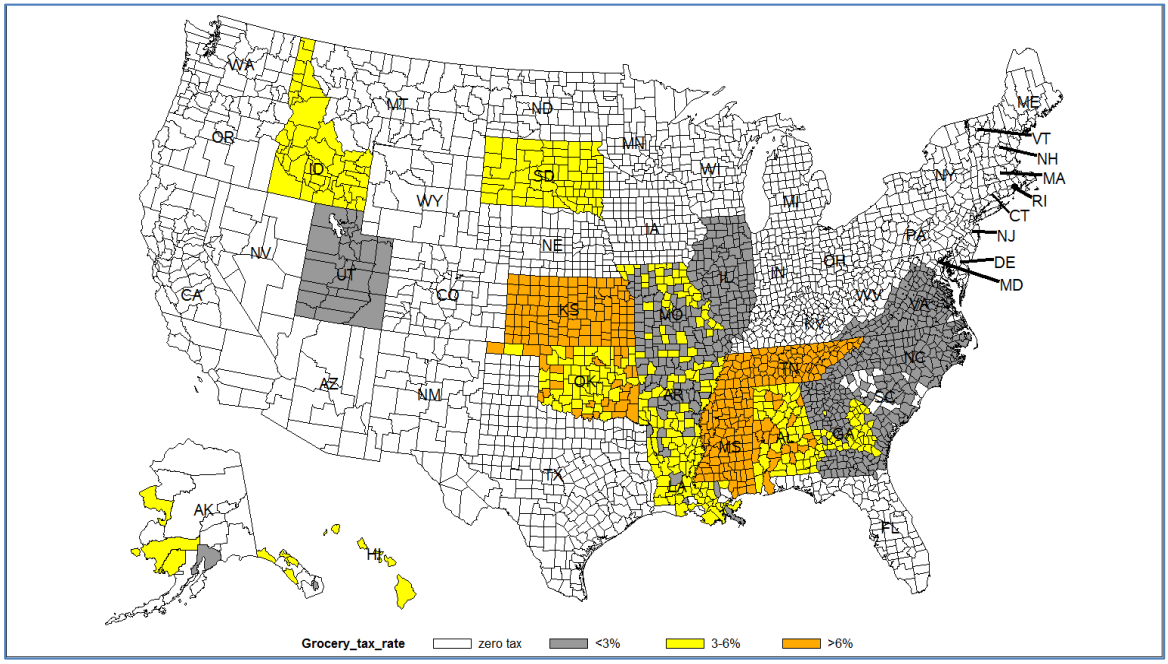
At least three implications follow from our findings. First, while previous studies have shown that the SNAP program reduces food insecurity by directly offering participants monetary benefits to purchase food (Gibson-Davis and Foster, 2006, Gregory and Coleman-Jensen, 2013, Gundersen and Kreider, 2008, Gundersen, et al., 2011, Ratcliffe, et al., 2011, Yen, et al., 2012, inter alia), our results show that the program also indirectly reduces food insecurity by shielding participants from the negative effects of grocery taxes. Unlike SNAP non-participants, our findings do not show a significant relationship between grocery taxes and food insecurity for SNAP participants. Consequently, for people living in non-exempt grocery tax states, two benefits for participation in SNAP hold: direct monetary benefits and tax exemption.

Second, states that tax food need to understand that this policy is increasing food insecurity among its poorer residents that do not participate in SNAP. To improve food security in these states, policy makers should look at ways to lessen the burden of this tax on non-SNAP households, particularly on lower income SNAP eligible households.

Lowering or eliminating the grocery tax would be one way to deal with this problem. Of course doing so would reduce tax revenue, and government officials would need to look at alternative revenue generating options if it lowered grocery taxes.

Finally, previous studies show strong evidence that many consumers are not attentive to a tax that is not salient (e.g., Chetty, et al., 2009). Our results show that even in the presence of inattentiveness, taxing grocery increases food insecurity. We argue that for attentive consumers, grocery taxes may increase food insecurity mainly through a reduction of grocery food purchases; for inattentive consumers, grocery taxes may increase food insecurity mainly through a reduction of restaurant food purchases. Therefore, grocery tax may change the relative spending of food consumed at home versus food consumed away from home, inducing further changes of nutritional intake.

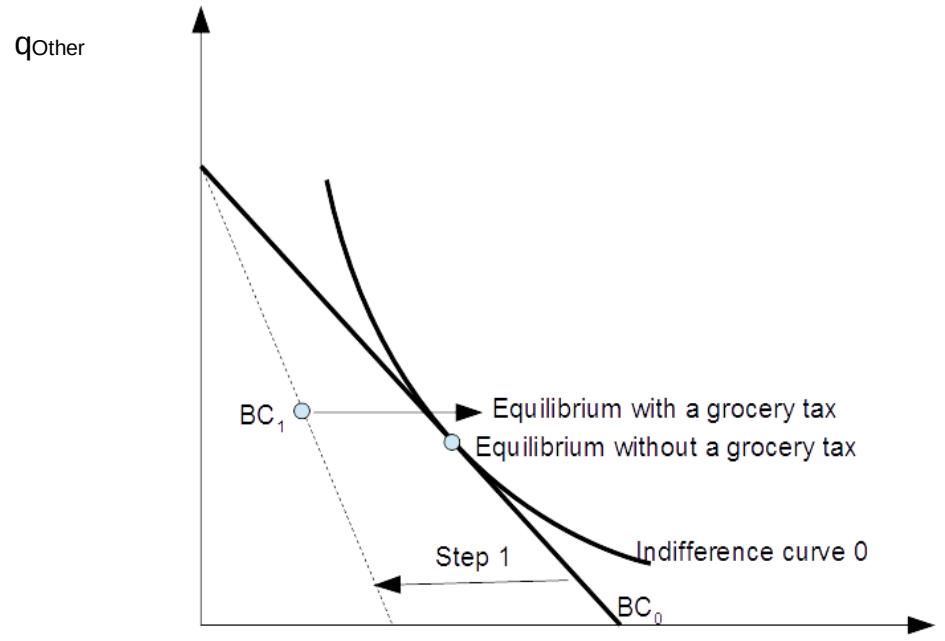
Figure 1. Grocery Food Sales Taxes (State and County Combined) in U.S. Counties, 2014



Sources: tax-rates.org, www.sale-tax.com, and state and local departments of taxation.

Figure 2. The Impact of Grocery Tax

(2a) SNAP non-participants



(2b) SNAP participants

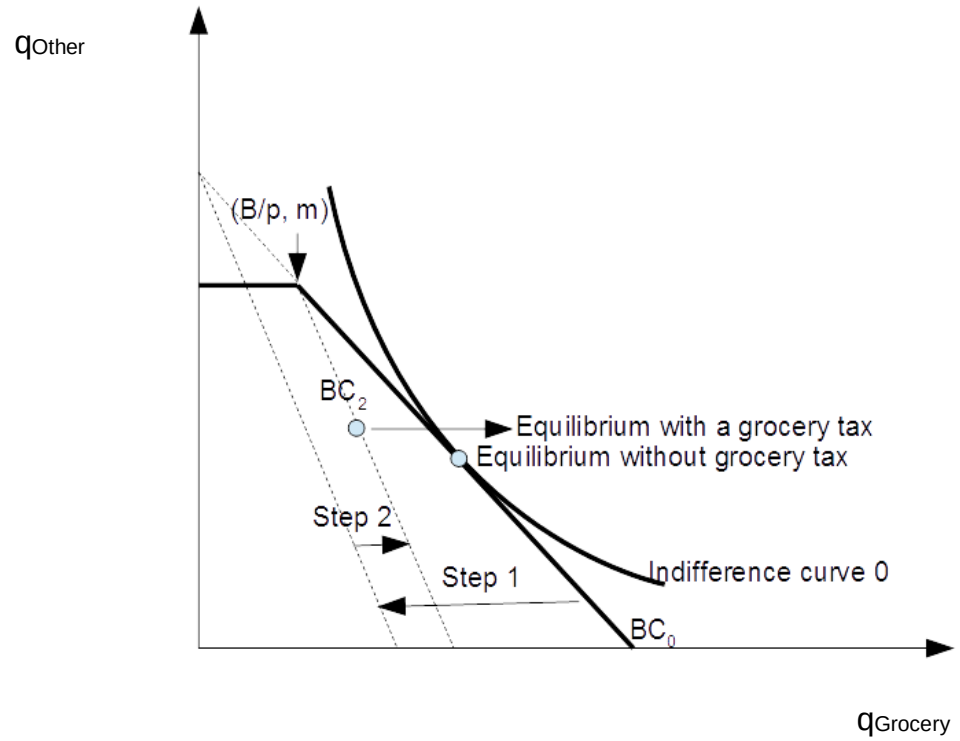


Figure 3. The Impact of Grocery Tax for Inattentive Consumers (SNAP non-participants)

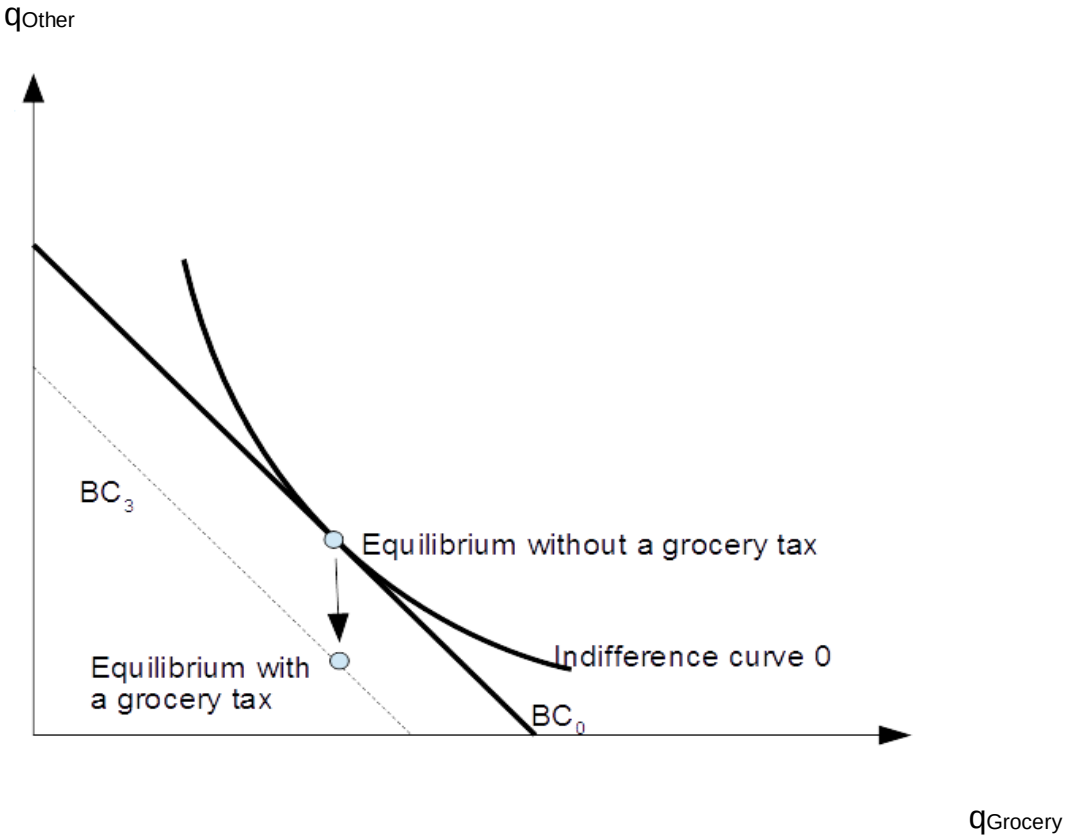


Table 1. How U.S. States and Counties Impose Grocery Taxes, 2014

State Grocery Tax	County Grocery Tax	Examples
State taxes grocery at full rate	Counties tax grocery	AL, KS
	Counties do not tax grocery	MS, SD
State taxes grocery at reduced rate	Counties tax grocery	AR, TN
	Counties do not tax grocery	IL
State exempts grocery from sales tax	Counties tax grocery	GA, LA
State has no sales tax	Counties tax grocery	AK

Sources: tax-rates.org, www.sale-tax.com, and state and local departments of taxation.

Table 2. Summary Statistics by SNAP Participation Status

	SNAP Non-Participants		SNAP Participants	
	Mean	Std. Dev.	Mean	Std. Dev.
Food Insecure (%)	17.2	(0.378)	52	(0.5)
Effective Tax Rate (%)*	4.913	(0.018)	2.851	(0.022)
Nominal Tax Rate (%)*	4.901	(0.018)	5.208	(0.018)
Living wage ($)	16.132	(6.6)	18.251	(7.7)
First income quartile	0.241	(0.428)	0.563	(0.496)
Age	51.623	(18.567)	46.942	(16.679)
Male	0.467	(0.499)	0.335	(0.472)
Black	0.112	(0.315)	0.230	(0.421)
Immigrant	0.088	(0.283)	0.091	(0.287)
College degree	0.254	(0.436)	0.137	(0.344)
Married	0.406	(0.491)	0.240	(0.427)
Number of children	0.536	(0.993)	0.885	(1.254)
Number of HH members	2.419	(1.444)	2.775	(1.575)
Presence of elderly in HH	0.390	(0.488)	0.287	(0.453)
Presence of disabled in HH	0.107	(0.3)	0.325	(0.468)
County metro status (urban)	0.737	(0.440)	0.746	(0.436)
State college degree rate (%)	29.486	(5.065)	29.459	(5.314)
State population	11.582	(11.649)	11.019	(10.885)
State unemployment rate (%)	7.076	(1.471)	7.199	(1.362)
State poverty rate (%)	15.046	(2.831)	15.294	(2.707)
Sample Size	8703		3124	

*Means are based on non-zero tax rates. The sample size for effective tax rate is 467 for SNAP non-participants and 137 for participants. The sample size for nominal tax rate is 525 for SNAP non-participants and 164 for participants.

Table 3. Probit Marginal Effects using 200% of Federal Poverty Guidelines Screen

	SNAP Non-Participants	SNAP Participants	
	Nominal Tax Rate	Nominal Tax Rate	Effective Tax Rate
Grocery tax	0.602**	0.33	-0.164
	(0.31)	(0.76)	(1.24)
Living wage	0.003**	-0.003	-0.002
	(0.00)	(0.00)	(0.00)
First income quartile	0.100***	0.065***	0.074***
	(0.01)	(0.02)	(0.02)
Age	-0.001*	-0.001	-0.001
	(0.00)	(0.00)	(0.00)
Male	-0.004	-0.026	-0.033
	(0.01)	(0.02)	(0.02)
Black	0.068***	0.011	0.012
	(0.01)	(0.02)	(0.02)
Immigrant	0.050***	-0.073**	-0.074**
	(0.02)	(0.03)	(0.03)
College degree	-0.060***	-0.002	-0.013
	(0.01)	(0.03)	(0.03)
Number of children	0.022***	0.020*	0.018
	(0.01)	(0.01)	(0.01)
Married	-0.072***	-0.048*	-0.049*
	(0.01)	(0.02)	(0.03)
Number of HH members	-0.001	0.012	0.012
	(0.01)	(0.01)	(0.02)
Presence of elderly in HH	-0.051***	-0.049*	-0.042
	(0.01)	(0.03)	(0.03)
Presence of disabled in HH	0.146***	0.137***	0.148***
	(0.02)	(0.02)	(0.02)
County urban status	-0.021**	0.025	0.031
	(0.01)	(0.02)	(0.02)
State college degree rate	-0.002*	-0.001	-0.001
	(0.00)	(0.00)	(0.00)
State population	0.001***	-0.001	0
	(0.00)	(0.00)	(0.00)
State unemployment rate	0.005	-0.007	-0.013
	(0)	(0.01)	(0.01)
State poverty rate	-0.003	0.003	0.006

	(0.00)	(0.00)	(0.00)
Sample Size	8703	3124	2731

* p<0.10, ** p<0.05, *** p<0.01.

Table 4. Probit Marginal Effects using 150% of Federal Poverty Guidelines Screen

	SNAP Non-Participants	SNAP Participants	
	Nominal Tax Rate	Nominal Tax Rate	Effective Tax Rate
Grocery tax	0.562**	0.289	0.024
	(0.28)	(0.78)	(1.27)
Living wage	0.002*	-0.003	-0.002
	(0)	(0)	(0)
First income quartile	0.153***	0.125***	0.135***
	(0.01)	(0.02)	(0.02)
Age	0.0003	-0.001	-0.001
	(0)	(0)	(0)
Male	-0.007	-0.019	-0.027
	(0.01)	(0.02)	(0.02)
Black	0.047***	0.012	0.014
	(0.01)	(0.02)	(0.02)
Immigrant	0.042***	-0.052	-0.053
	(0.01)	(0.03)	(0.03)
College degree	-0.062***	-0.006	-0.018
	(0.01)	(0.03)	(0.03)
Number of children	0.011**	0.033***	0.031**
	(0.01)	(0.01)	(0.01)
Married	-0.056***	-0.050**	-0.051*
	(0.01)	(0.03)	(0.03)
Number of HH members	0.005	0.012	0.013
	(0.01)	(0.02)	(0.02)
Presence of elderly in HH	-0.047***	-0.039	-0.027
	(0.01)	(0.03)	(0.03)
Presence of disabled in HH	0.124***	0.145***	0.158***
	(0.01)	(0.02)	(0.02)
County urban status	-0.015	0.017	0.019
	(0.01)	(0.02)	(0.02)
State college degree rate	-0.001	-0.001	-0.001
	(0)	(0)	(0)
State population	0.001***	-0.001	0
	(0)	(0)	(0)
State unemployment rate	0.004	-0.003	-0.008
	(0)	(0.01)	(0.01)
State poverty rate	-0.002	0.003	0.005

	(0)	(0)	(0)
Sample Size	8322	2988	2606

* p<0.10, ** p<0.05, *** p<0.01.

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