

# Taxing Consumption and the Take-Up of Public Assistance: The Case of Cigarette Taxes and Food Stamps

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March 8, 2017

## Abstract

We exploit cigarette tax variation across US states from 2001 to 2012 to show how taxing inelastic consumption goods can induce low-income households to enroll in public assistance programs. Using a novel household panel of monthly food stamp enrollment from the Current Population Survey, we enrich standard cigarette tax difference-in-differences models with an additional control group: non-smoking households. Smoking households are “treated” with higher taxes while non-smoking households are not. Marginal smoking households respond to increases in cigarette taxes by taking-up food stamps at rates higher than smoking households in other states and non-smoking households in the same state.

Keywords: consumption taxes, cigarette taxes, public assistance programs, food stamps, program participation, CEX, CPS

JEL codes: L66, H21, H23, H26, H71, I18

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<sup>‡</sup>We are grateful to Aaron Bodoh-Creed, Josh Chafetz, Michael Frakes, and Don Kenkel for great advice and stimulating discussions. Moreover, we thank Jorge Agüero, Rich Burkhauser, Resul Cesur, Alex Chernoff, Gary Cohen, Chris Cotton, Phil DeCicca, Svetlana Demidova, Davide Dragone, Maria Fitzpatrick, Delia Furtado, Teevrat Garg, Jacob Goldin, Andrew Green, Lloyd Grieger, Tatiana Homonoff, Michael Kottelenberg, Dan Lichter, Rick Mansfield, Tammy McGavock, James McKinnon, Morten Nielsen, Zhuan Pei, Vincent Pohl, Nishith Prakash, Pau S. Pujolas, Alex Rees-Jones, David Simon, Rok Spruk, Leigh Wedenoja, Shintaro Yamaguchi, and participants in seminars at the University of Connecticut, Queens University, McMaster University, the Institute on Health Economics, Health Behavior and Disparities at Cornell University, the 2014 Conference of Empirical Legal Studies, the 2014 CPC-CAPS Encore Conference, and the 2015 Population Association of America Annual Meeting. This is a revised version of a chapter of Kyle Rozema’s dissertation. A previous version circulated as “Behavioral Responses to Taxation: Cigarette Taxes and Food Stamp Take-Up” (IZA DP 8907). All remaining errors are our own.

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## 1 Introduction

Over the past two decades, policy makers in the United States have substantially increased cigarette taxes. Cigarette taxes raise government revenue and reduce cigarette consumption, but also alter behavior in ways unintended by policymakers: smokers respond strategically to increases in cigarette taxes by stockpiling (Chiou and Muehlegger, 2014), switching to higher tar and nicotine cigarettes (Farrelly et al., 2004), becoming more efficient smokers by extracting more nicotine out of cigarettes (Adda and Cornaglia, 2006, 2013), and purchasing cigarettes in nearby lower tax jurisdictions (Gruber, Sen, and Stabile, 2003; Lovenheim, 2008; Goolsbee, Lovenheim, and Slemrod, 2010; DeCicca, Kenkel, and Liu, 2013).

This article shows that taxation of demand-inelastic consumption can induce low-income households to take-up public assistance programs. To make this point, we use the example of cigarette taxes, low-income smoking households, and the Supplemental Nutrition Assistance Program (SNAP).<sup>1</sup> We use cigarette taxes as a case study because of its useful technical properties, including the rich variation across and within US states over time. However, we believe that any tax on basic consumption goods—such as sales taxes—could also trigger the behavioral response that we study.

Like many other public assistance programs, SNAP is means-tested and enrollment is not automatic. Because people have to be informed about the existence of the program and actively enroll, take-up is imperfect. In 2001, for instance, an estimated 48% of all eligible households participated in SNAP (Lerman and Wiseman, 2002). In addition to information frictions, two main barriers can prevent households from taking up public assistance programs: transaction costs and stigma. Transaction costs include the costs to enroll, such as the time spent on paperwork and travel costs (Currie, 2004). These costs might be non-trivial. Using SNAP as an example, initial applications may take five hours to complete and usually require several trips to an administration office (Ponza et al., 1999). The second type of costs are non-pecuniary in nature: stigma. Since Moffitt's (1983) seminal work on welfare stigma, most program participation models acknowledge that households incur disutility from the social stigma involved in program participation, and

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<sup>1</sup>SNAP was formerly known as the Food Stamp Program (until 10/2008). Henceforth, we use SNAP and “food stamps” interchangeably.

a rich literature has documented the existence of stigma and its role in take-up decisions (e.g., [Hoynes and Schanzenbach, 2009](#); [Kleven and Kopczuk, 2011](#); [Hansen, Bourgois, and Drucker, 2014](#)). Official data show that, in 2015, the average monthly SNAP benefit was just \$127 per person ([USDA, 2015](#)). This relatively small amount helps explain why transaction costs and stigma may prevent eligible households from enrolling.

Our empirical analysis uses data from the Current Population Survey (CPS) and the Consumer Expenditure Survey (CEX) from 2001 to 2012. In addition to making use of the the cross-sectional nature of both datasets, we construct a novel CPS pseudo-panel that follows households' food stamp enrollment throughout every month of a calendar year. This panel allows us to observe both smoking and non-smoking households transitioning onto food stamps from one month to another. Our identification strategy enriches difference-in-differences models by using non-smoking households within a state as an additional control group. Smoking households within a state are "treated" with higher taxes while non-smoking households within the state are not.

To investigate the extent that cigarette tax increases translate into cigarette expenditure increases, we first assess the degree to which taxes increase equilibrium prices. We then estimate the effect of cigarette taxes on cigarette expenditures and finally on food stamp enrollment. For each \$1 increase in cigarette taxes, cigarette prices as paid by consumers increase by \$0.80. For the mean smoking household consuming 22 packs per month, a \$1 increase in taxes without reductions in consumption would therefore translate into monthly spending increases of about \$18. However, 20% of all low-income smoking households consume at least 45 packs a month, and thus would experience monthly income shocks of at least \$36 for each \$1 increase in cigarette taxes. Results from the CPS and CEX confirm significant increases in cigarette expenditures following cigarette tax increases.

Our main findings show that cigarette tax increases can induce low-income smoking households to enroll in food stamps. A \$1 increase in cigarette taxes increases the probability that eligible, but non-enrolled, smoking households take-up food stamps by 3.2ppt from a baseline probability of about 25%. For the average \$0.56 state cigarette tax increase in our sample period, the point estimate implies a 7% increase in the probability that eligible, but non-enrolled, smok-

ing households take-up food stamps. In contrast, non-smoking households are not more likely to enroll in food stamps after cigarette tax increases.

Our findings contribute to several strands of the economics and public policy literatures. First, they contribute to the literature examining behavioral responses to taxation and tax avoidance behavior (e.g., [Adda and Cornaglia, 2006](#); [DeCicca, Kenkel, and Liu, 2013](#)). Second, they contribute to the behavioral public finance literature in the sense that we study concepts of uncoordinated regulation (e.g., [Kenkel, 1993](#); [Mason and Swanson, 2002](#)). Whereas governments gain revenues from higher taxes, higher prices contribute to spending increases in public assistance programs. Lastly, they contribute to the literature examining factors that affect the take-up of public assistance programs (e.g., [Ziliak, Gundersen, and Figlio, 2003](#); [Kabbani and Wilde, 2003](#); [Ribar, Edelhoch, and Liu, 2008](#); [Bitler and Karoly, 2015](#); [Pei, 2017](#)).

The organization of this article is as follows. Section 2 provides a brief background of SNAP. Section 3 describes the identification strategy and Section 4 describes the data. Section 5 presents the results and the final section concludes.

## 2 Background

Figure 1 shows that *real* cigarette prices increased by about 50% from \$4 to \$6 between 2000 and 2011.<sup>2</sup> Real state cigarette tax revenues also increased by over 50% from \$10.6 billion in 2000 to \$17.1 billion in 2011 ([Tax Burden on Tobacco, 2012](#)). Figure 1 also shows that the share of the US population enrolled in food stamps has more than doubled from 6% to over 14% over the same time period.<sup>3</sup> Part of the large increase in food stamp enrollment has been attributable to both demand side factors such as changes in the unemployment rate ([Ziliak, Gundersen, and Figlio, 2003](#); [Hanson and Oliveira, 2012](#); [Ziliak, 2015](#); [Bitler and Hoynes, 2016](#)) and supply side factors such as the eligibility rules concerning vehicle asset limits and reporting requirements ([Klerman and Danielson, 2011](#)).

[Insert Figure 1 about here]

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<sup>2</sup>Average cigarette prices are from the [Tax Burden on Tobacco \(2012\)](#).

<sup>3</sup>Food stamp enrollment is from [USDA \(2015\)](#), and population estimates are from [U.S. Census Bureau \(2016b\)](#).

This section provides a brief background of the general rules governing SNAP eligibility requirements and the calculation of benefit levels. See [Klerman and Danielson \(2011\)](#) for an overview of the changes to SNAP during the 1990s and 2000s.

**Eligibility.** There are two main eligibility requirements. First, households must meet income requirements, broken down into a gross and net income test. The general threshold for the gross income test is 130% of the Federal Poverty Line (FPL). In 2016, this amounts to \$1,276 per month for a one-person household and \$2,628 per month for a four-person household. The net income test takes the household's gross income and then applies the following deductions to calculate a household's "net income" ([USDA, 2016](#)): (i) a standard deduction of between \$155 and \$168, (ii) 20% from earned income, (iii) dependent care deductions or child support payments, (iv) medical expenses for disabled or elderly, and (v) other. The resulting net income must not exceed 100% of the FPL. In 2016, this amounts to \$981 per month for a one-person household and \$2,021 per month for a four-person household.

The second main eligibility requirement is an asset test. As of 2016, the general rule is that households must have \$2,250 or less in "countable" resources ([USDA, 2016](#)). The types of assets that are counted in the asset test differ across states. For instance, the asset test in 48 states excludes the value of the household's primary vehicle, and the asset test in 33 of those states excludes the value of all vehicles. The asset test is also applied differentially by household attributes. For instance, households with a disabled person or a person above the age of 60 have an asset threshold of \$3,250 ([USDA, 2016](#)).

**Benefits.** The calculation of SNAP benefits is premised on the general expectation that households spend 30% of their income on food. The benefit level is therefore set such that 30% of the net income is subtracted from the maximum SNAP benefits, which depend on the household size ([USDA, 2016](#)). In 2016, the maximum monthly benefit for a one-person household is \$194, and is \$649 for a four-person household. For example, if the monthly net income for a four-person household is \$1,500, then this household is expected to spend \$450 on food, and hence the available SNAP benefit is ( $\$649 - \$450 =$ ) \$199 per month.

### 3 Empirical Approach and Identification

Equation (1) sets out our main econometric specification.

$$y_{it} = \alpha + \beta \tau_{st-1} \times h_{it} + \gamma \tau_{st-1} + \psi h_{it} + \theta X_i + \zeta u_{st} + \pi f_{ct} + \sigma_t + \rho_s + \varepsilon_{it} \quad (1)$$

where  $y_{it}$  represents the dependent variable of interest for household  $i$  in state  $s$  in month-year  $t$ .  $\tau_{st-1}$  is the state cigarette tax in state  $s$  lagged by one month.  $h_{it}$  is an indicator for smoking households.  $X_i$  is a vector of socio-demographic covariates, and  $u_{st}$  is the state unemployment rate. Food price inflation,  $f_{ct}$ , is controlled for at the census region  $c$  level.  $\sigma_t$  are month-year fixed effects and  $\rho_s$  are state fixed effects. In our preferred specifications, we additionally include state time trends. For the panel of household food stamp enrollment, we employ household fixed effects and enrich the model by employing interactions between state fixed effects and the smoking household indicator ( $\rho_s \times h_{it}$ ) to net out state-specific behavior of smoking households.

The interaction term  $\tau_{st-1} \times h_{it}$  yields the main variable of interest. It relates changes in cigarette taxes to SNAP enrollment, but only for smoking households. The main effect of taxes  $\tau_{st-1}$ , by contrast, yields the impact for non-smoking households. Standard errors are routinely clustered on the state level (Bertrand, Duflo, and Mullainathan, 2004).

We employ Equation (1) using both cross sectional and panel data on food stamp enrollment. Using the cross-sectional data, Equation (1) links changes in cigarette taxes to smoker households' probability of enrolling in food stamps. Using the panel data with household fixed effects, Equation (1) links changes in state cigarette taxes to smoker households' probability to transition onto food stamps. When using the monthly panel data on food stamp enrollment, we add a set of contemporaneous and lagged cigarette tax regressors, both in levels and interactions with the smoking household indicator, to capture the full cumulative effect of a tax increase on take-up over several months.

The main identification assumption is that there are no other unobserved factors that are correlated with both state cigarette tax increases and an over-proportional increase in food stamp enrollment for smoking households. Changes to the SNAP program at the federal level (cf. Section 2) are absorbed by the month-year fixed effects. State level program changes are only a threat to the

identification strategy if they (i) were correlated with state cigarette tax changes, and (ii) would affect the take-up of low-income smoking households differently than the take-up of low-income non-smoking households, which is unlikely to be the case.

Another potential confounding factor is food price inflation. If, for whatever reason, food prices were to increase at the same pace as cigarette taxes, e.g., through supply shocks or state taxes, then it would be difficult to disentangle the increase in food stamp enrollment due to higher food prices from those of higher cigarette taxes. However, in that case, one would expect cigarette taxes to increase the likelihood that non-smoking households enroll in food stamps as well. As we will show below, this is not the case; the effects are solely driven by smoking households. In addition, we control for the monthly food prices at the level of the four US census regions. Figure [A1](#) in the Appendix plots food and cigarette prices for the four US regions over time using average cigarette prices from the [Tax Burden on Tobacco \(2012\)](#) and average food prices from [BLS \(2015a\)](#). In line with our priors, Figure [A1](#) shows that the increase in cigarette prices between 2000 and 2011 outpaced the increase in food prices. While food prices increased by about 50% in all four US regions (in the Northeast a little bit more, in the West a little bit less), cigarette prices more than doubled in all regions and even tripled in the Northeast.

In principle, there is a consensus in the economics literature that changes in state-level taxes are exogenous to individuals. However, it may be that people move or choose their state of residence based on preferences, among them cigarette taxes ([Tiebout, 1956](#); [Zodrow and Mieszkowski, 1986](#)). Our approach, like the majority of approaches similar to ours in the literature, conditions the findings on the behavior of people in specific high or low-tax states. It is not obvious that people in low-tax state A would react in the same manner in a high-tax state B to changes in taxes. In addition, but again like most studies in the literature, we cannot entirely preclude that migration based on tax changes biases our results. However, one would need to assume that moving out of state due to higher cigarette taxes induces lower costs than food stamp take-up, which is unlikely to be the case.

Consequently, all estimates ought to be interpreted as intent-to-treat (ITT) estimates. In our opinion, ITT estimates are the policy-relevant estimates and provide evidence on how people respond to incentives in real-world settings. This means that we deliberately allow for compen-

satory behavior of smokers as a reaction to higher taxes, such as reducing cigarette consumption, cross-border shopping, switching cigarette brands, or becoming a more efficient smoker.

## 4 Data and Descriptive Statistics

This paper makes use of several data sources. Our three main datasets are (a) CPS cross-sectional data, (b) CPS pseudo-panel data, and (c) CEX cross-sectional data. The unit of observation is always the household because it is the relevant economic unit where public assistance enrollment decisions are made and where the means-testing requirements are applied. Below we describe each of the three datasets. We merge in information on monthly state cigarette taxes ([Tax Burden on Tobacco, 2012](#)), monthly state unemployment rates ([BLS, 2015b](#)), and monthly food price inflation ([BLS, 2015a](#)). All monetary values are adjusted to 2016 dollars using the Consumer Price Index (CPI).

### 4.1 CPS: Food Security Supplement (FSS) & Tobacco Use Supplement (TUS)

Two of the datasets that we employ are based on the CPS. The CPS is conducted by the US Census Bureau for the Bureau of Labor Statistics (BLS). It is a monthly survey of approximately 60K US households, and is mainly used for labor force statistics. However, data on special topics ranging from tobacco use to food security are gathered periodically in “supplemental” surveys. All households in the CPS are interviewed in each of four consecutive months, then after eight months, are surveyed again for four months. A set of households surveyed in the main survey is also surveyed in the applicable supplemental survey of that month ([U.S. Census Bureau, 2016a](#)).

We combine the Tobacco Use Supplements (TUS) and the Food Security Supplements (FSS) of the CPS from 2001 to 2011. As a general CPS rule, each household is surveyed a maximum of one time in both of the TUS and FSS. We focus on CPS households that answered both the TUS and FSS. We use the TUS as baseline survey, and then merge in the FSS food stamp enrollment information. Because the FSS is carried out in December of each year in our sample, we make use of the following TUS supplements: November 2001, February 2002, February 2003, November 2003, January 2007, January 2011.



**Smoking Information.** The TUS reports the smoking status of each household member at the time of the survey. The TUS also elicits retrospective smoking information and reports the smoking status of each household member as of 12 months before the TUS interview.

**SNAP Information.** In each FSS, enrollment status in food stamps is elicited separately for *each month* of the past calendar year (January until December of the year of the FSS). It is important to note that the CPS only elicits food stamp enrollment information for households below 185% of the federal poverty line (FPL). This is because only those households are, in principle, eligible for SNAP.<sup>4</sup> We therefore restrict the sample to households below 185% of the FPL.

#### 4.1.1 CPS Cross-Sectional Data

We first generate a cross-sectional dataset which uses the TUS as the reference dataset. This means that we make use of the information on socio-demographics and cigarette consumption from the TUS, and merge in food stamp enrollment information of the same calendar month for households that completed the TUS in a month in which food stamp enrollment is observed from the FSS.<sup>5</sup> (The results are robust to using the FSS demographics). For the CPS cross-sectional dataset, we define a “smoking household” as one that has at least one smoking member in the month that we observe information on both smoking status and food stamp enrollment. (We do not project the smoking or food stamp enrollment status forward or backward in time.)

Table 1 reports descriptive statistics. Of the 26,729 food stamp eligible households in the sample, 10% are enrolled in food stamps and 28% have at least one member who currently smokes cigarettes. The mean smoking household consumes less than a pack per day (14.6 cigarettes), but there is significant heterogeneity in consumption with a large share of households consuming at least 2 packs per day (12%) and 3 packs per day (3%). With a mean state tax of \$0.91, the mean price of a pack of cigarettes is \$4.41. Multiplying the number of daily cigarettes consumed (in packs) by the cigarette prices and extrapolating to quarterly expenditures (to match the time frame of expenditures in the CEX), one observes that the average smoking household spends \$393

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<sup>4</sup>As explained in Section 2, the general gross income test requires households to have income below 130% FPL. However, because of the “Categorical Eligibility” possibility that may make some households eligible, the CPS producers chose the 185% threshold for the filter question.

<sup>5</sup>The CPS is conducted by physical location. We follow the CPS instructions to limit households to the same individuals in the TUS and FSS.

on cigarettes per quarter. However, the expenditure distribution is skewed to the right, with 20% of households spending more than \$500 per quarter on cigarettes—about one week of the average annual income (\$23,154).

State taxes vary between less than five cents for Virginia from 2001 to 2004 and over four dollars for New York after August 1, 2010. Figure A2 in the Appendix illustrates the rich state-time variation in the level of state cigarette taxes.<sup>6</sup> Conditional on an increase, the average tax increase was \$0.56. Most states increase cigarette taxes in relatively large amounts after longer periods without tax changes.<sup>7</sup>

[Insert Table 1 about here]

The regression models adjust the sample by a standard set of socio-economic characteristics, including household size, household income, race, and the education, age, and marital status of the head of the household. The average household has 2.5 members. Roughly half of all household members are male; the household head is on average 52 years old, most likely white and not married. Almost 30% have no high school degree.

#### 4.1.2 CPS Pseudo-Panel

We generate a CPS pseudo-panel which again uses the TUS as the reference dataset. This means that we extract the time-invariant information on socio-demographics from the TUS. This is the reason why we call the dataset a “pseudo-panel”—because socio-demographics are constant over time. What varies over time at the household level is food stamp enrollment, which is available for each month of the calendar year.

Because the TUS is carried out irregularly and the FSS is always carried out in December, the pseudo-panel follows households for different lengths of time. First, for households sampled in a January TUS, we use 11 months of food stamp enrollment information of the previous year.

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<sup>6</sup>The figure reports a binned scatterplot of the proportion of smoking households enrolled in food stamps against state cigarette taxes at the state-month-year level using the panel of food stamp enrollment described below.

<sup>7</sup>See Figure A3 in the Appendix, which reports a binned scatterplot of the change in the proportion of smoking households enrolled in food stamps against the change in state cigarette taxes at the state-year level using the CEX described below.

This applies to the TUS of January 2007 and 2011 which we merge with the FSS of December 2006 and 2010.<sup>8</sup>

Second, we use the households of the November 2003 TUS and the December 2003 FSS to track household food stamp enrollment information for 10 months. Hence, as shown in Table A1 of the Appendix, our pseudo-panel includes observations from 2003, 2006, and 2010. Note that we deliberately decided to restrict the pseudo-panel to households with at least 10 months of food stamp enrollment information. One reason is that it allows us to carry out an event study with a relatively balanced set of observations. (The results are robust to using all households that were interviewed in the TUS and FSS between 2001 and 2011.)

In the CPS pseudo-panel, 17% of households are enrolled in food stamps in any given month. The take-up rate in a given month is naturally much smaller, on average 0.6%, meaning that each month 0.6% of the households in our sample transition onto food stamps.

#### 4.2 *Consumer Expenditure Survey (CEX)*

Since 1984, the Consumer Expenditure Survey (CEX) has been carried out by the BLS. The main unit of observation is the so-called Consumer Unit (CU). The CEX is designed to be representative of the US non-institutionalized civilian population. Each quarter about 7,000 interviews are conducted (BLS, 2014).

The CEX consists of two main surveys: (i) the Interview Survey (IS), and (ii) Diary Survey (DS). In the IS, CUs are interviewed every three months over the course of 15 months. Income and employment information are solely surveyed in the second and fifth interviews while expenditure information is surveyed from the second to the fifth interview.

We focus on BLS provided family files, containing food stamp information from 2001 to 2012. Those files contain income, expenditure, and housing information at the CU level. Because we are using the public version of the CEX, only a subset of observations are available with state identifiers (BLS, 2014). We restrict the sample to CUs with complete income information and the second interview. This implies that we rely on representative cross sections for the CEX.

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<sup>8</sup>To be conservative, we omit the January 2006 and 2010 enrollment information because those surveyed at the end of the month might interpret the smoking status question referring to “12 month ago” as referring to February of 2003 and 2010, respectively. The results are robust to the inclusion of food stamp enrollment data in January 2006 and 2010.

We employ the CEX in addition to the CPS for three reasons: (a) to check for the consistency of the CPS results, (b) to exploit a sample that spans observations more evenly across calendar months and years (see Table A2 in the Appendix), and (c) to exploit the potentially more reliable expenditure information in the CEX. To make the findings comparable, we also condition the CEX on low-income households at or below 185% of the FPL. In contrast to the CPS, the CEX does not have a filter question for whether CUs are at or below 185% of the FPL. We employ the 2015 Poverty Guidelines as well as the annual gross CU income—as calculated by the BLS and provided in the CEX—to identify and restrict to households at or below 185% of the FPL. Our final sample contains information on 24,729 households.

Table 2 provides descriptive statistics. 12% of households were enrolled in food stamps in the sample, and 23% are smoking households. The average smoking households spends \$270 on cigarettes each quarter. Although cigarette expenditures are reported in a different fashion in the CEX as compared to the CPS—namely, total expenditures in the last quarter—the measures are remarkably consistent with the CPS.

[Insert Table 2 about here]

**Socio-Demographic Controls.** We generated a set of socio-demographics that compares to those in the CPS. The CEX has similar socio-demographic characteristics to that in the CPS. The CEX sample has an average of 2.5 members per household (CPS: 2.5) and the average age of the household head is 54 years (CPS: 52 years). 47% of household heads are employed (CPS: 44%) and 23% are high school dropouts (CPS: 23%). The CEX contains a slightly lower proportion of smoking households (23% vs. 28%), and has a lower average reported household income (\$12.9K vs. \$21.7K).

## 5 Empirical Results

We use cigarette tax increases as a case study for how taxes on inelastic consumption goods may induce eligible but non-enrolled households to enroll in public assistance programs. Section 5.1 investigates how taxes increase equilibrium cigarette prices and cigarette expenditures. Section 5.2 investigates the effect of cigarette taxes on food stamp enrollment.

### 5.1 *Cigarette Taxes, Prices, and Household Expenditures*

Using the cross-sectional CPS data, we first estimate the extent to which cigarette taxes are passed through to cigarette prices. For this exercise, we employ a specification similar to Equation (1) but omit non-smoking households. The dependent variable is the self-reported price for the last pack of cigarettes bought. Columns (1) and (2) of Table 3 show the results. Each column represents one specification that differs only by the inclusion of set of covariates as indicated in the lower portion of the table. In our preferred specification (Column (2)), we find that taxes are passed through to prices at a rate of 0.80. This pass-through rate is right in line with the recent literature (e.g., [Harding, Leibtag, and Lovenheim, 2012](#)).

[Insert Table 3 about here]

Next, we estimate the effect of higher cigarette taxes on cigarette expenditures, which are conveyed through the average pass-through rate of 0.80. We again employ a variant of Equation (1) to estimate the effect of taxes on expenditures. Columns (3) and (4) of Table 3 show the results using the CPS cross-sectional dataset and Columns (5) and (6) show the results using the CEX dataset. When adjusting the CPS sample for socio-demographics, a \$1 increase in cigarette taxes increases quarterly cigarette expenditures by \$30 (Column (4)). The estimates from the CEX yield very consistent and statistically significant increases in quarterly expenditures by roughly \$24 for the average smoking household.

### 5.2 *Cigarette Taxes and Food Stamp Enrollment*

**Event Study.** The panel nature of our CPS dataset naturally gives rise to a visual assessment of food stamp take-up before and after cigarette tax increases through an event study. The “treatments” (cigarette tax increases) are staggered in time and across households in different states over time. Only smoking households are “treated” by cigarette tax increases and non-smoking households serve as controls.

We define the event time as calendar month minus the month taxes were increased for each household such that the month of the increase in cigarette taxes becomes event time 0. We use a

balanced panel of households who were present in the data for four months before and after a tax change (e.g., [Simon, 2016](#)). We estimate Equation (1) for whether a household transitions onto food stamps in a given month using household fixed effects but replace taxes with event time indicator variables for each month around a state cigarette tax increase. The approach assumes that taxes across states have the same effect on food stamp take-up in the months around a tax change. Each event time coefficient indicates the propensity of households to take-up food stamps in a given month. We normalize the coefficients for both smokers and nonsmokers in the first month of the event study ( $t=-4$ ) to facilitate interpretation of the findings.

Figure 2 shows the event study graph where we plot the estimated event time coefficients (90% standard error bars are reported). The propensity of smoking and non-smoking households to take-up food stamps in the two to four months before increases in taxes is very similar, stable, and the confidence intervals overlap. The propensity of non-smoking households to take-up food stamps does not increase over the entire period after the tax-increase. However, the propensity of smoking households to take-up food stamps begins to increase in the month before the tax increase, and further increases in the month of the tax increase (becoming statistically different from non-smoking households at event time 0). In the months following the tax increase, the event time estimates for smoking households remain highly elevated at a level that is statistically different from the flat take-up propensity for non-smoking households.

**[Insert Figure 2 about here]**

One would expect the increase in enrollment to persist past the month of the tax change because many households who apply for food stamps in one month obtain benefits for the first time after the month in which they apply due to the timing of the application process. One would also expect the observed anticipatory effect because tax increases are enacted usually a number of months before the higher taxes become effective ([Gruber and Kőszegi, 2001](#)), and stockpiling behavior of smokers before a tax increase is well documented ([Chiou and Muehlegger, 2014](#)). The timing of stockpiling is very consistent with the observed timing of the anticipatory effect. In particular, [Chiou and Muehlegger \(2014\)](#) find that stockpiling behavior occurs over the course of 8 weeks after taxes have typically been enacted but before the higher taxes become effective. Given the timing of the food stamp application process, stockpiling beginning two months before

a cigarette tax increase is exactly the time period in which smoking households enroll in food stamps in Figure 2.

In summary, Figure 2 shows a clear increase in the propensity of low-income smoking households to take-up in food stamps in the month of a cigarette tax increase and the months following the increase. In contrast, over the tax increase cycle, Figure 2 shows flat take-up propensity for non-smoking households.

**Regression Framework.** Using the cross-sectional data, we now relate changes in state cigarette taxes to food stamp enrollment by estimating Equation (1). The dependent variable is food stamp enrollment—a binary indicator of whether the household is currently enrolled in food stamps. The results are shown in Table 4. The columns in Table 4 show specifications differing by the set of covariates included and dataset employed. Columns (1) through (3) use the CPS cross-sectional dataset, and Columns (4) through (6) use the CEX dataset.

[Insert Table 4 about here]

The main effect of interest is the interaction term between state cigarette taxes and smoking households. It indicates the statistical relationship between cigarette tax increases of \$1 and the probability that low-income smoking households are enrolled in food stamps.<sup>9</sup> We find that each \$1 increase in cigarette taxes increases in the likelihood that low-income smoking households enroll in food stamps by between 3.1 and 3.3 percentage points (ppt) in Columns (1) to (3). The results are consistent in the CEX where we find that each \$1 increase in taxes increases the likelihood of food stamp enrollment by between 2.5 and 3.4ppt (Columns (4) to (6)). It is noteworthy that the coefficients of interest remain relatively stable when we add covariates stepwise to the models. This reinforces that the identifying variation is exogenous.

Additional evidence against the notion of spurious correlations between tax increases and food stamp enrollment is represented by the main effect on state cigarette taxes, which reflects the effect of tax increases on food stamp enrollment of non-smoking households. Across all six specifications, the magnitude of the main effect is rather small and its sign ambiguous. The estimates

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<sup>9</sup>We report results from a linear probability model because the interaction terms are readily interpretable (see [Ai and Norton, 2004](#); [Karaca-Mandic, Norton, and Dowd, 2012](#)), but the results carry over to non-linear estimation.

show that the relationship between cigarette taxes and food stamp enrollment is driven through smoking households.

**Monthly Transitions Onto Food Stamps.** Next, we exploit within-household variation in food stamp enrollment from the CPS pseudo-panel. Because we have already witnessed that the actual effect of cigarette taxes on food stamp enrollment emerges gradually during the post-tax period (Figure 2), we estimate a distributed lag model where we include a set of contemporaneous and lagged tax effects in levels and interactions. The distributed lag model estimates month-by-month incremental changes in enrollment relative to the average enrollment before the tax change.<sup>10</sup> The sum of the coefficients provides the cumulative effect. We stop the series at three lags. (Very similar results are obtained with four and five lags.) The results are shown in Table 5.<sup>11</sup> We get consistent results with a first difference specification (see Table A3 in the Appendix), which provides evidence for the strict exogeneity assumption (Grieser and Hadlock, 2016).

[Insert Table 5 about here]

Column (1) includes household covariates. Column (2) includes household fixed effects, and Column (3) includes household fixed effects and state time trends. The main effect on state cigarette taxes indicates that tax increases do not increase food stamp enrollment for non-smoking households. In contrast, the interaction terms yield the relationship between tax increases and food stamp enrollment for smoking households. As seen, the contemporaneous coefficients are statistically significant and of economically relevant size.<sup>12</sup> The row below the lagged interaction terms yields the calculated cumulated effect of a tax increase on food stamp enrollment. The cumulative effect in Column (3) implies that a cigarette tax increase by \$1 increases food stamp enrollment of eligible low-income smoking households by 3.2ppt from a baseline of 25%, i.e., by 13%.

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<sup>10</sup>The distributed lag model is a standard approach in estimating an effect that emerges gradually during the post-reform period (e.g., Deschenes and Moretti, 2009; Paik, Black, and Hyman, 2017).

<sup>11</sup>We obtain consistent results by estimating a fixed effects model that includes only cigarette taxes in the previous month, i.e., not a distributed lag model. The point estimate using the preferred specification in Column (3) of Table 5 on the interaction term is 0.027\*\*\* (standard error 0.008). The results are also robust, but smaller in size and only marginally significant, when we additionally include full sets of state-month-year fixed effects as well as smoker-month-year fixed effects.

<sup>12</sup>The estimates slightly increase, albeit not in a statistically significant sense, when households with members who quit smoking within the past year are excluded from the sample.



**Duration Analysis.** Next, we take another slice at the empirical question by turning to a duration analysis. Duration analyses are commonly used in labor economics to study the impact of  $X$  on the length of unemployment spells (Van Den Berg, 2001). They have also been used in health economics to study the onset of smoking (e.g., DeCicca, Kenkel, and Mathios, 2002). We employ the duration analysis for two main reasons: (i) as a robustness check, and (ii) to be able to interpret our empirical findings in a different manner and obtain an answer to the question: do higher cigarette taxes decrease the *time span until* non-enrolled but eligible households take-up food stamps? Whereas it may be unrealistic to assume that eligible but non-enrolled households would have never enrolled in food stamps in the absence of a tax increase, it is plausible that the tax increase shortens the time span to take-up.

The basic setup of the model is as follows. Define the hazard function  $h_t = \alpha_t \exp(\beta X)$  as the households that take-up food stamps in time  $t$  divided by the number of “at risk” households (the total number of non-enrolled but eligible households at time  $t$ ).  $\alpha_t$  is the “baseline hazard” of a non-enrolled household taking up food stamps at time  $t$ , and  $X$  is a set of covariates as before. Note that the at risk population is limited to the subset of households who are not enrolled in food stamps in the first month we observe them. The sample excludes households once they take-up, so the sample size of the duration analysis differs slightly from the other models. In other words,  $h_t$  is interpreted as the conditional probability of taking up food stamps at time  $t$ , conditional on not being enrolled in food stamps. See Van Den Berg (2001) for further details on the estimation strategy.

**[Insert Table 6 about here]**

Table 6 reports the coefficients from estimating a Cox Proportional Hazard model for non-smoking households and smoking households. We split the sample and run the models separately for non-smoking and smoking households because of the readily interpretable coefficients. The specifications therefore avoid issues surrounding the calculation of marginal effects of interaction terms in non-linear models.

As seen, the point estimate on cigarette taxes for non-smoking households is insignificant and the size is a little over one third of that for smoking households. The interpretation of the

statistically significant coefficient for smoking households in Column (2) is as follows: a \$1 increase in cigarette taxes decreases the average time to take-up by about 11 days (0.383 months). Overall, the duration analysis provides evidence that is consistent with the results from the linear probability models and allows for a complement interpretation of the observed empirical pattern.

### 5.3 *Other Outcome Margins*

Table 7 tests for compensatory behavior outside of, and in addition to, food stamp enrollment by studying other outcome margins using the CPS cross-section. We estimate the specification in Equation (1), but employ the outcome variables as indicated in the column headers of Table 7. The main variable of interest is again the interaction between state cigarette taxes and an indicator for smoking households.

The binary dependent variable in Column (1) indicates whether at least one household member quit smoking. A household is defined to be a quitting household if at least one member smoked cigarettes one year ago but does not smoke cigarettes at the time of the interview. Note that households with and without current smokers can both have members who quit smoking within the past year. The results in Column (1) suggest that a \$1 increase in cigarette taxes is associated with a 0.5ppt (1.4% relative to the baseline of 0.368) increase in the probability that at least one household member quit smoking in the past year. Note, however, this estimate only captures temporary quitting behavior; relapse may occur.

**[Insert Table 7 about here]**

Column (2) uses the self-reported amount of daily household cigarette consumption as the dependent variable. The point estimate implies that a \$1 increase in cigarette taxes reduces the number of daily cigarettes consumed by 2.2 cigarettes at the household level.

Column (3) exploits a self-reported measure that indicates whether the household ran out of money for food within the last month. We find that smoking households are at a 12ppt higher risk of reporting that they ran out of money for food than non-smoking households, but find no evidence of a strong relationship with cigarette taxes.

Finally, we assess how food-related expenditures develop for smoking and non-smoking households after cigarette tax increases. For that purpose, we estimated Equation (1) using the CEX and (self-reported) quarterly household expenditures on food at home, food expenditures away from home, alcohol expenditures, and total expenditures. The findings (not reported) are imprecisely estimated and only provide suggestive evidence that low-income smoking households spend less money for food away from home and substitute toward eating more at home when taxes increase.

#### 5.4 *Summary of Effects and Mechanisms*

Table 8 summarizes the findings. The starting point and trigger in the causal chain of events is an increase in state cigarette taxes. Column (2) of Table 3 shows that a \$1 tax increase raises equilibrium cigarette prices by \$0.80. Next, and consistent with the literature that shows a relatively inelastic demand for cigarettes (e.g. Hansen, Sabia, and Rees, 2017), Columns (3) to (6) of Table 3 show that household cigarette expenditures increase significantly when taxes increase. Using the CPS, we obtain highly significant point estimates that suggest that quarterly cigarette expenditures increase by \$30 for each \$1 increase in state cigarette taxes. However, it is well documented that self-reported consumption and expenditure measures are under reported and contain measurement error (e.g., Bee, Meyer, and Sullivan, 2015), which may attenuate our expenditure estimates. A static calculation that considers the estimated demand response of 2.2 fewer daily cigarettes consumed per household (Table 7, Column (2)) would yield mean quarterly expenditure increases of \$45 for each \$1 increase in cigarette taxes ( $[22 \text{ packs per month on average} - 2.2 \text{ cigarettes per day} \times 30 \text{ days in month} / 20 \text{ cigarettes per pack}] \times 0.80 \times 3 \text{ months per quarter}$ ).

Our main findings are shown in Column (3) of Table 5: the cumulative effect of a \$1 cigarette tax increase is to increase food stamp enrollment by 3.2ppt among non-enrolled eligible smoking households (13.1% from a baseline of 0.247). The duration analysis presented in Table 6 offers an alternative and consistent interpretation of the empirical pattern: a \$1 increase in taxes significantly reduces the average time to take-up for low-income smoking households by 11 days (0.383 months). Independent of the model employed, non-smoking households do not respond to cigarette tax increases by enrolling in food stamps.

[Insert Table 8 about here]

Whereas governments gain revenues from higher cigarette taxes, higher taxes contribute to spending increases in food stamps. To assess the degree that the estimated increase in enrollment of smoking households influences governmental tax revenue, consider a back-of-the-envelope calculation for the proportion of cigarette tax revenues that are offset by increases in spending on food stamps.

$$\text{Offset} = \frac{N_s \times E_s \times \Delta_e \times \bar{B}}{N_s \times \Delta_\tau \times \bar{C}} = \frac{\Delta_e \times E_s \times \bar{B}}{\bar{C}}$$

where  $N_s$  is the number of smoking households that cancels out of the expression,  $E_s$  is the proportion of smoking households that are eligible for food stamps (34%, own calculation from the CEX),  $\Delta_e$  is the percentage point increase in enrollment among food stamp eligible smoking households from a  $\Delta_\tau = \$1$  increase in taxes (3.2ppt, Column (3) of Table 5),  $\bar{B}$  is the average smoking household monthly food stamp benefit (\$156, own calculation from the CEX), and  $\bar{C}$  is the average monthly cigarette consumption of smoking households (22 packs per smoking household per month, own calculation from the CPS). The numerator is the increase in food stamp spending from a \$1 tax increase and the denominator is the increase in tax revenue from the tax increase. We note that this back-of-the-envelope calculation relies on a number of strong assumptions, including the counterfactual that smoking households would never have enrolled in food stamps. The back-of-the-envelope calculation suggests that roughly 8% of the additional cigarette tax revenue collected from a tax increase is offset by the resulting increase in spending on food stamps.

## 6 Conclusion

This paper investigated whether tax increases on goods with price-inelastic demand induced eligible low-income households to enroll in public assistance programs. Using the Current Population Survey and the Consumer Expenditure Survey, we exploited tempo-spatial variation in cigarette taxes and food stamp enrollment across US states from 2001 to 2012 to study this question empirically.

Exploiting a novel household panel of food stamp enrollment, we enriched standard cigarette tax difference-in-differences models with an additional control group: non-smoking households.

Smoking households within a state are “treated” with higher taxes while non-smoking households within the state are not. We found that a \$1 increase in cigarette taxes increased the probability that eligible, but non-enrolled, smoking households take-up food stamps by 3.2ppt from a baseline probability of about 25%. Duration models offered a complementary interpretation of the empirical pattern: a \$1 increase in taxes significantly reduced the average time to take-up for low-income smoking households by 11 days. Independent of the model employed, non-smoking households do not respond to cigarette tax increases by taking up in food stamps.

In addition to cigarette taxes, other consumption taxes such as sales taxes can have a meaningful effect on low-income households. This paper showed that eligible but non-enrolled low-income households respond to consumption tax increases on price-inelastic goods by enrolling in public assistance programs. More research is needed to fully understand the mechanisms and implications of the relationship between taxes and enrollment in public assistance programs.

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## Figures and Tables

Figure 1: Cigarette Prices and Food Stamp Enrollment

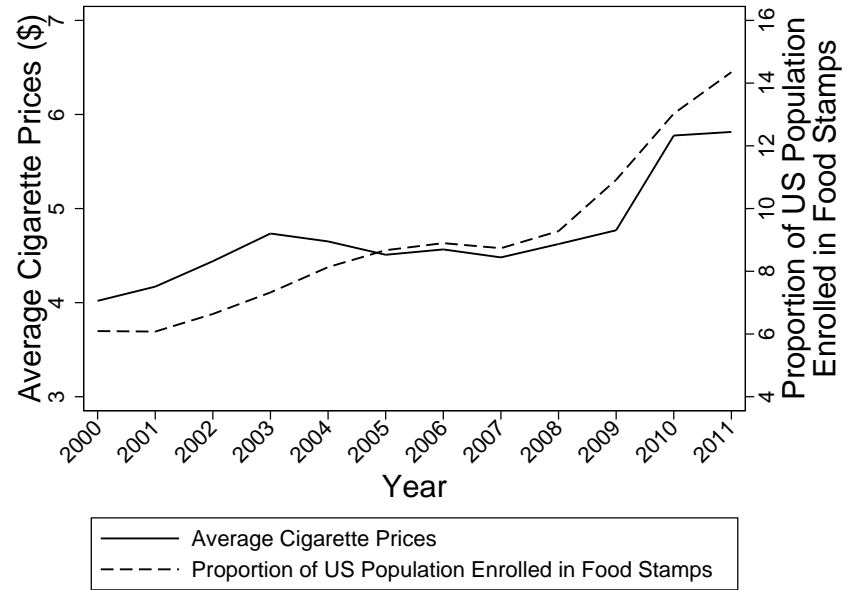
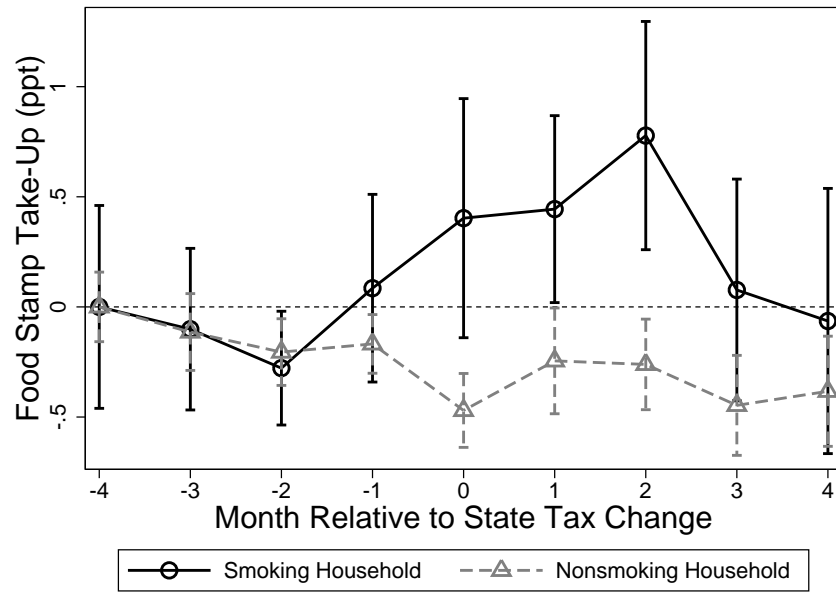


Figure 2: Event Study—Cigarette Tax Increases and Food Stamp Take-Up



**Table 1: Descriptive Statistics for the Current Population Survey**

Variable	Mean	Std. Dev.	Min.	Max.	N
Enrolled in Food Stamps	0.10	0.30	0	1	26,729
Smoking Household	0.28	0.45	0	1	26,729
Household Daily Cigarette Consumption	14.6	14.6	0	120	7,552
Cigarette Price (\$)	4.41	1.10	0	20	7,552
Quarterly Cigarette Expenditure (\$)	393	603	0	13,763	7,552
State Cigarette Tax (\$)	0.91	0.69	0.03	4.58	26,729
Change in State Cigarette Tax (\$) (conditional on change)	0.56	0.28	0.03	1.15	5,513
<b>Covariates</b>					
Monthly State Unemployment Rate	5.86	1.88	2.40	14.10	26,729
Household Head No High School	0.28	0.45	0	1	26,729
Household Head Employed	0.44	0.50	0	1	26,729
Gross Earned Household Income	23,154	14,937	2,633	115,231	26,729
# Household Members	2.53	1.62	1	16	26,729
# Male Household Members	1.17	1.07	0	9	26,729
# White Household Members	2.01	1.74	0	14	26,729
# Black Household Members	0.34	1.04	0	12	26,729
# Asian Household Members	0.08	0.57	0	16	26,729
Household Head Married	0.39	0.49	0	1	26,729
Age of Household Head	51.5	19.3	15	90	26,729

*Source:* CPS, FSS merged with TUS and state-month level cigarette tax information ([Tax Burden on Tobacco, 2012](#)). Cigarette prices are top coded at \$20. Note that cigarette price, consumption, and quarterly expenditures are reported for households which have at least one daily smoker. All monetary values are in 2016 dollars.

**Table 2: Descriptive Statistics for the Consumer Expenditure Survey**

Variable	Mean	Std. Dev.	Min.	Max.	N
Enrolled in Food Stamps	0.12	0.33	0	1	24,729
Smoking Household	0.23	0.42	0	1	24,729
Quarterly Cigarette Expenditure (\$)	270	300	4	5,932	5,740
State Cigarette Tax (\$)	1.01	0.70	0.03	4.49	24,729
Change in State Cigarette Tax (\$) (conditional on change)	0.67	0.41	0.01	1.69	3,493
<b>Covariates</b>					
Monthly State Unemployment Rate	6.75	2.35	1.80	14.80	24,729
Household Head No High School	0.23	0.42	0	1	24,729
Household Head Employed	0.47	0.50	0	1	24,729
Gross Earned Household Income	12,891	16,401	0	125,570	24,729
Rural Region	0.0121	0.1093	0	1	24,729
# Household Members	2.45	1.62	1	16	24,729
Household Head Male	0.43	0.49	0	1	24,729
Household Head White	0.79	0.41	0	1	24,729
Household Head Black	0.15	0.35	0	1	24,729
Household Head Married	0.42	0.49	0	1	24,729
Age of Household Head	54.0	20.1	16	87	24,729

*Source:* CEX merged with state-month level cigarette tax information ([Tax Burden on Tobacco, 2012](#)). Gross earned household income is bottom coded at \$0. All monetary values are in 2016 dollars.

**Table 3: State Cigarette Taxes, Cigarette Prices, and Cigarette Expenditures: CPS and CEX Cross Sections**

	<i>Price of Last Cigarette Pack Bought (CPS)</i>		<i>Quarterly Cigarette Expenditures (CPS)</i>		<i>Quarterly Cigarette Expenditures (CEX)</i>	
	(1)	(2)	(3)	(4)	(5)	(6)
State Cigarette Taxes	0.808*** (0.097)	0.803*** (0.096)	21.6 (22.8)	30.4* (16.6)	26.0** (11.2)	24.3** (10.4)
Dep. Var. Mean	4.41	4.41	392	392	270	270
<b>Covariates</b>						
Month FE	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes
State FE	yes	yes	yes	yes	yes	yes
Regional Food Prices	yes	yes	yes	yes	yes	yes
State Unempl. Rate	yes	yes	yes	yes	yes	yes
Socio-Demographics	no	yes	no	yes	no	yes
Observations	7,552	7,552	7,552	7,552	5,740	5,740

*Source:* Columns (1) to (4): CPS, FSS merged with TUS; Columns (5) to (6): CEX. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; standard errors are in parentheses and clustered at the state level. All samples condition on smoking households. Each column represents one regression as in Equation (1). The dependent variable in Columns (1) and (2) is the price of the last cigarette pack bought by the CPS smoking household. The dependent variable in Columns (3) and (4) is quarterly household cigarette expenditures, extrapolated from the price and daily cigarette consumption information reported by the household. The dependent variable in Columns (5) and (6) is the cigarette expenditures in the last quarter prior to the interview, as reported by the household. *State Cigarette Taxes* indicates the state cigarette tax level in the previous month.

**Table 4: State Cigarette Taxes and Food Stamp Enrollment: CPS and CEX Cross Sections**

	<i>CPS Cross Section</i>			<i>CEX Cross Section</i>		
	(1)	(2)	(3)	(4)	(5)	(6)
State Cigarette Taxes × Smoking Household	0.032*** (0.008)	0.033*** (0.008)	0.031*** (0.007)	0.033*** (0.010)	0.034*** (0.011)	0.025** (0.010)
State Cigarette Taxes	0.019* (0.010)	-0.012 (0.011)	-0.011 (0.011)	0.013* (0.008)	0.006 (0.009)	0.006 (0.008)
Smoking Household	0.035*** (0.008)	0.034*** (0.008)	0.017** (0.009)	0.065*** (0.015)	0.062*** (0.015)	0.054*** (0.013)
Mean Smoking Households	0.145	0.145	0.145	0.197	0.197	0.197
<b>Covariates</b>						
Month FE	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes
Month×Year FE	yes	yes	yes	yes	yes	yes
State FE	yes	yes	yes	yes	yes	yes
Regional Food Prices	yes	yes	yes	yes	yes	yes
State Unemployment Rate	yes	yes	yes	yes	yes	yes
State Time Trend	no	yes	yes	no	yes	yes
Socio-Demographics	no	no	yes	no	no	yes
Observations	26,729	26,729	26,729	24,729	24,729	24,729

*Source:* Columns (1) to (3): CPS, FSS merged with TUS; Columns (4) to (6): CEX. \* p<0.1, \*\* p<0.05, \*\*\* p<0.01; standard errors are in parentheses and clustered at the state level. Each column represents one regression as in Equation (1). The binary dependent variable indicates whether the household is enrolled in food stamps in the current month. *State Cigarette Taxes* indicates the state cigarette tax level in the previous month.

**Table 5: State Cigarette Taxes and Food Stamp Take Up: CPS Monthly Pseudo Panel**

	<i>Food Stamp Enrollment</i>		
	(1)	(2)	(3)
State Cigarette Tax (t=0) × Smoking Household	0.021*** (0.007)	0.022*** (0.007)	0.021*** (0.007)
State Cigarette Tax (t=-1) × Smoking Household	0.006 (0.004)	0.006 (0.004)	0.006 (0.004)
State Cigarette Tax (t=-2) × Smoking Household	0.004 (0.007)	0.004 (0.007)	0.004 (0.007)
State Cigarette Tax (t=-3) × Smoking Household	-0.001 (0.007)	0.001 (0.007)	0.000 (0.007)
Cumulative Interaction Effect	0.030*** (0.008)	0.033*** (0.009)	0.032*** (0.009)
Cumulative Main Effect State Cigarette Taxes	-0.007** (0.003)	-0.009*** (0.003)	-0.008* (0.004)
Mean Smoking Households	0.247	0.247	0.247
<b>Covariates</b>			
Month FE	yes	yes	yes
Year FE	yes	yes	yes
Month × Year FE	yes	yes	yes
State FE	yes	no	no
State FE × Smoking Household	yes	yes	yes
Unemployment Rate	yes	yes	yes
Regional Food Prices	yes	yes	yes
State Time Trend	yes	no	yes
Socio-Demographics	yes	no	no
Household FE	no	yes	yes
Household-Month Observations	285,685	285,685	285,685
Unique Households	26,989	26,989	26,989

*Source:* CPS, FSS merged with TUS. \* p<0.1, \*\* p<0.05, \*\*\* p<0.01; standard errors are in parentheses and clustered at the state level. Regressions are based on a monthly panel of household food stamp enrollment from the FSS. Each column represents one regression as in Equation (1), where the binary dependent variable indicates food enrollment in calendar month t=0. The specifications include a full set of contemporaneous and lagged monthly tax effects, in levels and interactions with household smoking status. The four interaction terms, the cumulative interaction effect, and the cumulative main effect are displayed. The four main tax effects in levels are included but not displayed due to space constraints.

**Table 6: Duration Analysis for State Cigarette Taxes and Food Stamp Take Up**

	<i>Nonsmoking Households</i> (1)	<i>Smoking Households</i> (2)
State Cigarette Taxes	0.157 (0.186)	0.383*** (0.136)
<b>Covariates</b>		
Month FE	yes	yes
Year FE	yes	yes
Month × Year FE	yes	yes
Unemployment Rate	yes	yes
Regional Food Prices	yes	yes
State Time Trend	yes	yes
Socio-Demographics	yes	yes
Household-Month Observations	156,266	55,550
Unique Households	16,625	6,072

*Source:* CPS, FSS merged with TUS. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; standard errors are in parentheses and clustered at the state level. Regressions are based on a monthly panel of household food stamp enrollment from the FSS. The results are from a duration analysis estimated by a Cox Proportional Hazard Model, separately for non-smoking and smoking households. The sample (i) is limited to households who are initially not participating in food stamps in the first month in which we observe them, and (ii) only includes households until the month they take-up food stamps or fall out of the sample (censored).



Table 7: State Cigarette Taxes and Other Outcome Margins: CPS Cross Section

	<i>HH Member Quit Smoking</i> (1)	<i>Cigarettes Per Day</i> (2)	<i>Ran Out of Money for Food</i> (3)
State Cigarette Taxes × Smoking Household	0.005** (0.002)	-2.24*** (0.405)	0.005 (0.009)
State Cigarette Taxes	0.004 (0.003)	0.40*** (0.138)	0.014 (0.011)
Smoking Household	-0.021*** (0.003)	16.41*** (0.551)	0.122*** (0.012)
Mean Smoking Households	0.368	14.57	0.500
<b>Covariates</b>			
Month FE	yes	yes	yes
Year FE	yes	yes	yes
Month×Year FE	yes	yes	yes
State FE	yes	yes	yes
State FE× Smoking Household	yes	yes	yes
Unemployment Rate	yes	yes	yes
Regional Food Prices	yes	yes	yes
State Time Trend	yes	yes	yes
Observations	26,729	26,729	26,729

*Source:* CPS, FSS merged with TUS. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; standard errors are in parentheses and clustered at the state level. Each column represents one regression as in Equation (1). *State Cigarette Taxes* indicates the state cigarette tax level in the previous month.

**Table 8: Summary of Findings**

<i>Effect of \$1 Increase in State Cigarette Taxes</i>	
Δ Equilibrium retail prices (mean \$4.41)	\$0.80*** (Table 3, Column 2)
Δ Quarterly Cigarette Expenditures (mean \$392)	\$30.4* (Table 3, Column 4)
Δ Food Stamp Enrollment	
- Non-smoking households (baseline 0.141)	-0.008* (Table 5, Column 3)
- Smoking households (baseline 0.247)	0.032*** (Table 5, Column 3)
Δ Months until Food Stamp Take-up	
- Non-smoking households	0.157 (Table 6, Column 1)
- Smoking households	0.383*** (Table 6, Column 2)
<i>Notes: * p&lt;0.1, ** p&lt;0.05, *** p&lt;0.01.</i>	

# Appendix

## Figure A1: Food Price and Cigarette Price Inflation

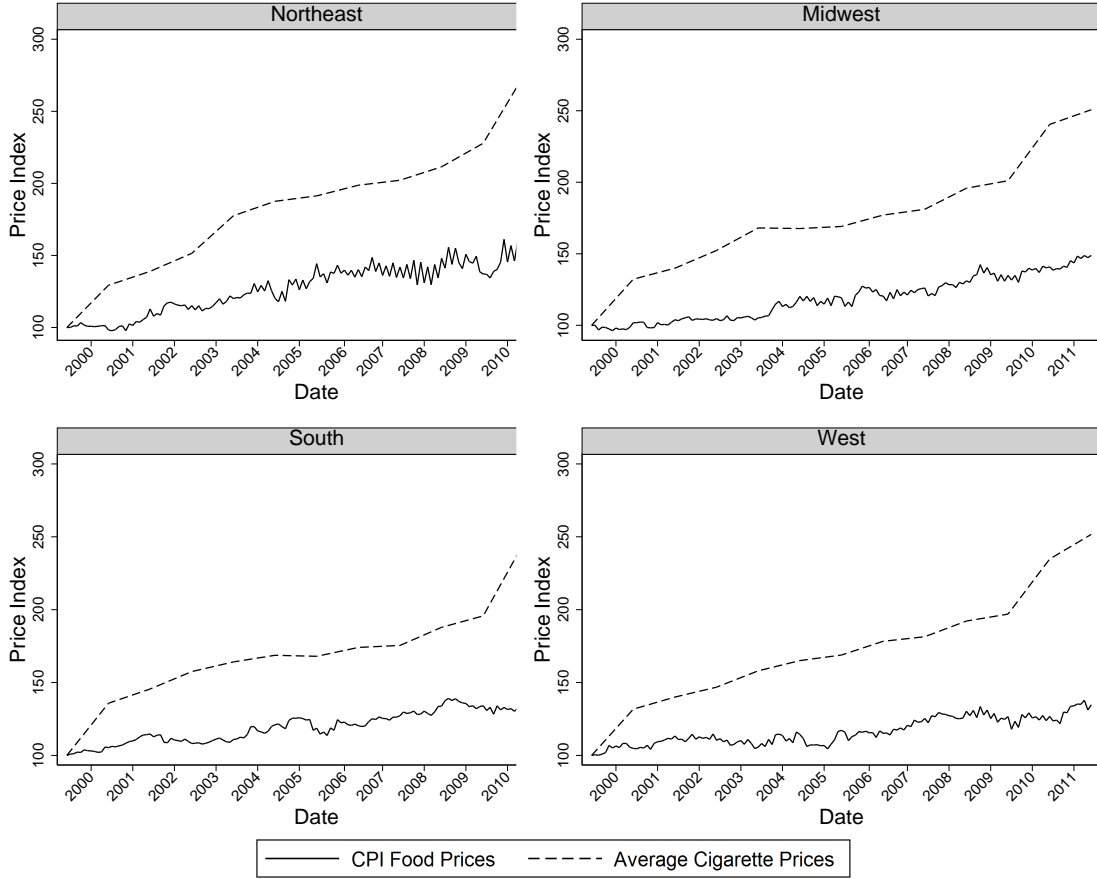


Figure A2: State Cigarette Taxes and Proportion of Smokers Enrolled in Food Stamps (CPS)

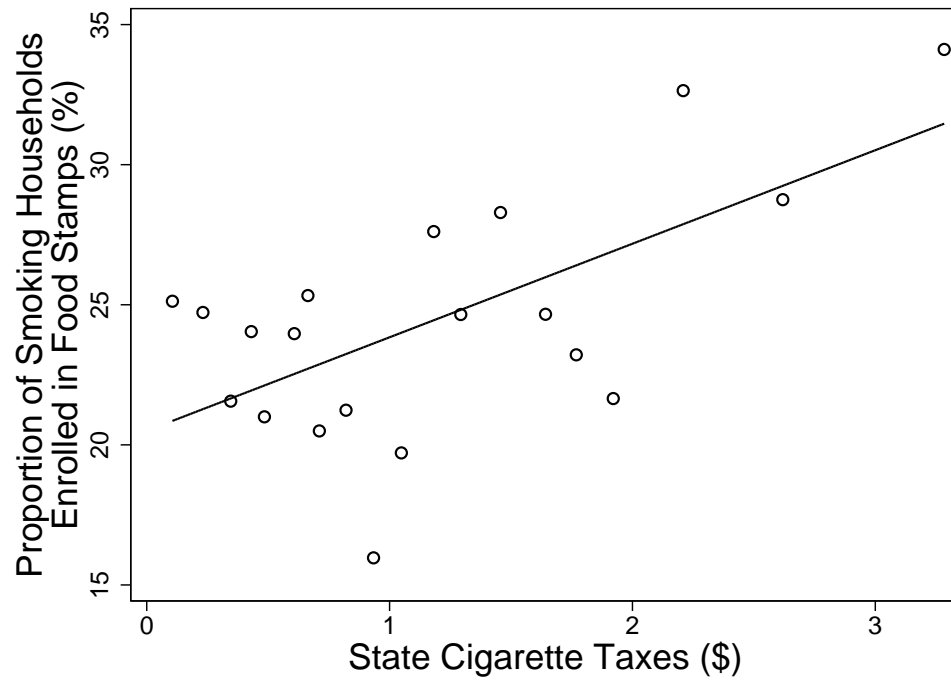
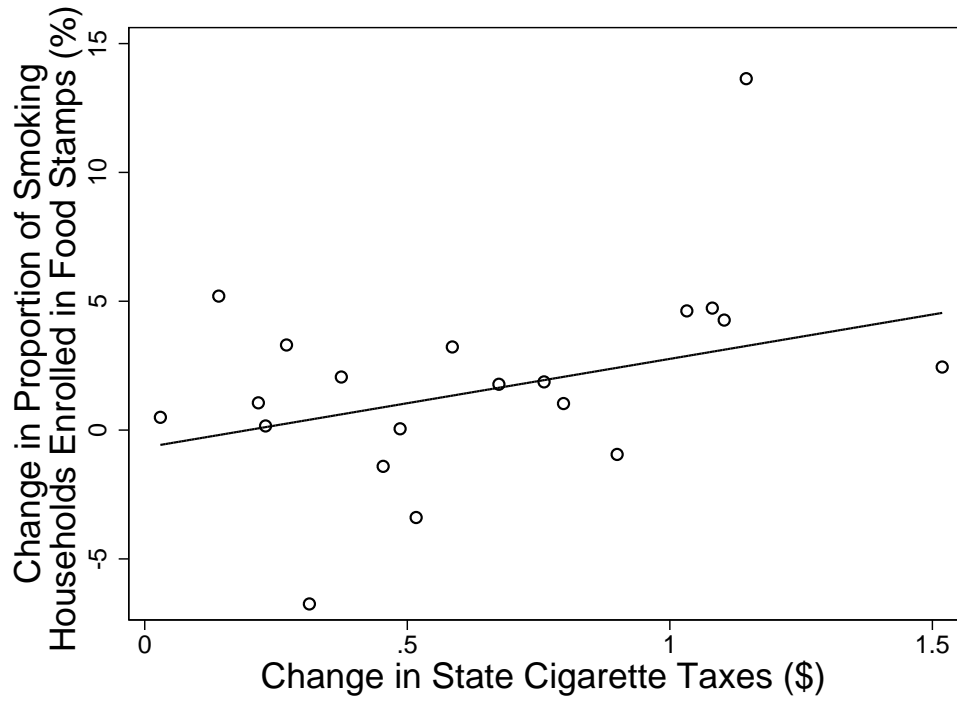


Figure A3: Yearly Change in State Cigarette Taxes and Share of Smokers on Food Stamps (CEX)



**Table A1: CPS FSS-TUS Pseudo-Panel Observations Over Years and Months**

Variable	Frequency	Percent	Cum.
Feb 2003	7,578	2.65	2.65
Mar 2003	8,252	2.89	5.54
April 2003	8,252	2.89	8.43
May 2003	8,252	2.89	11.32
June 2003	8,252	2.89	14.21
July 2003	8,252	2.89	17.10
Aug 2003	8,252	2.89	19.98
Sept 2003	8,252	2.89	22.87
Oct 2003	8,252	2.89	25.76
Nov 2003	8,252	2.89	28.65
Feb 2006	7,817	2.74	31.39
March 2006	8,887	3.11	34.50
April 2006	8,887	3.11	37.61
May 2006	8,887	3.11	40.72
June 2006	8,887	3.11	43.83
July 2006	8,887	3.11	46.94
Aug 2006	8,887	3.11	50.05
Sep 2006	8,887	3.11	53.16
Oct 2006	8,887	3.11	56.27
Nov 2006	8,887	3.11	59.38
Dec 2006	8,887	3.11	62.49
Feb 2010	8,652	3.03	65.52
March 2010	9,850	3.45	68.97
April 2010	9,850	3.45	72.42
May 2010	9,850	3.45	75.87
June 2010	9,850	3.45	79.31
July 2010	9,850	3.45	82.76
Aug 2010	9,850	3.45	86.21
Sep 2010	9,850	3.45	89.66
Oct 2010	9,850	3.45	93.10
Nov 2010	9,850	3.45	96.55
Dec 2010	9,850	3.45	100.00
Total	285,685	100.00	

**Table A2: CEX Cross-Sectional Observations Over Years and Months**

<b>Variable</b>	<b>Frequency</b>	<b>Percent</b>		<b>Frequency</b>	<b>Percent</b>
2001	2,592	10.48	Jan	2,057	8.32
2002	2,829	11.44	Feb	2,082	8.42
2003	2,937	11.88	Mar	2,091	8.46
2006	2,527	10.22	Apr	2,011	8.13
2007	2,248	9.09	May	2,148	8.69
2008	2,248	9.09	June	1,999	8.08
2009	2,304	9.32	July	1,990	8.05
2010	2,401	9.71	Aug	2,003	8.10
2011	2,346	9.49	Sept	2,143	8.67
2012	2,297	9.29	Oct	2,132	8.62
			Nov	2,033	8.22
			Dec	2,040	8.25
Total	24,729	100.00		24,729	100.00

**Table A3: First Differences—Change in State Cigarette Taxes and Change in Food Stamp Enrollment**

	$\Delta$ Food Stamp Enrollment		
	(1)	(2)	(3)
$\Delta$ State Cigarette Taxes (t=0,t=-1) $\times$ Smoking Household	0.009* (0.005)	0.010** (0.005)	0.010** (0.005)
$\Delta$ State Cigarette Taxes (t=-1,t=-2) $\times$ Smoking Household	0.006** (0.003)	0.008** (0.004)	0.008** (0.004)
$\Delta$ State Cigarette Taxes (t=-2,t=-3) $\times$ Smoking Household	0.004 (0.007)	0.005 (0.008)	0.005 (0.008)
Cumulative Interaction Effect	0.019** (0.009)	0.024* (0.012)	0.024* (0.012)
Cumulative Main Effect $\Delta$ State Cigarette Taxes	-0.004** (0.002)	-0.007*** (0.003)	-0.007*** (0.003)
Mean Smoking Households	0.247	0.247	0.247
<b>Covariates</b>			
Month FE	yes	yes	yes
Year FE	yes	yes	yes
Month $\times$ Year FE	yes	yes	yes
State FE	yes	no	no
State FE $\times$ Smoking Household	yes	yes	yes
Change in Unemployment Rate	yes	yes	yes
Change in Regional Food Prices	yes	yes	yes
State Time Trend	yes	no	yes
Socio-Demographics	yes	no	no
Household FE	no	yes	yes
Household-Month Observations	258,696	258,696	258,696
Unique Households	26,989	26,989	26,989

*Source:* CPS, FSS merged with TUS. \* p<0.1, \*\* p<0.05, \*\*\* p<0.01; standard errors are in parentheses and clustered at the state level. Regressions are based on a monthly panel of household food stamp enrollment from the FSS. Each column represents one first differenced variant of Equation (1), where the binary dependent variable indicates whether the household transitioned onto food stamps between months t=-1 and t=0. The specifications include a full set of contemporaneous and lagged changes in monthly taxes. The three interaction terms, the cumulative interaction effect, and the cumulative main effect are displayed. The three main effects on changes in taxes are included but not displayed due to space constraints.