The Heterogeneous Geographic and Socioeconomic Incidence of Cigarette Taxes: Evidence from Nielsen Homescan Data*

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July 2010

Abstract

This paper uses Nielsen Homescan data at the Universal Product Code-transaction level to identify how cigarette taxes are passed through to consumer prices in order to determine how the supply and demand-side split the excess burden of taxation. We find that these excise taxes are less than fully passed through to consumer prices. Using information on consumer location and the location of purchases, we show that the availability of lower-tax goods across uncontrolled borders creates significant differences in how consumer prices are affected by excise taxes. Close to lower-tax borders, about half of the cigarette tax is passed on to consumers through higher prices. Far from these borders, however, consumer prices are much more responsive to excise taxes. We also demonstrate that tax evasion opportunities have a sizable effect on purchasing behavior by altering consumer search, prices paid and quantities purchased. With the household demographic information contained in our data, we show that the incidence of cigarette taxes and the border effect varies across household income groups and race. These findings have important consequences for the distribution of the excess burden of cigarette taxes and thus for the social welfare costs and benefits of these taxes.

KEYWORDS: Cigarette Taxes, Excise Taxes, Tax Incidence, Tax Evasion, Consumer Search
JEL CLASSIFICATION: H22, H26, H71, H73, I18, D12, R28

*We would like to thank Adam Cole, Jerry Hausman, Don Kenkel, David Agrawal and Shirlee Lichtman as well as participants at the American Tax Association Mid-year Meeting, the IFS Workshop on the Econometric Analysis of Scanner Data and the Michigan Tax Invitational (MTax-I) for helpful comments and suggestions. We also are grateful to Stephen Schwarz for excellent research assistance.

†The views expressed herein are those of the authors and do not necessarily reflect the views of the U.S. Department of Agriculture.

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1 Introduction

Sin taxes, and in particular taxes on cigarettes, are increasingly popular in the United States due to their revenue-generating potential and their potential benefits for public health. In 2008, the average state-level cigarette tax was $1.10 per pack and ranged from $0.07 in South Carolina to $2.58 in New Jersey. Large cross-state tax differences also exist in certain regions: the per-pack excise tax difference in January 2008 between Washington, DC and Virginia was $0.70, it was $1.01 between Michigan and Indiana, it was $0.43 between Massachusetts and New Hampshire, and it was $0.81 between Missouri and Illinois. Gross state cigarette excise tax receipts topped $15.6 billion in 2008.

Given the pervasive nature of these taxes and states' increasing reliance on them to close rising budget deficits, a question of central policy importance is who bears the economic burden of cigarette taxes. The incidence of a tax is a critical component in assessing its social welfare implications; the distribution of the tax burden across different agents in the economy can change the net welfare gain or loss from taxation significantly.[1] Is the burden of these taxes "passed forward" to consumers or is it "passed backward" to suppliers (and thus onto the factors of production)? The incidence of state cigarette taxes is of particular interest because of the evasion opportunities supplied by large cross-state tax differences.[2] The ability to subvert local laws by driving to another state to purchase cigarettes may change how the burden of taxation is split between the supply and demand side of the market. Furthermore, the incidence of these taxes may differ depending on the socioeconomic status of households.

Our research examines the incidence of cigarette taxes by estimating the degree to which excise taxes are passed through to consumer prices. We make several

[1] See Fullerton and Metcalf (2002) for a detailed discussion of tax incidence.

[2] Lovenheim (2008), Stehr (2005), Goolsbee, Lovenheim and Slemrod (2010) and Merriman (Forthcoming) show evidence of large-scale cross-state tax evasion among cigarette consumers. Stehr (2007) and Beard, Gant and Saba (1995) show similar tax evasion activity exists for alcohol. Lovenheim and Slemrod (2010) and Baughman et al. (2001) further demonstrate the existence of cross-state evasion of alcohol access restrictions.

contributions to the literature. First, we employ a unique and detailed data set, the Nielsen Homescan data. These data contain household purchases at the Universal Product Code (UPC) level from 2006 through 2007. They are linked to the store at which the purchase was made, and each consumer's Census tract is known along with her demographic characteristics. These data offer a level of detail in the types of products purchased, the location of purchase, and information on purchasers that has not been used in the cigarette incidence literature to date. Most of the previous literature has used aggregate data or has studied micro-data on a small subset of individual products in a small number of states. This is the first analysis to use a nationally-representative panel of consumers with complete product-level data to analyze the response of consumer prices to taxes.

Second, because we observe the zip code of the purchasing store and the Census tract of the purchasing consumer, we are able to analyze how tax shifting behavior changes relative to the distance of the consumer to lower-tax borders and the distance of the stores in which they shop to lower-tax borders. The difference between these estimates will allow us to disentangle how actual store-level prices are affected by excise taxes and how equilibrium prices consumers pay that take into account endogenous search behavior are affected by excise taxes. These unique data also allow us to describe how cross-border purchasing responds to tax differences and evasion opportunities as well as to estimate the effect of tax evasion on prices paid and quantity purchased. Finally, we assess whether prices paid by consumers respond differently to taxes across the socioeconomic spectrum.

Contrary to much of the literature on cigarette tax incidence, we find taxes are less than fully passed through to consumer prices on average. A 1 cent increase in taxes leads to a 0.85 cent increase in prices. This result suggests the economic burden of state cigarette excise taxes is somewhat split between the consumption and production sides of the market, though consumers bear more of the burden. Furthermore, we find consumers quality upgrade when cigarette taxes increase, which

underscores the importance of using a comprehensive set of product-level data to identify the incidence of cigarette taxes.

The average effects mask considerable heterogeneity across the geographic and socioeconomic spectrum. On the border with a lower-tax state, a 1 cent increase in cigarette taxes leads to a price increase of only 0.51 cents and is 0.07 cents larger for every 1 percent increase in distance from that state. These estimates are suggestive of a large amount of geographic heterogeneity in how consumer prices respond to cigarette taxation, which ostensibly is driven by the opportunities for cross-state evasion. We also find that measuring distance from stores rather than from consumers' home Census tracts leads to a smaller estimate of the effect of distance on the pass-through rate, which is consistent with a reduced response of consumer search to tax changes farther from lower-tax borders.

We further find differences in the tax pass-through by consumer family income and race. The effect of taxes on consumer prices is non-linear across the income distribution, with middle income families experiencing almost full pass-through and families with higher and lower income experiencing less than full pass-through. Cigarette prices paid by Hispanic and White consumers increase by about 0.9 cents for every 1 cent increase in excise taxes, while African American consumers' prices only increase by 0.68 cents for every 1 cent increase in taxes.

Our finding of large amounts of geographic and socioeconomic heterogeneity in the price response to cigarette excise taxes suggests it is not simple to characterize who bears the economic burden of these taxes. Though we find clear evidence it is split between consumers and the factors of production, the size of this split varies significantly by consumer tax evasion opportunities as well as by the socioeconomic background of the consumer. The specific mechanisms driving these differences deserve more attention in future work.

The rest of this paper is organized as follows: Section 2 describes the previous literature on price response to excise taxes, and Section 3 contains a detailed descrip-

tion of our data and empirical methodology. Empirical results are shown in Section 4, and Section 5 concludes.

2 Previous Literature

The modern study of tax incidence dates back to Harberger (1962), who shows that the incidence of a given tax is a function of the relative supply and demand elasticities. These relative elasticities describe how much of the deadweight loss from a tax can be attributed to reduced consumer surplus and reduced producer surplus. The degree to which excise taxes are passed through to consumer prices is directly related to the relative size of these elasticities and thus provides a succinct characterization of the incidence of a tax.

While there is a large literature examining the public health benefits of cigarette taxation, there is a much smaller literature that attempts to estimate the responsiveness of consumer prices to these excise taxes.[3] One the one hand, this lack of prior research is surprising, because not only is the relationship between prices and taxes important in the assessment of tax incidence, but it also has direct public health implications; if consumer prices do not respond to taxes, one should not expect consumer behavior to be affected by these taxes either. However, data constraints have made it difficult to credibly identify the incidence of cigarette excise taxes.

Keeler et. al. (1996) use a state-level panel of cigarette taxes and prices from 1960 to 1990 and estimate state-level taxes are more than fully passed on to consumers by between 3% and 26%. Their use of aggregate prices is potentially problematic, however, since consumers may respond to a per-unit tax by purchasing higher quality items.[4]

[3] In addition to the previous literature examining the incidence of cigarette excise taxes, Poterba (1996) finds that clothing prices rise approximately one-for-one with state and local retail sales taxes. Besley and Rosen (1999) examine the effect of sales taxes on several goods and finds overshifting for over half the goods and full shifting of taxes onto consumer prices for the other goods. The available literature on alcohol tax incidence also suggests consumer prices respond more than fully to excise tax changes (Kenkel, 2005; Young and Bielinska-Kwapisz, 2002).

[4] For a given per-unit change in taxes, higher quality goods will increase by a smaller percentage than will lower-quality goods. An increase in a per-unit tax thus could cause individuals to alter their consumption bundle and purchase more expensive products. In the aggregate data, it will appear there is over-shifting while in reality at least

Hanson and Sullivan (2009) study the effect of a $1 increase in cigarette taxes in Wisconsin in 2008 on cigarette prices. They conduct a telephone survey of cigarette retailers in Wisconsin and surrounding states to collect information on the price of one un-named generic and one un-named name brand cigarette pack. The paper estimates difference-in-difference models and finds a 1 cent increase in excise taxes increases prices by between 1.13 and 1.18 cents. Though an advancement over previous work, the focus on one state and one product makes it hard to generalize the conclusions to a more national sample of consumers and purchases. In addition, by using store-level data, Hanson and Sullivan are unable to control for demographic characteristics of consumers that might affect the pass-through of taxes to prices.

DeCicca, Feng and Liu (2010) use consumer-reported prices from the 2003 and 2006-2007 Current Population Survey Tobacco Use Supplements to estimate the pass-through of excise taxes to consumer prices. They find a pass-through of about 1 and show that this rate does not vary by the intensity with which the consumer smokes. This finding suggests consumer search behavior may be a small part of the consumer burden of excise taxes, as those with more to gain by searching (i.e., heavy smokers) are equally affected by taxes as those with less to gain from search.

Finally, Chiou and Muehlegger (2010) use store-level scanner data from the Dominicks retail chain in the Chicago Metropolitan Area on Lorriard, Liggett and R.J. Reynolds brand cigarettes. They estimate a tax pass-through rate just under 1 that varies across packs and cartons as well as across premium and discount cigarettes. There also is evidence of lower pass-through rates for stores closer to the Indiana border, in particular for premium cartons. Due to the use of store-level data, Chiou and Muehlegger are unable to observe consumer characteristics and do not know where consumers live. Our analysis focuses on estimating how taxes affect consumer prices using a nationally-representative set of consumers whose UPC-level purchases are matched to the store at which each transaction takes place. With our unique data,

part of this shift is due to a change in the consumption bundle.

we will be able to more directly identify changes in individual search behavior due to tax changes as well as explore how cigarette tax incidence varies across different types of consumers.

3 Data and Estimation Strategy

3.1 Data

3.1.1 Nielsen Homescan Data

We use the 2006-2007 Nielsen Homescan panel data covering a total of 160,969 transactions.[5] The aim of the dataset is to provide marketing intelligence to retailers by constructing a nationally-representative panel of consumer purchases. Recruitment into the panel is ongoing, and interested consumers register on the Nielsen website, after which they are placed on a waiting list. Periodically, consumers over the age of 18 are added to the panel with the explicit aim to maintain a nationally-representative panel, or a "mini-USA" as Nielsen promotional materials emphasize.

Once enrolled, households are provided with a scanner and are required to scan all items following a purchase. The scanner scans the barcode of the product and records the Universal Product Code (UPC) for each product. Households are additionally told to record further information such as the price and quantity for that particular purchase as well as details on whether the item was purchased as part of a specific promotion or whether the household used coupons for the purchase. At the end of the week, households connect the scanner to a computer or telephone and the data are transmitted to Nielsen. Participating households are not paid for their participation, however they earn a set number of points with each data upload. Households are rewarded the longer they stay with the program, and those who already have been

[5]The use of scanner data provides important advantages over more aggregate measures and consequently, there has been a notable increase in the popularity of these data in recent economic studies. Aguiar and Hurst (2007) and Harding and Lovenheim (2010) use these data to study consumer search behavior; Hausman and Leibtag (2005) use them to study the impact of Walmart on retailer competition; Burda, Harding and Hausman (2008, 2009) estimate latent consumer preferences with these data and show clustering in the way consumers trade-off between product attributes; Broda, Leibtag and Weinstein (2009) use Nielsen scanner data to measure inequality in consumption; and Cole (2009) examines the effect of sales tax holidays on computer sales using retail scanner data.

in the panel for at least six months receive a substantially larger number of points for each transmission. The points can be redeemed in exchange for products similar to the way credit card points can be exchanged for merchandize in an online store. Furthermore, households are entered into prize draws for special gifts every month. For the purpose of this analysis, it is important to emphasize that participating households have a strong incentive to upload their purchase data to Nielsen.

Despite these incentives, it could be the case that consumers are less likely to record small, frequent purchases, such as cigarettes at gas stations and convenience stores, and are more likely to record purchases from large shopping trips.[6] If tax changes alter consumer purchasing behavior in a manner that makes consumers more or less likely to record their cigarette purchases, our estimates of the tax pass through could be biased in either direction. In order to gain insight into the existence and extent of this problem, we collapse the data to the household-week level and examine the probability of purchasing in a given week as a function of state excise taxes. Table 1 contains results from our analysis of how the extensive margin is affected by tax changes. In the first two columns, we show the mean probability of purchasing before and after the tax change in the 12 states in our data that raise their excise tax between 2006 and 2007 (see Section 4 for a list of these states). The drop in purchasing implies an extensive margin elasticity of -0.062. In the third column, we use the sample of all states and estimate an OLS regression of the probability of purchasing in each week as a function of log excise taxes as well as state and week-of-purchase fixed effects. The implied elasticity is -0.073. This elasticity is a combination of quitting behavior due to the tax change and potential altered purchasing/reporting behavior. Lovenheim (2008) obtains extensive margin elasticities of between -0.06 and -0.21 using the CPS Tobacco Supplements and Chiou and Muehlegger (2008) find a price elasticity of demand of about -0.2 on the extensive margin using similar data. Chaloupka and

[6]Illegal purchases of cigarettes through organized smuggling operations, which typically involve transporting large quantities of cigarettes from one of the tobacco producing states for illegal resale in another state, are unlikely to be recorded by survey participants as these purchases do not occur in a store. Organized smuggling became a federal crime in 1978 with the Contraband Cigarette Act and was followed by a marked decrease in interstate bootlegging (ACIR, 1985), so this type of behavior is unlikely to be large enough to significantly influence our results.

Warner (2000) report extensive margin elasticities in this range as well for adults in their review of the literature. That the extensive margin in our panel is similarly responsive to taxes as in other data that do not have the same reporting structure as the Nielsen data suggests there is little systematic change in reporting behavior surrounding tax changes in our data. All of the reduction in purchasing probability can be accounted for by reduced smoking participation.

The mean frequency of cigarette purchases per household is 1.5, meaning the average household that ever purchases in our sample engages in 1.5 transactions a week. Furthermore, 19% of households make more than 2 purchases per week and 5% of households make more than 5 purchases per week. Conditional on making any cigarette purchases in a week, the average household engages in 2.4 transactions. This is *prima facia* evidence that households report transactions in addition to their main weekly shopping trip. In Table 1, we estimate that excise taxes have no relationship with the frequency of purchases. This lack of an effect of excise taxes on purchase frequency is further evidence against tax changes inducing measurement error, because if individuals only reported their main shopping trip of the week, a tax change that induced a change in cigarette purchasing patterns also would affect the reported purchase frequency. We find no evidence that our sample is altered by tax changes in this manner.

In order to minimize the effort it takes consumers to enter the data, Nielsen does not require households to record the price of purchases made at certain stores. Instead, Nielsen will "impute" the price based on store records for the given week. Typically, this procedure is sound since store prices are unlikely to change too frequently. However, the possibility exists that prices are not recorded correctly if the "Nielsen week" fails to overlap fully with the "store week" or if special prices are offered to loyalty card members in some weeks that are not recorded by Nielsen. The extent to which this practice introduces measurement error has been documented recently by Einav, Leibtag and Nevo (2010) by matching data from Nielsen with data

provided by a large retailer. Because such measurement error likely is uncorrelated with excise taxes, it should not cause a bias in our estimates.[7]

A major advantage of the Nielsen data is that consumption is monitored at the UPC level, which allows Nielsen to include product characteristics for each purchase in the dataset. Furthermore, the store at which each purchase is made is identified in the data by name, type and zip code. The Nielsen data cover a whole range of retailers such as super-centers (e.g., Walmart) and grocery stores (e.g., Safeway) but also club stores selling in bulk (e.g., Costco), convenience stores (e.g., Seven Eleven) and drug-stores (e.g., Walgreens).

For each household, Nielsen records a wealth of socio-economic characteristics as well as the main place of residence. Means of these characteristics are presented in Table 2. The table illustrates that cigarette purchases typically are made by smaller households, with 22% of the purchases made by single-member households. The majority of the household heads are over 40 years old, white, high-school graduates, possibly with some college education and in full-time employment. Note however, that close to 30% of the panel participants are not employed.[8] Overall, these demographic characteristics among cigarette purchasers tracks those measured using other data sets, such as the Behavioral Risk Factor Surveillance System (BRFSS) and the National Health and Nutrition Examination Survey (NHANES).

3.1.2 Measuring Distance

Distance between consumers or stores and lower-tax borders is calculated similarly as in Lovenheim (2008) for cigarette taxes and Lovenheim and Slemrod (2010) for minimum legal drinking ages. For each consumer, the data contain the Census tract of residence. For each purchase, we match this tract with the closest lower-tax

[7] We will use prices as our dependent variables. Because classical measurement error in the dependent variable does not produce a bias in OLS estimates, it is a small concern in this study.

[8] Those not employed are either unemployed or not in the labor force. While Table 2 shows a substantial proportion of our sample does not work, these large percentages are consistent with other data sets. For example, in the 2001 Current Population Survey Tobacco Use Supplement, 25.2% of male smokers are not employed and 34.9% of female smokers are not employed.

locality.[9] Using the latitude and longitude of the centroid of the Census tract,[10] we calculate the minimum crow-flies distance from each tract to a road crossing into the lower-tax state that we find using the Census Major Road Tiger Files and GIS software. Note that the lower-tax state often is, but does not need to be, a border state. Once each Census tract and purchase date is matched to the closest lower-tax state, we then calculate the tax difference from purchasing in this state relative to one's home state.

The calculation of the distance between stores and lower-tax border states proceeds similarly. Instead of using the geographic centroid of the Census tract, we use the geographic centroid of the zip code in which the store is located.[11] Because zip codes are relatively small geographically, particularly in metropolitan areas, using the geographic center rather than the population center likely has little effect on our distance estimates but reduces our computational burden dramatically. We calculate the crow-flies distance from the store's zip code centroid to the closest road crossing of the closest lower-tax state. The difference between the tax in the store's home state and the tax in the closest lower-tax state is the tax difference when we use stores as our unit of analysis.

Table 2 presents means of distances and tax differences. On average, consumers live rather far from lower-tax borders, but the large averages are driven by some consumers who live very far away. The median distance is 81.5 miles. In addition, 17.4 percent of cigarette consumers live within 25 miles of a lower-tax border and 6.6 percent live within 10 miles of a lower-tax border. Thus, a significant fraction

[9] Throughout this analysis, we exclude sales taxes. We exclude these taxes because there is no within-state variation in sales taxes over the period of our sample, and the state fixed effects we use in our econometric models therefore control for these fixed differences across states. Furthermore, because these taxes are *ad valorem*, it is difficult to calculate the sales tax savings across states as it is endogenous to the product purchased. Cross-state variation in sales taxes typically is small, particularly in comparison to cigarette excise taxes, so their exclusion is unlikely to affect our estimates.

[10] In Lovenheim (2008) and Lovenheim and Slemrod (2010), population-weighted minimum distances are calculated by calculating the distance from each Census block point in the MSA or county to the closest relevant border crossing and then taking the block-point population averages of these distances. Because MSAs and counties are much larger than Census tracts, using the geographic centroid rather than the population-weighted centroid will have negligible effects on the distance calculation for this application.

[11] We do not have store addresses in the data, so we are unable to ascertain at which store in the zip code a consumer shops.

of the populace lives relatively close to a lower-tax border, and as Table 2 shows the tax savings across these borders are non-trivial. On average, the cigarette tax difference is 38.51 cents, which is 11.1% of the average retail price and 44.1% of the average cigarette excise tax. Within 50 miles of the border, consumers face larger tax differences of 48.39 cents on average. We will examine empirically below whether these sizeable tax differences across uncontrolled borders affect how consumer prices react to cigarette excise taxes.

3.2 Estimation Strategy

Our baseline econometric strategy is to estimate transaction-level regressions of prices on excise taxes of the following form:

$$P_{uijt} = \beta_0 + \beta_1 \tau_{jt} + \theta X_i + \delta_j + \psi_t + \alpha_u + \epsilon_{uijt}, \tag{1}$$

where P_{uijt} is price per pack paid for UPC u by household i in state j on day t. The variable τ is the per-pack state excise tax and X is a vector of household demographic characteristics described in Section 3.1.1. We also include in most models day-of-purchase fixed effects and state fixed effects.

One of the major benefits of our data is that we observe the UPC code of each product purchased. These codes provide extremely fine product descriptions for each good.[12] The UPC codes allow us to include UPC fixed effects in equation (1), α_u, which control for the potential for consumers to change their purchasing bundle of cigarettes when excise taxes increase. Because these excise taxes are per-unit, a given tax will increase the price of higher quality goods (and thus higher price goods) by relatively less than low quality goods. If product quality enters into consumer utility, the substitution effect implies consumers will upgrade the quality of cigarettes when excise taxes increase. However, the income effect implies the opposite, so what

[12]For example, Marlboro and Marlboro Light packs would have separate UPC codes, and cartons of each also would have separate UPC codes.

happens to the bundle of goods purchased when excise taxes increase is an empirical question. Our use of UPC fixed effects allows us to abstract from this change in product quality by examining within-UPC changes in prices when taxes increase.

The state fixed effects control for the fact that some states may have systematically higher prices due to some unobservable factor that may also be correlated with tax levels, such as state anti-smoking sentiment. The state fixed effects identify β_1, which is the coefficient of interest in equation (1), off of changes in prices in the 12 states that increase their cigarette excise taxes in 2006 and 2007: New Jersey, North Carolina, Vermont, Arizona, South Dakota, Texas, Iowa, Colorado, Indiana, Connecticut, New Hampshire and Delaware. These states are representative of the United States and are not clustered in any specific region of the country, which supports the generalizability of our findings. Equation (1) is thus a within-UPC difference-in-difference model, such that β_1 is identified by comparing the change in prices within each UPC among states that increase their taxes relative to those that do not, holding household demographic characteristics constant.

A critical factor in employing a difference-in-difference methodology in this setting is that purchase date must be exogenous. This assumption may be violated if tax change dates are known and consumers stockpile cigarettes prior to the tax change (Chiou and Muehlegger, 2010). If more or less price-responsive consumers stockpile, it could bias our estimate of β_1. Figure 1 contains event study estimates of consumer prices surrounding tax changes that allow us to examine the dynamics of tax pass-through surrounding tax changes. In Panel A, we control for UPC and state fixed effects and include dummy variables for weeks relative to a tax change, examining 10 weeks prior and 10 weeks post-tax change. Each point in the figure represents a coefficient from these relative time dummy variables, with the bounds of the 95% confidence interval given by the bars extending from each point. Because all states are included in these models, all relative time coefficients show prices relative to prices paid in non-changing states and to prices paid in states that change their

excise tax in time periods more than 10 weeks to or since a tax change.

Panel A shows no evidence of differential pre-tax-change price trends. Furthermore, when excise taxes change, prices respond within one week and remain stable thereafter. Panel B, which includes purchase data fixed effects, shows identical trends surrounding tax changes. If stockpiling behavior were biasing our estimates, we would observe different price dynamics in the weeks just prior to and just after a tax increase. No such difference is evident in Figure 1. If stockpiling behavior is occurring, it does not appear to influence within-UPC price adjustments to excise taxes. As a further robustness check, Appendix Table A-1 presents tax pass-through estimates that exclude the 5 weeks surrounding each tax change. The results and conclusions from this table are virtually identical to those presented below, which provides further evidence that our estimates are not being confounded by cigarette stockpiling.

In addition to estimating the average effect of excise taxes on prices, we test for heterogenous effects based on consumer and store distance to the closest lower-tax border using the following model:

$$\begin{aligned} P_{uijt} &= \beta_0 + \beta_1 \tau^h_{jt} + \beta_2 (\tau^h - \tau^b)_{jt} + \beta_3 ln(D)_{ijt} + \beta_4 (\tau^h - \tau^b)_{jt} * ln(D)_{ijt} \quad (2) \\ &\quad + \theta X_i + \delta_j + \psi_t + \alpha_u + \epsilon_{uijt}, \end{aligned}$$

where τ^h is the home state price tax, τ^b is the closest lower-tax state's tax, $(\tau^h - \tau^b)$ is the tax difference between states, D is the distance to the closest lower-tax state, and all other variables are as previously defined.

Equation (2) allows for the pass-through of taxes to prices to be a function of the tax difference between the home and closest lower-tax state, the log distance between the consumer or store and that state, and the interaction between the tax difference and log distance.[13] To better understand the parameters of interest in this model, it

[13]Another way to specify equation (2) would be to control for τ^h and τ^b separately and interact each with log distance. This method would relax the assumption that home and border state prices have equal and opposite effects on prices, holding distance constant. We find the data to be consistent with this assumption, and so we use the

is useful to consider the partial effect of a home state tax change on price paid:

$$\frac{\partial P}{\partial \tau^h} = \beta_1 + \beta_2 + \beta_4 * ln(D). \tag{3}$$

For a consumer on the border with a lower-tax state, $\frac{\partial P}{\partial \tau^h} = \beta_1 + \beta_2$, and if cross-state competition leads to consumers on the border experiencing no change in price due to the tax change, $\beta_1 = -\beta_2$. If, on the other hand, the existence of the border does not completely wipe out the economic burden of the tax increase for consumers, β_1 will be greater than β_2 in absolute value, though they still will have opposite signs.

As one moves 1 percent further from the border, $\frac{\partial P}{\partial \tau^h}$ changes by β_4. A positive value of β_4 will indicate consumers bear a relatively larger burden of the tax the farther they are from a cross-state evasion opportunity. Note that distance is logged in equation (2). Specifying the functional form for distance is complicated by the fact that the effect of distance on the pass-through of taxes to consumer prices is non-linear. Hundreds of miles from the border, a one mile increase in distance likely has little additional effect on the incidence of excise taxes, while close to the border such a change may have a large impact. A log distance function allows the effect of distance on $\frac{\partial P}{\partial \tau^h}$ to decline with distance, such that far from borders a given distance increase has a negligible effect on the pass-through rate.[14]

As equation (3) illustrates, β_2 and β_4 show whether the availability of lower-taxed goods across uncontrolled borders affect the incidence of state excise taxes on cigarettes. The parameter β_1 shows the effect of taxes on consumer prices if tax differences are zero. It should equal the estimate of β_1 from equation (1) only when border effects are small, such that the average effect does not mask heterogeneity across space.

current form of equation (2) due to its ease of interpretation. Results that relax this assumption are available from the authors upon request.

[14]Lovenheim (2008) also employs a log distance function in cigarette demand regressions that test for heterogeneous effects of home state price changes on consumption. Lovenheim and Slemrod (2010) use distance range dummies to study the effect of minimum legal drinking age evasion on traffic fatalities. Both methods allow for a non-linear effect of distance on the pass-through of taxes to prices, but using log distance imposes a stronger parametric assumption on the distance-pass-through relationship than using distance range dummies. We use log distance, however, due to its ease of interpretation - results using distance dummies are qualitatively similar and are available upon request from the authors.

The assumption underlying identification of β_2 through β_4 in equation (2) is that neither consumers nor stores make location decisions based on relative tax rate changes over time. Given that cigarettes are likely to be a small part of any retailer's sales, we believe this assumption to be valid.

We estimate equation (2) using two sets of tax difference and distance calculations. The first set is distance from each Census tract to the closest lower-tax border and the tax difference between the home state and this lower-tax border state. Using these measures, the coefficient estimates from equation (2) show how consumer location affects the incidence of cigarette taxes. We also measure distance from the zip code of the store at which a purchase is made to the closest lower-tax border from that store's zip code and the tax difference between the store's home state and the lower-tax state. These distance and tax difference measures allow us to estimate how store-level prices are influenced by taxes. These two methods will yield identical results as long as consumers do not change the types of stores at which they purchase cigarettes when taxes increase. However, consumers may react to price changes by increasing search behavior by traveling to a lower-price state, searching out local deals, or going to discount stores. In this case, consumer search will yield smaller effects of taxes on prices consumers actually pay than on prices offered at a given store, particularly over the distance distribution because cross-border purchasing is likely a large aspect of consumer search behavior. Comparing estimates using different distance and tax difference measures will give us insight into how much search behavior is influenced by excise taxes with the possibility of cross-state evasion. Because consumer search costs are part of the excess burden borne by consumers, this comparison also will be instructive as to whether our pass-through measure understates the incidence of cigarette taxes on consumers.

As equations (1) and (2) illustrate, although the unit of observation is a transaction, most of the independent variables vary at either the state or Census tract level; within Census tracts, there is little independent variation. All estimates we present

below therefore are accompanied by standard errors that are clustered at the Census tract level.[15]

4 Results

4.1 Baseline Results

Table 3 presents baseline parameter estimates from estimation of equation (1) using the Nielsen Homescan data described in Section 3.1.1. Each column of the table contains estimates from a separate regression that adds fixed effects and demographic controls sequentially across columns in order to understand how each set of controls impacts our estimates.

In column (i), we estimate bivariate regressions of prices on excise taxes. We find full shifting of taxes to consumer prices: a 1 cent increase in taxes is associated with a 0.99 cent increase in price per pack. While this estimate is different from zero at the 5% level, it is not statistically different from 1 at conventional levels. This estimate is roughly consistent with previous studies that find full to over-shifting.

In column (ii), we add state fixed effects and the estimated pass-through increases to 1.02. We then include UPC fixed effects in the model in column (iii), which as discussed in Section 2 is rare in the literature due to data unavailability. The UPC fixed effects reduce the pass-through estimate to 0.96, which still is not statistically significantly different from 1 at conventional levels. However, most studies estimate pass-through rates higher than 1, so the fact that with the UPC fixed effects we obtain a pass-through estimate less than 1 is notable.

Adding household demographic characteristics has little effect on the estimates, as shown in column (iv). This finding does not necessarily indicate that these characteristics are unrelated to the pass-through rate, but rather suggests that the UPC

[15]Because excise taxes vary by state, one might argue it is more appropriate to cluster standard errors at the state level. While this level of clustering increases the size of standard errors slightly, it does not affect the results or conclusions of the analysis. However, because there is substantial variation in prices across Census tracts, we believe it is more appropriate to cluster at the Census tract level.

and state fixed effects are sufficient to control for endogenous product selection that is correlated with taxes and household demographics. Finally, in column (v), we employ purchase date fixed effects. These fixed effects reduce the coefficient estimate dramatically, to 0.846, which is statistically different from both 0 and 1 at the 5% level. The reason adding purchase date fixed effects to the model has such a large effect on the pass-through estimate for cigarettes likely is due to the fact that there is seasonality in cigarette prices that causes a spuriously high correlation between consumer prices and state excise taxes. Since most states increase their taxes in our sample on January 1 or July 1, any price seasonality will be confounded with pass-through rates in our model without purchase date fixed effects. With these fixed effects, we therefore find a lower pass-through of taxes to prices, suggesting consumers and producers split the economic burden of cigarette excise taxes.

If we estimate equation (1) including purchase date and state fixed effects as well as demographic characteristics but excluding UPC fixed effects, we estimate a pass-through of 0.90. Why does including UPC fixed effects reduce the pass-through estimate? One potentially compelling explanation is that consumers alter their purchasing behavior when taxes increase. We explore this possibility by generating a UPC-level quality index, which is the average national price paid by consumers at the UPC level. We then estimate a regression of this price index on excise taxes, household demographic characteristics and state and purchase date fixed effects. Our results suggest consumers' purchasing behavior is affected by state excise taxes: a 1 cent increase in taxes increases the quality-level consumers pay by 0.11 cents. This estimate is significantly different from zero at the 5% level. These results are suggestive of one reason why our results differ from previous work: per-unit excise taxes cause cigarette consumers to upgrade quality. Failing to account for the altered purchasing patterns of consumers causes a bias in the estimation of the pass-through of excise prices to taxes.

4.2 Estimates Including Distance to Lower-tax Borders

Table 4 presents estimates from equation (2) using distance and tax-difference measures. In Panel A, distance and tax differences are measured from consumers' home Census tracts. Column (i) includes only state and UPC fixed effects, column (ii) adds in demographic controls, and column (iii) controls for purchase date fixed effects. Similar to the results in Table 3, purchase date fixed effects in particular reduce the baseline pass-through rate of cigarette taxes to cigarette prices. Because the estimates in column (iii) are identified under fewer assumptions than those in columns (ii) and (i), we focus on the column (iii) results throughout.

For consumers on the border, a 1 cent increase in cigarette excise taxes increases cigarette prices by 0.51 (=0.856-0.345) cents. This result is suggestive of a substantial border effect because on the border, only half of the tax increase is passed through to consumer prices despite the finding in Table 3 of an average effect of 0.85. For each 1 percent increase in distance, this pass-through rate increases by 0.07 cents.[16] At the mean of distance, which according to Table 2 is 126.51, the pass-through rate is 0.85=0.511+ln(126.51)*0.07, which is identical to the average estimate in column (iv) of Table 3. Panel A of Table 4 also shows that if there were no tax differences across borders, the pass-through would be 0.86. This result means that border differences do not affect the average burden borne by consumers, but they do alter the incidence of the excise tax by distance to lower-tax borders.

In Panel B of Table 4, we present estimates that are similar to those in Panel A but using distance and tax differences calculated from stores at which consumers purchase rather than from Census tracts. The results are qualitatively similar to those in Panel A, although the distance effect is somewhat attenuated: a 1 cent increase in taxes is associated with a 0.57 cent increase in prices on the border.

[16] Many smokers purchase their cigarettes in local smoke shops. These cigarettes mostly are generic brands with small individual market shares, and we may miss some of these purchases in our data. Table A-2 shows our estimates for cigarettes, both overall and by distance to a lower-tax border, for generic and premium cigarettes. The estimates are very similar, and since the premium brands typically are not purchased at local smoke shops, we believe it unlikely that prevalence of these stores is biasing our estimates.

This is somewhat higher than the 0.51 estimate in Panel A, suggesting that prices respond more at stores on the border than do prices paid by consumers who live on the border. Furthermore, a 1 percent increase in distance increases the pass-through by 0.057 cents, which is smaller than the distance effect in Panel A. This finding is consistent with more consumer search intensity nearer to lower-tax borders, where the returns to search are the highest. Thus, farther from the border, pass-through at the store-level increases at a slower rate than the consumer-level pass-through because the latter incorporates diminished search activity while the former does not.

That search declines with distance to the border also can be observed by examining how the likelihood of cross-state purchasing changes with home state excise tax changes by distance to lower-tax borders. We estimate equation (2) with a dummy variable equal to 1 for crossing state lines as a dependent variable in a linear probability model.[17] Column (1) of Table 5 shows the results that are scaled to be relative to the baseline likelihood of cross-state purchasing for ease of interpretation. A 1 cent excise tax increase raises the probability of a cross-state purchase by 5.56% (=(0.0018+0.0438)*100) for consumers on the border, and for each 1 percent increase in distance, this probability declines by 1.36%. As excise taxes rise, the likelihood a consumer crosses state lines to purchase cigarettes increases significantly on the border, but this likelihood declines steeply as one moves farther from cross-state evasion opportunities. These estimates are consistent with search behavior declining with consumer distance to lower-tax borders.

Another measure of consumer search costs is the frequency of cross-border purchasing. The detailed nature of our data allows us to examine such behavior, which previous work has not been able to analyze due to data limitations. Among households who make at least one cross-border purchase in a given week, 83% make all purchases in another state. About 7% of these households make 50% of their cigarette purchases across borders, and the rest of the distribution is evenly distributed be-

[17] All distances in this table refer to distance from the home Census tract.

tween 0 and 1. Thus, there is considerable heterogeneity in the within-week frequency of cross-border purchases across households. In column (ii) of Table 5, we examine how this frequency among households who purchase across borders within a given week responds to tax differences and distance to lower-tax borders. For households who already engage in a cross-border transaction, the frequency of those transactions is unresponsive to the tax difference but increases with the home state tax and increases with distance. Thus, tax increases lead to a higher frequency of tax evasion, and those who live farther from lower-price borders who engage in tax evasion across state lines make a higher proportion of their purchases in lower-tax states (although they also likely make fewer transactions).

What effect does this cross-state purchasing behavior have on the prices consumers pay and the quantities purchased per trip? These are important parameters to identify, because lower prices combined with stockpiling behavior driven by the fixed cost of evasion could lead to more smoking. To overcome the identification concern that consumers who purchase across state lines may have stronger preferences for cigarettes, we use the tax difference, log distance and the interaction of the two as instruments for cross-state purchasing. Under the assumption that these variables influence smuggling behavior (as shown in columns (i) and (ii) of Table 5) and that consumers do not make location decisions based on relative cigarette taxes, these instruments are valid. Column (iii) of Table 5 demonstrates that consumers purchasing cigarettes across state lines save almost $1 per pack, and column (iv) shows that they purchase 76.17 more cigarettes, or about 3.8 more packs, per transaction. We are unable to measure in our data whether purchasing more per transaction leads to more overall smoking, but consumers faced with higher portions tend to consume more (Wansink, 1996; Wansink and Park, 2001; Chandon and Wansink, 2002). The addictive nature of cigarettes is likely to exacerbate this tendency, which is suggestive that the increased number of cigarettes purchased by cross-border shoppers causes more cigarette consumption among these consumers. Overall, the evidence from

Table 5 indicates that the availability of lower-tax cigarettes has a sizable effect on consumer search behavior, on prices paid and on quantity purchased. These effects create significant heterogeneity in who bears the economic burden of cigarette taxes.

4.3 Results by Household Income and Race

An important distributional question surrounding cigarette excise taxes is whether and how the incidence of taxation varies across the socioeconomic spectrum. Previous analyses have not been able to examine such heterogeneous effects due to their lack of purchaser demographics. In Table 6, we present the first evidence in this literature on how the prices different income and racial groups pay are affected by excise taxes. All estimates come from models comparable to column (v) of Table 3, so they include demographic controls and state, UPC and purchase date fixed effects.

The effect of taxes on prices is non-linear across the income distribution. For low-income households, who earn less than $35,000 per year, there is a 0.82 pass-through, which rises to 0.91 for the middle-income group (making between $35,000 and $100,000 per year) and then falls to 0.76 for the high-income group (with yearly earnings over $100,000). It therefore is among the highest income families that the tax increase is passed through the least to prices, although the pass-through rate still is high. That taxes are passed through less to prices for low-income families relative to middle-income families has important distributional implications because of the relatively high prevalence of smoking among lower-income consumers (see Table 2). The lower pass-through rate for the households who consume the most serves to reduce somewhat the regressive nature of cigarette taxes.

The effects for households with different racial makeups also differ markedly. It is Hispanic-headed households that experience the largest increase in prices when taxes increase, with a pass-through of 0.88. White-headed households have a tax pass-through of 0.86 and black-headed households have the lowest pass-through, at 0.68. These findings for both income and race have potentially important implications for

the distributional costs and benefits of these taxes as well as the potential distribution of public health benefits across income and racial groups.

Part of the reason for the average differences across groups may be explained by differences in where consumers of different backgrounds live, particularly with respect to lower-tax borders. Table 7, Panel A presents estimates of equation (2), separately by income and household head race group using distance and tax differences from the home Census tract. Neither the low-income nor the high-income households exhibit significant differences in pass-through by distance to lower-tax borders. On the border, the groups have a pass-through rate between 0.59 and 0.67. The pass-through for the low-income and high income groups is 0.032 and 0.040 higher for every 1 percent increase in distance, respectively, which are not statistically significantly different from zero at conventional levels. For middle-income households, however, the pass-through rate on the border is 0.53 and increases by 0.08 for every 1 percent increase in distance. These differences across the income distribution may be driven by the fact that high income households have a high opportunity cost of time and low income households have a high direct cost of search. The finding from Table 6 that the economic burden of a cigarette tax increase falls more on the middle income households only holds true farther from the border; close to the border, all three income groups experience relatively small increases in excess burden from such a tax increase.

Across households with heads of different races, the pass-through of cigarettes taxes to prices is the largest for Hispanics on the border (at 1.23), and the effect of distance is negative at -0.059 but is very imprecisely estimated. White households exhibit the largest differences across space, while African American households do not experience different pass-through rates at different distances to lower-tax borders. The results by race illustrate the large amount of heterogeneity across different racial groups in the effect of evasion opportunities on the economic burden of cigarette taxes. These are again important parameters in assessing the welfare implications

of these taxes to the extent that how different types of consumers respond to the availability of nearby lower-price goods impacts how much of the burden they bear of the tax.

In Panel B of Table 7, we estimate equation (2) by racial and income groups using distances and tax differences from the stores at which consumers shop to lower price borders. The most notable differences between these results and those in Panel A are low-income households have a higher pass-through as distance increases, and for the middle income group the effect of distance is smaller. This finding suggests low income households may increase search intensity as distance increases and middle-income households reduce search intensity, reflecting the substitution versus the income effect in search costs. As distance increases, search costs increase as the distance to much lower-priced items is higher. But, as store prices increase with distance, poorer consumers may search harder as the opportunity cost of their time, at least in terms of wages, is low. The income effect thus would outweigh the substitution effect. Higher-income households reduce search when the cost rises, such that the substitution effect outweighs the income effect.

5 Conclusion

This paper uses Nielsen Homescan data on cigarette transactions from 2006-2007 to analyze the incidence of cigarette excise taxes. In particular, we estimate the pass-through of excise taxes to consumer prices, which indicates how much of the excess burden of a tax is "passed forward" to consumers versus "passed backward" to the factors of production. Contrary to the small existing literature, we find cigarette taxes are less than fully passed through to consumer prices on average. One of the reasons for the differences between our results and previous estimates is that we are able to control for endogenous changes in the product mix when excise taxes change using UPC fixed effects.

Using the detailed geographic information on consumer and store locations, we estimate how the pass-through of taxes to prices is affected by distance to lower-tax borders. We find evidence of a large amount of geographic heterogeneity in the incidence of these excise taxes that varies systematically by evasion opportunities. On the border with a lower-tax state, a 1 cent increase in excise taxes increases cigarette prices by less than 0.51 cents, and the pass-through rate increases with distance to the lower-tax border. Finally, we examine the incidence of these taxes separately by household income and race and find important differences across household type. The burden of cigarette taxation is higher for middle-income households, and prices paid by African American households respond less to taxes than do prices paid by white and Hispanic households.

The estimates in this paper provide detailed insight into how consumers are affected by cigarette excise taxes. That the effects are heterogeneous across both space and household type suggests that the public health benefits of these taxes also will have differential impacts on households depending on where they live[18] and their demographic characteristics. These results also indicate that consumers and producers split the excess burden of these excise taxes, and among consumers there are often large geographic and socioeconomic differences. While our findings have important implications for how the excess burden of cigarette taxes is distributed among consumers and between consumers and producers, calculating the social welfare cost of these taxes is beyond the scope of our analysis. The results from this analysis are suggestive that this would be a fruitful area for future research.

[18]Lovenheim (2008) and Lovenheim and Slemrod (2010) make this point explicitly with cigarette taxes and alcohol control policies, respectively.

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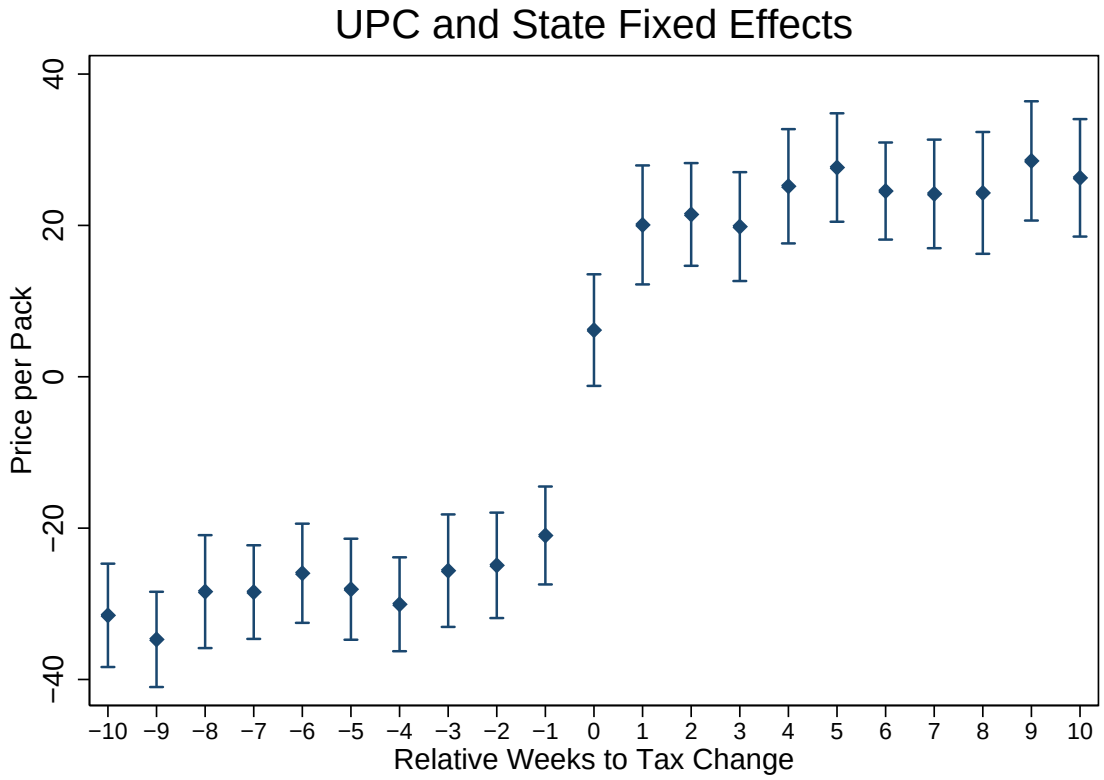
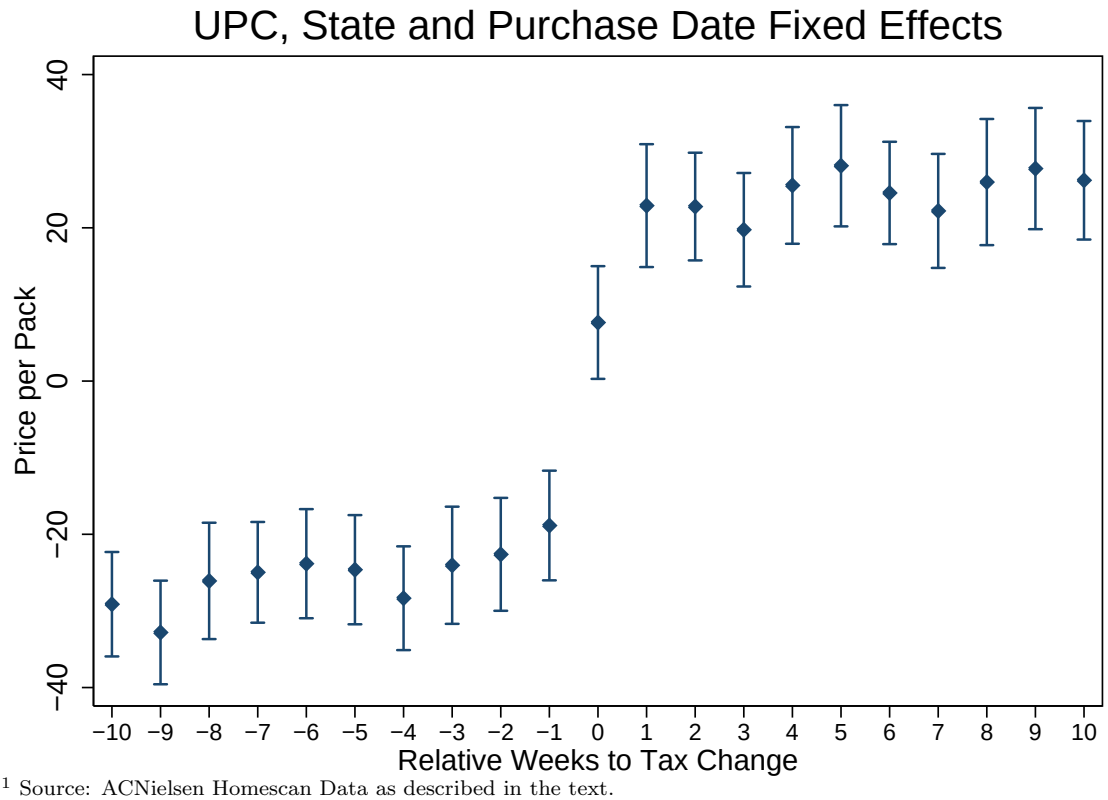
Figure 1: Cigarette Prices Surrounding State Excise Tax Changes





[1] Source: ACNielsen Homescan Data as described in the text.

[2] Each point represents the coefficient estimate on the respective relative week to tax change indicator variable. Week 0 is the week in which the tax is increased. The bars extending from each point represent the bounds of the 95% confidence interval calculated from standard errors that are clustered at the census tract level.

Table 1: The Effect of Excise Taxes on Cigarette Purchasing Behavior for Smokers

Variable	Purchase Probability Before Tax Change Mean	Purchase Probability After Tax Change Mean	Dummy=1 if Purchase This Week OLS	Weekly Frequency of Purchase OLS	Weekly Frequency of Purchase Poisson
Log Excise Tax	0.779	0.731	-0.057**	-0.048	-0.042
			(0.014)	(0.096)	(0.057)
Implied Elasticity	-0.062		-0.073	-0.062	-0.042

[1] Source: Nielsen Homescan data and state-level excise cigarette tax rates. The sample includes all households that make a cigarette purchase in 2006 or 2007. Frequencies include zeros. All regressions include state and week of purchase fixed effects. Regressions are estimated on data that vary at the household-week level.

[2] The implied elasticity is calculated by dividing the Log Excise Tax coefficient by the dependent variable mean. For the poisson regression, the coefficient is the elasticity.

[3] Standard errors clustered at the census tract level are in parentheses in the final 3 columns: * indicates significance at the 10 percent level and ** indicates significance at the 5 percent level.

Table 2: Descriptive Statistics of Analysis Variables

Variable		Mean	SD
Price (Cents)		346.90	135.28
Tax (Cents)		87.33	58.03
Distance from Home Tract (Miles)		126.51	130.51
Distance from Store (Miles)		128.73	131.37
Border Tax Difference From Home Tract		38.51	33.11
Border Tax Difference From Store		38.96	33.07
Number of Household Members	1	0.224	0.417
	2	0.418	0.493
	3	0.179	0.383
	4	0.107	0.309
	5	0.050	0.217
	6+	0.022	0.148
Total Household Income	<$5,000	0.052	0.221
	$5,000-$7,999	0.022	0.147
	$8,000-$9,999	0.038	0.190
	$10,000-$11,999	0.062	0.241
	$12,000-$14,999	0.083	0.276
	$15,000-$19,999	0.078	0.269
	$20,000-$24,999	0.098	0.298
	$25,000-$29,999	0.071	0.256
	$30,000-$34,999	0.069	0.253
	$35,000-$39,999	0.071	0.258
	$40,000-$44,999	0.110	0.313
	$45,000-$49,999	0.076	0.264
	$50,000-$59,999	0.117	0.321
	$60,000-$69,999	0.035	0.183
	$70,000-$99,999	0.010	0.097
	≥$100,000	0.010	0.075
Male Household Head Age	<25	0.002	0.039
	25-29	0.011	0.103
	30-34	0.027	0.161
	35-39	0.047	0.212
	40-44	0.104	0.305
	45-49	0.128	0.334
	50-54	0.135	0.342
	55-64	0.189	0.391
	≥65	0.092	0.289
Female Household Head Age	<25	0.002	0.048
	25-29	0.018	0.134
	30-34	0.032	0.175
	35-39	0.057	0.231
	40-44	0.110	0.313
	45-49	0.182	0.386
	50-54	0.147	0.354
	55-64	0.226	0.418
	≥65	0.122	0.327
Male Head Education Attainment	Grade School	0.008	0.086
	Some HS	0.072	0.259
	HS Graduate	0.265	0.441
	Some College	0.231	0.421
	BA	0.130	0.337

	Graduate School	0.027	0.162
	Grade School	0.007	0.083
Female	Some HS	0.046	0.210
Head	HS Graduate	0.330	0.470
Education	Some College	0.320	0.466
Attainment	BA	0.163	0.369
	Graduate School	0.030	0.172
	White	0.833	0.373
	Hispanic	0.046	0.210
Race	Black	0.093	0.290
	Asian	0.005	0.070
	Other	0.023	0.150
Kids Under 18?		0.239	0.427
Male Head	$<$ 30 Hours	0.028	0.165
Weekly	30-34 Hours	0.029	0.169
Labor	$\geq$35 Hours	0.464	0.499
Supply	Not Employed	0.211	0.408
Female Head	$<$ 30 Hours	0.088	0.283
Weekly	30-34 Hours	0.048	0.213
Labor	$\geq$35 Hours	0.366	0.482
Supply	Not Employed	0.395	0.489
Male Household Head		0.812	0.391
Female Household Head		0.878	0.397
Number of Transactions		160,969	
Number of Households		10,784	
Number of UPC Codes		1,005	
Number of Census Tracts		9,501	

Table 3: OLS Estimates of the Effect of Cigarette Excise Taxes on Consumer Prices

Independent Variable	(i)	(ii)	(iii)	(iv)	(v)
Excise Tax (Cents)	0.985**	1.015**	0.962**	0.961**	0.846**
	(0.023)	(0.043)	(0.025)	(0.024)	(0.025)
State Fixed Effects:	No	Yes	Yes	Yes	Yes
UPC Fixed Effects:	No	No	Yes	Yes	Yes
Demographic Controls:	No	No	No	Yes	Yes
Purchase Date Fixed Effects:	No	No	No	No	Yes

[1] Source: Nielsen Homescan data and state-level excise cigarette tax rates.
[2] Excise taxes and prices are in cents per pack.
[3] Standard errors clustered at the census tract level are in parentheses: * indicates significance at the 10 percent level and ** indicates significance at the 5 percent level.

Table 4: OLS Estimates of the Effect of Excise Taxes on Cigarette Prices by Distance to Lower Tax Borders

Panel A: Distance from Home Census Tract			
Independent Variable	(i)	(ii)	(iii)
Excise Tax (Cents)	0.997**	0.994**	0.856**
	(0.040)	(0.038)	(0.040)
Tax Difference with Nearest	-0.362**	-0.362**	-0.345**
Lower Tax State	(0.095)	(0.090)	(0.088)
Log Distance to Nearest	-0.682	-0.917	-1.483
Lower Tax State	(1.041)	(0.985)	(0.975)
Log Distance-Tax Difference Interaction	0.069**	0.069**	0.073**
for Nearest Lower Tax State	(0.021)	(0.020)	(0.019)
Demographic Controls:	No	Yes	Yes
Purchase Date Fixed Effects:	No	No	Yes
Panel B: Distance from Store Zip Code			
Excise Tax (Cents)	0.989**	0.982**	0.871**
	(0.040)	(0.039)	(0.040)
Tax Difference with Nearest	-0.321**	-0.326**	-0.297**
Lower Tax State	(0.092)	(0.088)	(0.086)
Log Distance to Nearest	-1.028	-1.250	-1.806**
Lower Tax State	(0.948)	(0.903)	(0.896)
Log Distance-Tax Difference Interaction	0.059**	0.060**	0.057**
for Nearest Lower Tax State	(0.019)	(0.019)	(0.018)
Demographic Controls:	No	Yes	Yes
Purchase Date Fixed Effects:	No	No	Yes

[1] Source: Nielsen Homescan data and state-level excise cigarette tax rates. All regressions include UPC fixed effects and state fixed effects.

[2] Tax Difference with Nearest Lower Tax State is the difference in tax rates between the state of the consumer's home Census tract (in Panel A) or the state of the purchasing store (in Panel B) and the nearest lower-tax state (in cents). Distance to nearest lower tax state is the distance to this lower tax state (in miles) from the Census tract (in Panel A) or store (in Panel B). The distance-tax difference interaction is the interaction of these two variables.

[3] Standard errors clustered at the census tract level are in parentheses: * indicates significance at the 10 percent level and ** indicates significance at the 5 percent level.

Table 5: Cigarette Taxes and Cross-state Purchasing Behavior

	Dependent Variable:			
Independent Variable	Percent Purchasing Cross-State (Percent from Baseline) (i)	Weekly Proportion of Cross-State Purchases (ii)	Price per Pack (cents) (iii)	Total Cigarettes Purchased per Trip (iv)
Purchase Cross-state	.	.	-99.50**	76.17
	.	.	(7.01)	(58.03)
Excise Tax (Cents)	0.0118*	0.0014**	0.85**	-0.22**
	(0.0066)	(0.0006)	(0.001)	(0.06)
Tax Difference with Nearest	0.0438**	-0.0001	.	.
Lower Tax State	(0.0213)	(0.0009)	.	.
Log Distance to Nearest	-0.5764**	0.0258**	.	.
Lower Tax State	(0.2786)	(0.0122)	.	.
Log Distance-Tax Difference Interaction	-0.0136**	-0.0002	.	.
for Nearest Lower Tax State	(0.0045)	(0.0003)	.	.
Model:	OLS	OLS	IV	IV

[1] Source: Nielsen Homescan data and state-level excise cigarette tax rates. All regressions include state fixed effects as well as the full set of demographic characteristics shown in Table 2. Purchase date fixed effects are included in all models except column (ii), which includes week of purchase fixed effects as the data for this regression vary at the household-week level. The estimates in column (iii) include UPC fixed effects. Estimates in columns (i), (iii) and (iv) include the full sample of cigarette purchasers, while the estimates in column (ii) include only those household-week observations in which at least one cross-state purchase was made in the week.

[2] Tax Difference with Nearest Lower Tax State is the difference in tax rates between the state of the consumer's home Census tract and the nearest lower-tax state (in cents). Distance to nearest lower tax state is the distance to this lower tax state (in miles) from the Census tract, and the distance-tax difference interaction is the interaction of these two variables.

[3] In columns (iii) and (iv), the cross-state purchasing dummy is instrumented with the tax difference with the nearest lower-tax state, the log distance to the nearest lower-tax state and with the interaction of these two variables.

[4] Standard errors clustered at the census tract level are in parentheses: * indicates significance at the 10 percent level and ** indicates significance at the 5 percent level.

Table 6: OLS Estimates of the Effect of Cigarette Excise Taxes on Consumer Prices, by Household Income and Race

	Low Income	Medium Income	High Income	White	Black	Hispanic
Excise Tax (Cents)	0.815**	0.912**	0.762**	0.860**	0.682**	0.882**
	(0.043)	(0.029)	(0.069)	(0.026)	(0.076)	(0.085)

[1] Source: Nielsen Homescan data and state-level excise tax rates. All estimates include controls for household demographic characteristics, state fixed effects, UPC fixed effects and purchase date fixed effects.

[2] Excise taxes and prices for cigarettes are in cents per pack.

[3] Low Income households are those whose household income is less than $35,000, medium income households are those with household income between $35,000 and $100,000 and high income households are those with household income higher than $100,000.

[4] Standard errors clustered at the census tract level are in parentheses: * indicates significance at the 10 percent level and ** indicates significance at the 5 percent level.

Table 7: OLS Estimates of the Effect of Excise Taxes on Cigarette Prices by Distance to Lower Tax Borders, by Household Income and Race

Panel A: Distance from Home Census Tract						
	Low Income	Medium Income	High Income	White	Black	Hispanic
Excise Tax (Cents)	0.764**	0.962**	0.657**	0.858**	0.990**	0.768**
	(0.067)	(0.048)	(0.107)	(0.042)	(0.112)	(0.125)
Tax Difference with Nearest	-0.091	-0.432**	-0.070	-0.364**	-0.258	0.462**
Lower Tax State	(0.122)	(0.109)	(0.227)	(0.096)	(0.211)	(0.392)
Log Distance to Nearest	-1.825	-1.232	-5.561	-1.398**	1.835	7.035
Lower Tax State	(1.497)	(1.125)	(3.479)	(0.990)	(2.871)	(4.507)
Log Distance-Tax Difference Interaction	0.032	0.081**	0.040	0.081**	-0.025	-0.059
for Nearest Lower Tax State	(0.028)	(0.024)	(0.050)	(0.021)	(0.045)	(0.080)

Panel B: Distance from Store Zip Code						
	Low Income	Medium Income	High Income	White	Black	Hispanic
Excise Tax (Cents)	0.819**	0.948**	0.676**	0.866**	0.955**	0.864**
	(0.068)	(0.045)	(0.108)	(0.042)	(0.100)	(0.119)
Tax Difference with Nearest	-0.207*	-0.348**	0.023	-0.301**	-0.332	0.434
Lower Tax State	(0.123)	(0.105)	(0.216)	(0.092)	(0.209)	(0.309)
Log Distance to Nearest	-1.542	-1.796*	-3.983	-1.819**	0.005	4.920
Lower Tax State	(1.467)	(0.963)	(3.117)	(0.890)	(2.681)	(3.926)
Log Distance-Tax Difference Interaction	0.050*	0.062**	0.001	0.064**	0.003	-0.074
for Nearest Lower Tax State	(0.027)	(0.022)	(0.049)	(0.020)	(0.043)	(0.062)

[1] Source: Nielsen Homescan data and state-level excise cigarette tax rates. All regressions include UPC, state and purchase date fixed effects.

[2] Tax Difference with Nearest Lower Tax State is the difference in tax rates between the state of the consumer's home Census tract (in Panel A) or the state of the purchasing store (in Panel B) and the nearest lower-tax state (in cents). Distance to nearest lower tax state is the distance to this lower tax state (in miles) from the Census tract (in Panel A) or store (in Panel B). The distance-tax difference interaction is the interaction of these two variables.

[3] Low Income households are those whose household income is less than $35,000, medium income households are those with household income between $35,000 and $100,000 and high income households are those with household income higher than $100,000.

[4] Standard errors clustered at the census tract level are in parentheses: * indicates significance at the 10 percent level and ** indicates significance at the 5 percent level.

Table A-1: OLS Estimates of the Effect of Excise Taxes on Cigarette Prices Excluding the 5 Weeks Surrounding Tax Changes

	Panel A: Average Effects		
Independent Variable	(i)	(ii)	(iii)
Excise Tax (Cents)	0.979**	0.978**	0.862**
	(0.025)	(0.024)	(0.026)
Demographic Controls:	No	Yes	Yes
Purchase Date Fixed Effects:	No	No	Yes
	Panel B: Effects by Distance to Lower-Tax Border		
Independent Variable	(i)	(ii)	(iii)
Excise Tax (Cents)	1.016**	1.014**	0.874**
	(0.040)	(0.038)	(0.026)
Tax Difference with Nearest	-0.358**	-0.357**	-0.342**
Lower Tax State	(0.096)	(0.091)	(0.088)
Log Distance to Nearest	-0.615	-0.848	-1.417
Lower Tax State	(1.043)	(0.989)	(0.975)
Log Distance-Tax Difference Interaction	0.068**	0.068**	0.071**
for Nearest Lower Tax State	(0.021)	(0.020)	(0.019)
Demographic Controls:	No	Yes	Yes
Purchase Date Fixed Effects:	No	No	Yes

[1] Source: Nielsen Homescan data and state-level excise cigarette tax rates. All regressions include UPC fixed effects and state fixed effects.

[2] Tax Difference with Nearest Lower Tax State is the difference in tax rates between the state of the consumer's home Census tract and the nearest lower-tax state (in cents). Distance to nearest lower tax state is the distance to this lower tax state (in miles) from the Census tract. The distance-tax difference interaction is the interaction of these two variables.

[3] Standard errors clustered at the census tract level are in parentheses: * indicates significance at the 10 percent level and ** indicates significance at the 5 percent level.

Table A-2: OLS Estimates of the Effect of Excise Taxes on Premium and Generic Cigarette Prices

Panel A: Average Effects		
	Premium	Generic
Excise Tax (Cents)	0.842**	0.803**
	(0.032)	(0.048)
Panel B: Effects by Distance		
	Premium	Generic
Excise Tax (Cents)	0.773**	0.635**
	(0.052)	(0.065)
Tax Difference with Nearest	-0.264**	-0.251*
Lower Tax State	(0.114)	(0.147)
Log Distance to Nearest	-2.870**	-3.019*
Lower Tax State	(1.227)	(1.599)
Log Distance-Tax Difference Interaction	0.074**	0.106**
for Nearest Lower Tax State	(0.025)	(0.031)

[1] Source: Nielsen Homescan data and state-level excise tax rates. State, UPC and purchase date fixed effects are included in all models.

[2] Tax Difference with Nearest Lower Tax State is the difference in tax rates between the state of the consumer's home Census tract and the nearest lower-tax state (in cents). Distance to nearest lower tax state is the distance to this lower tax state (in miles) from the Census tract. The distance-tax difference interaction is the interaction of these two variables.

[3] Standard errors clustered at the census tract level are in parentheses: * indicates significance at the 10 percent level and ** indicates significance at the 5 percent level.