Social Interactions and Smoking Initiation: The Intergenerational Impact of Cigarette Taxes

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Abstract

This paper explores the role of social interactions on a youth's decision to begin smoking. Specifically, we estimate the effect of cigarette taxes during early childhood on beginning smoking later in adolescence in a discrete-time hazard model. These taxes do not directly affect children but may change the prevalence of smoking among parents, older relatives, or other adults. We find that a $0.25 cigarette tax increase during childhood decreases smoking initiation by 12.5 percent. Our results suggest that parents and older siblings do not account for the entire intergenerational effect, so other members of the community also likely play a role. Prior work understates the total effect of cigarette taxes by not considering this indirect channel.

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1 Introduction

Tobacco use is the leading preventable cause of death in the United States, with external costs of cigarette smoking of over $300 billion per year.[1] Policymakers often use cigarette excise taxes to discourage smoking and reduce these smoking-related costs. This preference is reflected in the fact that average cigarette taxes increased from $0.51 to $1.53 per pack over the last four decades (Orzechowski and Walker, 2014). The staggered timing of these tax increases across states provide an opportunity to assess their effect on smoking behavior and has spawned a large literature. Early studies found large elasticities using aggregate time-series and cross-sectional data (Chaloupka and Warner, 2000). Recent work using more sophisticated techniques suggests that the magnitude of this relationship is smaller than previously thought (Callison and Kaestner, 2014; Hansen et al., 2017; Decicca et al., 2018), calling into question the ability of cigarette taxes to influence behavior.

Evidence for whether cigarette taxes affect youth smoking initiation in particular is even murkier. Smoking is addictive, so it is likely more efficient to keep people from starting than to encourage them to quit (U.S. Department of Health & Human Services, 2014). Still, a review of the literature by Guindon (2014) concludes that empirical evidence is "too limited to make any conclusive statements about the impact of tobacco prices or taxes on smoking onset." Many cite the lack of consensus as evidence that cigarette taxes do not reduce smoking initiation.

However, previous studies focus only on the direct effect of cigarette taxes. This focus may overlook an important indirect effect operating through social interactions. Social interactions, such as peer effects, can increase the effectiveness of public policies. For example, the aggregate effects of a policy can be larger than expected given the direct effect on each individual (Glaeser et al., 2003). Such social multipliers have been documented in retirement plan choices (Duflo and Saez, 2003) and in labor market decisions such as maternal

[1] This figure includes around $170 billion in direct medical costs (Xu et al., 2015), of which public programs pay the majority. The figure also includes over $156 billion in productivity lost to decreased health and premature death (U.S. Department of Health & Human Services, 2014).

employment (Maurin and Moschion, 2009). Social interactions with family members are shown to be especially important for parental leave decisions (Dahl et al., 2014) and military service (Bingley et al., 2019). Correlational evidence suggests that social interactions are also important in smoking decisions. Youth are more likely to begin smoking if older friends and family members smoke (Jackson and Henriksen, 1997; Avenevoli and Merikangas, 2003; Hill et al., 2005; Bricker et al., 2007; Gilman et al., 2009; Göhlmann et al., 2010). Yet, due to difficulties in estimating social effects, there is currently no clear evidence that this correlation represents a causal relationship.

We provide the first causal evidence that cigarette taxes influence smoking initiation through social interactions between generations. Consider cigarette taxes when someone is very young, say from birth to age seven. Since very few children begin smoking at such a young age these taxes have no direct effect but may change the prevalence of smoking among the child's parents, older relatives, and other associated adults. These taxes during childhood will affect smoking onset to the extent that the smoking behavior of the adults in their community influences a person's decision to smoke.

We draw on data from the National Longitudinal Survey of Children and Young Adults (NLSCYA) to estimate a hazard model of smoking initiation. The variable of interest is cigarette taxes during childhood, but we also control for taxes at the time of initiation. This strategy isolates the intergenerational effect from any direct effect. We also show that parents and older siblings in our sample respond to cigarette taxes and may be part of the link. Yet, properly identifying the mechanisms would require full information on the smoking behavior of every person in each individual's social network. Data limitations make this impractical. Instead, we focus on the reduced form evidence between cigarette taxes in childhood and smoking initiation. We find that a \$0.25 cigarette tax increase during childhood decreases smoking initiation by 12.5 percent. This effect is not unique to those whose mothers ever smoked, suggesting that the intergenerational effect does not function exclusively through parents.

This paper provides four contributions to the literature. We are the first to estimate the indirect, intergenerational effect of cigarette taxes on smoking initiation. Second, we provide causal evidence for social interactions in smoking behavior. Third, we show that contemporaneous cigarette taxes do not affect smoking initiation in the NLSCYA, which adds new evidence to studies using other panel data (Cawley et al., 2004; DeCicca et al., 2008; Nonnemaker and Farrelly, 2011; Lillard et al., 2013). Finally, we establish a method that uses all information from multiple retrospective reports.[2] Although our results do not rely on this method it is useful to consider when combining panel data and retrospective information.

Our findings provide several implications for policy. This intergenerational effect of cigarette taxes is larger than the direct effect estimated in prior work.[3] A back-of-the-envelope calculation suggests that increasing cigarette taxes by $0.25 during childhood saves $68 billion in lifetime external costs. Prior work understates the effect of cigarette taxes by not considering this intergenerational channel. Other tobacco control policies may also be more effective than past estimates suggest due to social multipliers. These spillover effects also imply that tobacco control policies are more effective when implemented at larger geographic levels by influencing more widespread social networks.

In the next section, we relate our results to the current policy environment, review previous studies of cigarette taxes and smoking initiation, and discuss potential mechanisms for an intergenerational effect of cigarette taxes. We discuss our empirical strategy in Section 3. In Section 4, we discuss the data and our method for dealing with multiple retrospective

[2]Studies that depend on retrospective information to measure smoking initiation either take a single response from a cross-section (Douglas and Hariharan, 1994; Hammar and Martinsson, 2001; López Nicolás, 2002; Kidd and Hopkins, 2004; Peretti-Watel, 2005; Madden, 2007) or use the response from a single year of a panel (Forster and Jones, 2001; Boudarbat and Malhotra, 2009; Lillard et al., 2013). The approach that chooses one response ad hoc is more sensitive to mismeasurement in a given year.

[3]Most studies report a range of estimates. Take the largest elasticity from each study that finds a negative effect (Douglas and Hariharan, 1994; Forster and Jones, 2001; Tauras et al., 2001; DeCicca et al., 2002, 2008; Glied, 2002; Cawley et al., 2004, 2006; Coppejans et al., 2007; Nonnemaker and Farrelly, 2011; Lillard et al., 2013). The average is -0.62 with the largest being -1.52. This includes elasticities for models without state fixed effects. Most models with state fixed effects find insignificant results. The intergenerational tax elasticity implied by our results is -5.39.

reports. We present and discuss our results in Section 5 and provide concluding remarks in Section 6.

2 Background

2.1 Cigarette Taxes and Smoking Initiation Literature

Empirical evidence on the effect of cigarette taxes on smoking initiation is mixed. For example, some studies find no effect of cigarette taxes on smoking initiation (Douglas and Hariharan, 1994; DeCicca et al., 2002; Madden, 2007; DeCicca et al., 2008), while others find that cigarette taxes are negatively related to initiation in Spain (López Nicolás, 2002) and among certain demographic subgroups in the United States (Cawley et al., 2004; Nonnemaker and Farrelly, 2011). Guindon (2014) reviews 27 papers, most with important limitations, and concludes that the current literature is insufficient to form a consensus about whether or not cigarette taxes or prices affect smoking initiation. One potential reason for the inconsistency of findings is the inconsistency of methods used between studies.

Many of these studies do not include state fixed effects. This omission is often due to a lack of sufficient within-state variation in cigarette taxes. Those studies that are unable to include state fixed effects still discuss the importance of controlling for unobserved state characteristics and attempt to do so with other observed state characteristics (e.g. indicators for tobacco producing states in Cawley et al., 2004). However, the inclusion or exclusion of state fixed effects does not fully explain the inconsistent findings in the literature. For instance, DeCicca et al. (2002, 2008) find a negative effect of cigarette taxes on smoking initiation in specifications without state fixed effects, but when they include fixed effects the coefficient on taxes is slightly positive and not statistically significant. While Lillard et al. (2013) include state fixed effects in all their models and some specifications produce statistically significant results. We find a small, negative effect of contemporaneous cigarette taxes on initiation that is not robust to the inclusion of state fixed effects, which is consistent

with DeCicca et al. (2002, 2008). By comparison, the intergenerational effect of taxes from childhood is robust to the inclusion of state fixed effects or state-time trends.

Many studies are also unable to accurately determine exposure to cigarette taxes over time due to limited geographic information. For example, many studies use state of birth or state at the time of data collection to calculate the taxes an individual faces at the time of initiation. This method assumes the individual has not moved states either between birth and initiation or between the time of initiation and data collection. We require fewer assumptions about mobility because the NLSCYA gives the actual state of residence for most years since birth.[4]

Previous studies also differ in the way they measure initiation. Most studies either compare smoking status between waves in a longitudinal dataset or use retrospective reports on the age of smoking initiation. The approach using the change in smoking status between waves neglects individuals who begin smoking prior to entering the survey[5] and suffers from measurement error when follow ups are infrequent. The two primary drawbacks of the retrospective approach are misreported age of initiation and lack of demographic characteristics from the time of the initiation decision. Measurement error in the age of smoking initiation becomes more of a concern as recall bias increases due to asking individuals about events farther in the past. In addition, later-in-life demographic characteristics, such as eventual educational attainment and family income, are endogenous to earlier smoking behavior (Kenkel et al., 2006). We use the retrospective method, but are able to reduce the impact of these common problems. Individuals in our data are asked the age they started smoking beginning at ten years old, so recall bias is minimized. Also, because our data originally focused on the parents of our respondents, we are able to control for family demographic information contemporaneous to the initiation decision no matter how young respondents

[4]In alternative analyses, we find that our results hold even if we assume people remain in their state of birth or were born in the state they lived when we first observe their smoking behavior. This suggests the intergenerational effect we detect would also be observed using other, more limited data sources.

[5]One exception is Nonnemaker and Farrelly (2011), who supplement their longitudinal data with retrospective information to measure the timing of initiation before respondents are observed in the data.

started smoking.

2.2 Potential Mechanisms of Smoking Transmission

People are more likely to begin smoking if their parents, friends, or other close connections smoke (Jackson and Henriksen, 1997; Avenevoli and Merikangas, 2003; Hill et al., 2005; Bricker et al., 2007; Gilman et al., 2009; Göhlmann et al., 2010). These correlations could reflect similar socioeconomic status, genetic predisposition to nicotine, or other shared experiences. Yet, there are reasons to believe increased exposure to smoking influences the decision to initiate. Cutler and Glaeser (2010) discuss the role of social interactions in smoking decisions and lay out three potential mechanisms. These include direct social effects, social learning, and market forces. The direct social effects refer to reinforcing factors such as increased enjoyment from smoking with other people and a key social connection to a certain person or group of people, or discouragement from disapproval or stigma making it more costly to smoke. Social learning refers to gaining information from the decisions of others. People use the behavior of others to infer the costs and benefits associated with a given behavior. If someone they perceive as more informed than they are chooses to smoke, they may overestimate the benefits and underestimate the costs. Similarly, if someone chooses not to smoke then those who look up to that person may infer greater costs or fewer benefits to smoking. Finally, market forces generally decrease the cost of obtaining cigarettes. This could be in a formal market sense where stores in communities with many smokers make cigarettes easier to access because local stores will only bother selling cigarettes if there is a large enough market to justify the fixed cost of providing them. The informal market is also affected as cigarettes are more easily resold, shared, or stolen.

Our estimation strategy does not require that we specify a particular causal mechanism. Even so, the policy implications depend on whether the transmission includes non-parent adults, so it is important to distinguish between intra- and inter-family effects. Children interact socially with many adults, but parents may be the adults they interact with the

most. Thus, the transmission of smoking behavior may be more concentrated within families. Cigarette taxes are unlikely to affect non-smokers. So, an intergenerational effect for youth whose parents never smoked suggests that other adults matter. Additionally, a mother's behavior while pregnant has a unique effect on her children. For example, Simon (2016) finds that cigarette taxes improve child health by reducing smoking among pregnant mothers. We test whether this explains the intergenerational relationship by considering the effect of taxes while in utero separately from the rest of childhood. We will show that the transmission of smoking behavior does not appear to be exclusive to parents.

3 Empirical Strategy

Our primary strategy estimates the effect of cigarette taxes from birth to age seven on later smoking initiation.[6] We control for other factors that may influence smoking initiation, including contemporaneous cigarette taxes. Specifically, we estimate a discrete-time hazard model of the following form:

$$\lambda_{ist}(\text{age}) = \lambda_0(\text{age})g\left(\beta_1 \text{Tax}_i^{0-7} + \beta_2 \text{Tax}_{st} + \mathbf{X}_{it} \cdot \boldsymbol{\alpha} + \gamma_s + \gamma_t\right) \tag{1}$$

where λ_{ist} is the hazard of smoking initiation as a function of age for person i living in state s in year t, $\lambda_0(\text{age})$ is the baseline hazard (i.e. the hazard at each age given average characteristics), $g(\cdot)$ is the inverse complementary log-log function ($y = 1 - \exp(-\exp(x))$),[7] Tax_i^{0-7} is the time-invariant mean cigarette tax from birth to age seven for individual i,[8] Tax_{st} is the state-level cigarette tax corresponding to the current state of residence, and $\mathbf{X}_{it}$

[6] Our main strategy assumes individuals are not at risk of smoking until age eight but results are robust when we allow the hazard to begin at other ages. Estimates with start ages ranging from six to ten are available in Appendix Table A1.

[7] We explore various functional forms for $g(\cdot)$ in Appendix Table A2. The results are larger in magnitude with logit or probit specifications, so the complementary log-log specification provides a conservative estimate as well as having the useful property that exponentiated coefficients return hazard ratios.

[8] When we assume the age an individual is first at risk of initiation is something other than 8, this variable is defined as the average cigarette tax from birth until one year before individuals are assumed to be at risk.

is a vector of controls for sex, race/ethnicity, family income, mother's age when individual i was born, birth order, parent smoking history, and parents' highest educational attainment. The baseline hazard is estimated by individual indicators for each age with the constant term omitted. We also include γ_s and γ_t, which are state and year fixed effects, respectively. We account for within-state correlation in factors that influence smoking initiation by clustering standard errors at the state level.

State fixed effects account for time-invariant smoking behaviors and/or attitudes at the state-level (such as being a tobacco producing-state or a state with high levels of anti-smoking sentiment). Year fixed effects account for differences in the underlying smoking initiation hazard across cohorts.[9] Demographic controls are motivated by previous research, which suggests race, sex, parent characteristics, and socioeconomic status (including income and education) are important determinants of smoking behavior (e.g. Chaloupka and Pacula, 1999; Powell and Chaloupka, 2005; Nonnemaker and Farrelly, 2011).

The main coefficient of interest is β_1, which is the effect of cigarette taxes during early childhood on the hazard of initiation. This coefficient is identified by within-state changes in cigarette taxes over time and differences across states in the size and timing of tax increases. Policy endogeneity is a primary concern in this type of estimation strategy. Nevertheless, the assumption that changes to state cigarette taxes are exogenous to individual smoking decisions is ubiquitous in the literature. Legislatures increasing cigarette taxes in response to either increases in youth smoking rates (as seen in the 1990s) or rising anti-smoking sentiment threatens a causal interpretation of β_2, or the coefficient on the contemporaneous tax. However, one strength of considering lagged cigarette taxes is that legislators are unlikely to base policy on future trends in smoking rates of infants or young children. Another potential threat to identification is if movement between states is related to unobserved smoking preferences. To address this concern, we estimate Equation 1 separately for those who ever moved states and those who never moved and we find similar results for both groups.[10] Fur-

[9] Due to the age fixed effects, the year fixed effect is equivalent to including birth year fixed effects.

[10] The difference in the intergenerational effect between these two subsamples is not statistically significant

ther, our results are similar if we measure the average tax during childhood using a fixed measure for state of residence in all years (e.g. state of birth or state of residence at age 8) regardless of actual interstate mobility, or simply the tax in the state and year of birth.[11]

Our main effect is slightly larger in magnitude when we estimate a version of Equation 1 with state-specific linear time trends.[12] However, isolating pre-treatment trends for many overlapping tax increases is problematic, so we are unable to evaluate the expected effect of these trends on our estimates (see Wolfers, 2006). Our preferred specification does not include these trends, which provides a more conservative estimate that also uses fewer degrees of freedom.

Equation 1 is our preferred specification, but we present results for various subsamples and additional specifications. To distinguish between familial and other social influences, we estimate Equation 1 separately for subsamples split by parent smoking history. We also explore the importance of in-utero exposure by adding a measure of cigarette taxes in the year before birth to the model. This helps distinguish between the physiological effects of mother's smoking while pregnant, such as those seen in Simon (2016), and social transmissions of smoking behavior.

3.1 First-Stage Considerations

Our main estimates reflect a reduced-form relationship between cigarette taxes and smoking initiation. The first stage of the relationship is the effect of cigarette taxes on the smoking behavior of adults who interact with the focal youth. The second stage is the relationship between the smoking behavior of adults and the youth's decision to begin smoking. The literature suggests that the size of the first stage for any particular person is likely small and has probably gotten weaker over time (Callison and Kaestner, 2014; Hansen et al., 2017). The relevant first stage involves any older person with which the focal youth interacts,

($p = 0.609$) in a fully interacted model. The results for separate subsamples are available in columns (2) and (3) of Appendix Table A3 and the results of the fully interacted model are available upon request.

[11] These results are available in columns (2) through (4) of Appendix Table A4.

[12] These results are available in column (1) of Appendix Table A4.

such as parents, older siblings, other relatives, or older friends and acquaintances. Properly estimating this first stage would require exhaustive data on that individual's social network. Instead, we provide estimates that reflect the portion of the first stage attributable to the older individuals we observe in our data. Even a small effect on these individuals could reflect a substantial shift at the community level as that small effect is multiplied by everyone in the social network.

Our sample consists of the children of a representative sample of women. We also have information on those women as well as a representative sample of men who are not related to the child. However, these men reflect the pool of potential fathers and their response to cigarette taxes informs the expected behavior of the fathers of our sample of children. This parent sample changing smoking behavior in response to taxes suggests a potential mechanism through which our reduced form operates. Older siblings are another potential group whose smoking behavior might respond to these cigarette taxes and could impact youth smoking initiation. The structure of the NLSCYA allows us to observe the set of individuals who are the older sibling of another individual in our sample.

We estimate the effect of cigarette taxes on participants in the NLSY79 (actual mothers and probabilistic fathers) and individuals in the NLSCYA who have at least one younger sibling. The approach to these models is much more closely related to previous estimates of the direct effect of cigarette taxes on smoking behavior. The outcomes we consider are smoking participation, measured as whether the individual reports being a current smoker at the time of the survey, and the number of cigarettes smoked. These models include state and year fixed effects and controls for sex, race, and family income.[13]

[13]Alternative models controlling for state-specific linear time trends provide similar results but with generally larger magnitudes. These results are available in the online appendix.

4 Data

4.1 NLSCYA

The National Longitudinal Study of Youth 1979 (NLSY79) is a nationally representative sample of 12,686 young men and women who were 14-22 years old when they were first surveyed in 1979. These individuals were interviewed annually through 1994 and are currently interviewed on a biennial basis by the Bureau of Labor Statistics. In 1986, the NLSY began surveying the biological children of female participants biennially from birth to age 14 in the Child (C) survey. Beginning in 1994, the NLSY also includes a Young Adult (YA) survey for these children who are age 15 and older. We use information from all three of these surveys, which we refer to as the National Longitudinal Survey of Children and Young Adults (NLSCYA). This sampling pattern results in a sample that is not nationally representative of children in these cohorts, rather the sample is representative of children born to mothers in the original NLSY79 sampling frame.

Our outcome of interest is smoking initiation. Participants answer questions about their tobacco use from age 10 to 14 in the C survey and for all ages in the YA survey. While some questions differ between the surveys, all individuals in our sample gave the age at which they first smoked cigarettes.[14] We describe how we use the answers to these questions to create our measure of smoking initiation in Section 4.2. Information about parent smoking behavior comes from the NLSY79 and is only available for mothers. We therefore measure parent smoking history as whether an individual's mother has smoked at least 100 cigarettes in her life. The demographic controls in our model include sex, race, family income, and the highest educational attainment of either parent.[15] We include additional controls to account

[14]The exact wording in the C sample is "How old were you when you first smoked a cigarette?" and the wording is "How old were you the first time you smoked cigarettes" in the YA sample.

[15]The race categories given in the NLSCYA are Hispanic, Non-Hispanic black, and Non-black/Non-Hispanic. We categorize total family income by quartile. Specifically, we create a categorical variable for the quartile family income falls into for each year, then assign each individual to the average quartile their family's income falls into for the majority of their life. Parent education is categorized as less than high school diploma, high school diploma, some college, and BA or higher.

for the selection of birth-year cohorts into our sample. Because our sample is made up of children from a fixed cohort of mothers, those born in earlier years are born to a mother that is younger and generally more disadvantaged. To account for this, we include measures for mother's age at the focal child's birth and birth order.

Our independent variable of interest is the cigarette excise tax levels to which children are exposed. In the restricted-access version of the NLSCYA, we observe the state of residence for each child since birth.[16] This lets us match cigarette tax information from the Tax Burden on Tobacco Historical Compilation (Orzechowski and Walker, 2014) to our sample. Taxes are adjusted for inflation and reported in 2014 dollars.

Our data is formatted as person-age observations. Therefore, each person contributes one observation for each age beginning at age 8 until age 25 or until that person reports having initiated smoking, after which they are dropped from the sample. Only 2 percent of our sample initiates before age 8 and we only observe 11 initiations past the age of 25, which amounts to 0.12 percent of our sample.[17] This pattern is consistent with a 2014 report of the U.S. Surgeon General indicating that 99 percent of smokers begin smoking before age 26 (U.S. Department of Health & Human Services, 2014). We use survey weights provided with the NLSCYA to adjust for the probability of mothers being sampled in the original 1979 survey in all summary statistics and analyses. These weights primarily adjust for the original oversampling of minority groups, and results are robust to whether or not we include these weights.[18]

Although we observe many individuals in each state, initiation is a relatively rare event. It is therefore not surprising that we do not observe anyone initiate smoking in some less-populous states. If we do not observe an initiation for a state, then the predicted probability of initiating is 0 within that state, which in turn causes the fixed effect for that state to be

[16] This is available every year from 1979 to 1994, then biennially thereafter. We carry forward the most recent state of residence to fill in these gaps.

[17] Our results are not changed if we do not impose a right censor (available upon request).

[18] Unweighted summary statistics are available in Appendix Table A5, and results are provided in Appendix Table A6 and Appendix Table A7.

estimated as $-\infty$. In practice, both the fixed effect and any observations from these states are dropped from the analysis. This problem is exacerbated when we stratify our sample and the number of states with no initiations increases. To balance our panel and allow comparisons between subsamples, we remove individuals from our data who ever report living in a state for which we do not observe an initiation event. These restrictions do not change the results enough to alter our conclusions, but the coefficients are smaller in magnitude after the restrictions. We therefore view our reported results as conservative in this regard. Ultimately, we restrict our sample to individuals with no missing information, who are born after 1976, who enter the sample prior to age 8, and never report living in Delaware, Hawaii, Idaho, Utah, Vermont, or Wyoming. Most of these restrictions amount to trimming out low-density areas of our data.[19] Our resulting estimation sample consists of 8,228 individuals from 45 states.

4.2 Measuring Smoking Initiation

Due to the longitudinal nature of the data, respondents report their age of smoking initiation up to six separate times. Approximately 12 percent of respondents (972 out of 8,228 individuals in the estimation sample) have a discrepancy in reported age of initiation. This could be due to measurement error at the time of data collection, misremembering the true age, intentionally providing an inaccurate report due to social desirability bias, or misunderstanding the intention of the question. However, for most people (91 percent), all reported ages are within one year so this does not constitute significant measurement error.

Most smoking initiation studies that rely solely on retrospective smoking information take a single response from a cross section (Douglas and Hariharan, 1994; Hammar and Martinsson, 2001; López Nicolás, 2002; Kidd and Hopkins, 2004; Peretti-Watel, 2005; Madden, 2007) or a single year of a panel (Forster and Jones, 2001; Boudarbat and Malhotra, 2009;

[19] Only 2,680 of the 11,506 children and young adults in the NLSCYA have valid tobacco-use information. By comparison, only 103 (less than 1 percent) are removed because of our state limitations. Appendix Table A8 reports summary statistics for the group included in our estimation sample compared to those omitted.

Lillard et al., 2013). Strategies include using the first response recorded, the last response recorded, the modal response, the minimum response, or the maximum response. These approaches make an ad hoc decision about which response to use and throw out the remaining information. Using the modal response is attractive, but unless there is a single mode one must still make a decision about which mode to choose. Without additional information about the underlying reason for conflicting reports, each of these methods discards some of the information provided.

To retain as much information as possible, we average the smoking initiation age across multiple reports. Specifically, we code the smoking status at each age as the fraction of times an individual reports having started smoking by that age. This creates a variable that ranges from 0 to 1, with the possibility of values in between.[20] An example illustrates this procedure. Assume a respondent answers the smoking questions in 5 different waves. In two waves, she reports having initiated smoking at age 15, in one wave she reports 16, and in two waves she reports 17. The initiation status variable is then 0 for ages 14 and younger, 0.4 for age 15, 0.6 for 16, and 1 for ages 17 and older. We report results using the value of 0.5 as the cutoff to define age of smoking initiation, therefore our example respondent is coded as initiating at age 16. Results are robust to the choice of cutoff between 0 and 1 and to removing all individuals with a discrepancy from the analysis.[21] The robustness of our results in this regard is potentially due to the short retrospective window in the NLSCYA (children are asked about their smoking behavior as early as age 10).

4.3 Summary Statistics and Baseline Hazards

The distribution of birth-year cohorts and sample years are shown in Figure 1. Our sample includes individuals born between 1976 and 2004 who were at risk of smoking initiation between 1984 and 2014. Figure 1 also plots the number of states with tax increases for each

[20] We remove responses if the reported starting age is larger than the person's age at the time the question was asked. We also remove responses of zero, as these appear to be a reporting error in the data.

[21] These additional analyses are available in Appendix Figure A1 and Appendix Table A9.

year. This highlights the variation in cigarette tax faced both in childhood (all changes in the seven years following birth) and in adolescence, which identifies our coefficients of interest.

Our outcome of interest is the hazard of smoking initiation, which is the probability that an individual smokes at age a conditional on not having smoked prior to age a. We estimate the baseline hazard rate at each age by the number of initiations at the age divided by the number of individuals remaining in the sample. The fraction initiated is calculated as the fraction of individuals originally observed at age 8 who have initiated by a given age. The baseline hazard of smoking initiation and fraction initiated for each age in the estimation sample are graphed in Figure 2 Panels A and B, respectively. The average smoking initiation hazard across all ages is 0.054. The hazard gradually increases from about zero at age 8 to a peak of 0.14 at age 18 and then decreases rapidly. This pattern is also apparent in the fraction initiated in panel B, in which the curve increases steeply after age 10 and then quickly flattens out after age 20. Table 1 catalogues the calculation of the hazard rate at each age and shows the prevalence of right censoring in our estimation sample. The number of initiations outweighs the number censored (i.e. left the sample without initiating) until age 20, when censoring becomes more prevalent.[22] Of the original 8,228 individuals in our estimation sample, 1,691 are still in the sample and did not initiate by age 25.

Summary statistics for the rest of the variables used in our estimation sample are reported in column (1) of Table 2. Panel A reports time-invariant measures and Panel B reports measures that vary over time. Our sample includes 8,228 individuals which amounts to 89,289 individual-age level observations. People are removed from the sample after they initiate, so the individual-age level statistics are weighted toward people who never start smoking or who initiate at older ages. About 58 percent of people initiate within the sample, with the other 42 percent leaving the sample without initiating. The average cigarette excise tax faced from birth to age seven is \$0.45 and \$0.87 from age eight onward. The

[22]To determine the importance of censoring for our results, we estimate our model on the sample of those observed until at least age 25 in Appendix Table A10. The percentage point effect is the same as our main results.

sample is evenly split between male and female respondents.

The summary statistics for the sample split by mother's smoking history are reported in columns (2) and (3) of Table 2. The proportion of the sample with a parent who ever smoked cigarettes is 59 percent. Mothers who smoke are on average less educated and make less money, and individuals whose mother ever smoked are 50 percent more likely to initiate smoking than those whose parents never smoked (6.5 percent vs. 4.1 percent).

Before turning to the results of our parametric models, we provide graphical evidence and non-parametric tests of the effect of cigarette taxes in childhood on smoking initiation. Figure 3 presents the graphs of the hazard function and the fraction initiated for those with a cigarette tax during childhood above and below the mean. 64.1 percent of those with an above-average cigarette tax in childhood ever initiate smoking compared to 52.9 of those who experienced a below-average tax. A non-parametric Wilcoxon test rejects the null hypothesis that the functions are the same with $p < 0.001$. This difference is driven by the lower hazard of initiation up to age 18, after which there is no difference in the hazard.

5 Results

We begin the discussion of our results with a note on interpreting coefficients from a hazard model. Exponentiated coefficients from a complementary log-log regression are interpreted as hazard ratios. For example, the exponentiated coefficient on the cigarette tax during childhood (e^{β_1}) represents how many times more likely someone with a one dollar higher tax during childhood is to initiate at any given age relative to someone who faces an average cigarette tax level. Values between 0 and 1 suggest a negative relationship between the variable of interest and the probability of smoking initiation; values greater than 1 suggest a positive relationship. Thus, statistical significance for hazard ratios is measured against the null hypothesis that the coefficient is equal to 1. Subtracting 1 from the hazard ratio gives the marginal effect of a \$1.00 tax increase on the initiation probability. However,

the average tax increase in our study period is only $0.30, significantly less than the $1.00 increase implied by the hazard ratio. To interpret our estimates in a way that reflects the relevant policy variation, we report marginal effects of cigarette taxes relative to a $0.25 increase in addition to the standard hazard ratios.[23] Mathematically, the reported marginal effect is given by:

$$\text{Marginal Effect} = (\exp(\beta) - 1) \times 0.25,$$

where β is the coefficient on the variable of interest.

We display the main results of our preferred specification in column (1) of Table 3.[24] Panel A shows standard hazard ratios and panel B reports the marginal effect of a $0.25 increase. The hazard ratio for cigarette taxes during childhood is 0.498 with a corresponding marginal effect of -0.125 ($(0.498-1)\times 0.25 \approx -0.125$). Thus, a $0.25 increase in the average cigarette tax during childhood reduces the hazard of later initiation by 12.5 percent (0.68 percentage points off a base of 5.4 percent). This estimate is statistically significant at the 5 percent level. The coefficient on the current cigarette tax is small, positive, and not statistically significant. Panel B of Figure 4 shows the baseline hazard of smoking initiation as well as the hazard given a $0.25 increase in cigarette taxes during childhood. Our model includes a proportional hazards assumption,[25] so the percent effect is the same across ages, but the percentage point effect is largest at ages people are most likely to begin smoking (evidenced by a larger gap between the baseline and treated hazard graphs). The average effect of a $0.25 increase in cigarette taxes across all ages is -0.7 percentage points ($-0.125 \times 0.054 \approx -0.007$). Similarly, panel A of Figure 4 shows that increasing cigarette taxes during childhood by $1.00 decreases the hazard of smoking initiation by 50.2 percent (2.7 percentage points off a base of 5.4 percent).

Columns (2) and (3) of Table 3 report results for those whose mother ever smoked at

[23] We choose $0.25 as a benchmark because it lies between the average tax increase ($0.30) and the standard deviation of taxes during the childhood of our respondents ($0.21).

[24] The results for the full set of demographic controls is available in Appendix Table A11.

[25] We find no evidence to contradict the validity of this assumption in alternative specifications where it is relaxed. These results are available upon request.

least 100 cigarettes and for those whose mothers did not, respectively. The hazard ratio for cigarette taxes from childhood is 0.449 for those with a parent who smoked cigarettes and is 0.566 for those with never-smoking parents. Though the difference between these two estimates is not statistically significant ($p = 0.398$ in a fully interacted model), a closer evaluation of the differences between the two groups is informative. The marginal effects reveal the importance of considering the baseline hazard when interpreting the effect size. Those with a parent who ever smoked have a higher hazard of starting to smoke, on average (6.5 percent compared to 4.1 percent). Thus, the percentage-point effect of a $0.25 increase in cigarette taxes during childhood is twice as large for those with a smoking parent than for those without (-0.897 percentage points compared to -0.447 percentage points), while the percent change is roughly the same for both groups (-13.8 percent for those with a smoking parent and -10.9 percent for those without). The difference in the percent and percentage point effects is further evident in Figure 5, which shows the baseline hazards and the hazards with a $0.25 higher cigarette tax in childhood for each group. Those whose mother ever smoked have a higher baseline hazard (predominantly in the teenage years) and experience a larger intergenerational tax effect as evidenced by both the distance between baseline and treated hazard rates and the distance between average hazard lines. One implication of these results are that those with a higher baseline risk of initiation are potentially more responsive to policy intervention. Also, the fact that the intergenerational effect for those whose mother never smoked is nearly as large suggests that the causal link between generations is not solely driven by a familial mechanism.

Table 4 reports the effect of the contemporaneous cigarette tax separately from the effect of cigarette taxes in childhood. Controlling only for age and year effects, a $0.25 higher cigarette tax is associated with a 0.9 percent lower initiation hazard. The magnitude of this relationship increases to -1.6 when we include demographic controls, but the effect disappears entirely with the inclusion of state fixed effects. This replicates the previous finding of a modest negative effect of cigarette taxes, which is not robust to the inclusion

of state fixed effects (DeCicca et al., 2002; **?**). This supports the argument that the current price of cigarettes plays, at most, a small role in youth smoking initiation. By comparison, the final column shows that a $0.25 increase in cigarette taxes from childhood decreases the initiation hazard by 12 percent. We also note that the standard errors on the tax variables only increase slightly when both are estimated simultaneously as in Table 3. This suggests that the estimates and their statistical significance are not driven by collinearity between the two measures of cigarette taxes.

The results for the model that separately considers cigarette taxes while in utero and taxes during childhood are reported in Table 5. The tax effects are not statistically significant in this specification. The hazard ratios for taxes in utero and taxes in childhood are similar at 0.692 and 0.788, respectively. In-utero exposure may play a role, but does not appear to be the dominant factor in intergenerational transmission of smoking behavior. This provides further support that the intergenerational effect constitutes a broader social phenomenon than just the biological connection between parents and children.

5.1 Evidence for a First Stage

Finally, we present results from our first stage models in Table 6. Panel A shows the effect of cigarette taxes on the probability of being a current smoker and the number of cigarettes smoked for respondents to the NLSY79 or those who are adults compared to our main sample of youth. Panel B shows similar results for respondents in the NLSCYA who have at least one younger sibling. Estimates are reported separately by gender in columns (1) and (2) and pooled in column (3). Column (4) reports the elasticity for the estimates of number of cigarettes smoked. There is not strong evidence that cigarette taxes effect the probability of smoking in the adult sample. There is a marginally significant decrease for women, but a small and not statistically significant increase for men. There is a stronger response on the intensive margin. A one dollar increase in cigarette taxes decreases the number of cigarettes smoked by 0.28 (2.1 percent) for men and 0.65 (5.6 percent) for women, although the estimate

for men is not statistically significant. This suggests an elasticity of -0.042. Overall, adults respond to cigarette taxes by smoking fewer cigarettes but are not likely to quit.

The results for older siblings in the NLSCYA sample suggest a stronger effect on the probability of smoking and small effect on the number of cigarettes smoked. Specifically, a one dollar increase in cigarette taxes decreases probability of smoking by 1.2 percentage points (4.3 percent) for men and 2.4 percentage points (11.4 percent) for women. The response in number of cigarettes is not statistically significant for either sex. Estimates are small and positive for men and negative for women with an elasticity about two-thirds the size estimated for the adults. Since the older siblings in our sample are younger they are less engaged with smoking as evidenced by the lower prevalence of smoking and number of cigarettes smoked on average. This suggests they have less room to adjust the number of cigarettes they smoke but they also may be more likely to quit out right.

In sum, these estimates are consistent with the recent literature that suggests that people respond to cigarette taxes, but the response is not very large. If this was the total first stage, then our reduced-form estimates would be implausibly large. However, youth interact with more people than their parents and older siblings, so no one person needs to change their behavior dramatically because small changes from each individual can have a large impact on the number of people smoking and the number of cigarettes smoked across the community.

6 Conclusions

This paper poses a novel question: how do cigarette taxes affect youth smoking initiation via social interaction with older generations? We answer this by estimating the effect of cigarette taxes from before a person is at risk of initiating on their later smoking decisions. We estimate that a $0.25 cigarette tax increase during childhood decreases the risk of initiating smoking by 12.5 percent (0.68 percentage points off of a base of 5.4 percent). This effect is

robust to many specifications and independent of any direct effect of contemporaneous taxes. Importantly, even those whose mother's never smoked cigarettes are indirectly affected. We also rule out in-utero exposure as the driving factor. This suggests that community-level smoking behavior, and not just the immediate family, is an important causal element in the decision to begin smoking. Although we lack the data to estimate the relevant first stage (i.e., smoking behavior of each person in the social network), we show that parents and older siblings do respond to cigarette taxes by adjusting their smoking behavior.

To provide greater context for these estimates, consider two back-of-the-envelope exercises. First, Figure 6 shows that a $0.25 cigarette tax during childhood decreases the fraction of people who ever start smoking by 7.4 percentage points (0.588-0.514=0.074). There are currently about 32,170,166 children under the age of 8 in the U.S. (U.S. Census Bureau, 2016). This suggests that a current federal tax increase of $0.25 will deter roughly 2,380,592 children who are currently under 8-years-old from smoking in the future. Given an average lifetime external cost of smoking of $28,500 (Sloan et al., 2004), this amounts to about $68 billion in savings. This illustrates what previous research misses by focusing on only the direct effect of cigarette taxes. Second, assume the only way cigarette taxes from childhood influence smoking initiation is through the number of cigarettes smoked by adults. Say a youth has 10 adult smokers in their social network. Then, based on our estimates, increasing cigarette taxes by one dollar leads to 0.5 fewer daily cigarettes per smoker, or 5 fewer cigarettes being smoked per day. A one-dollar cigarette tax reduces smoking initiation by 50.2 percent, so a one cigarette-per-day decrease reduces smoking initiation by about 10 percent on average. Given that the average number of cigarettes smoked per day is 12.4, this implies an elasticity of about 1.25. This is a fairly large elasticity, but based on several strong assumptions. The most implausible assumption is that the entire first stage effect is captured by the number of cigarettes smoked by adults. This also ignores a massive amount of variation in the importance of a particular individual. Someone you see and interact with every day will have a larger effect on you than someone more loosely related. This

underscores the difficulty of properly measuring the first stage and the rich social network data required. The ideal data would have detailed information about smoking behavior for each person in the social network as well as a measure of the closeness of the connection between each individual and the focal youth in order to properly weight the importance of each person's behavior.

Our results suggest that the total benefits of a cigarette tax are not immediately observed. We also find that there is a causal transmission of smoking behavior from older to younger individuals. This transmission suggests that neighbors amplify the direct effect of policies on individual behavior through a social multiplier (Glaeser et al., 2003). In our context, there is no direct effect of taxes in childhood, so we measure the indirect social effect via older individuals. Unfortunately it is difficult to draw specific conclusions as to the size of the indirect social effect from our results.

Like much of the research on cigarette taxes, the current study is limited by the data available in existing longitudinal surveys. No large-scale dataset measures the smoking behavior of all family members and associated individuals. This type of data is necessary for identifying the mechanisms and directly estimating the importance of social interactions in smoking response to broad policy changes. Still, the reduced-form evidence we present is novel and informative regardless of the mechanism. Our estimates likely overestimate the intergenerational effect of cigarette taxes. People respond less to cigarette taxes over time (Hansen et al., 2017), possibly because cigarette taxes are now so high that most marginal smokers have already been forced out. One way to address this directly is to compare effects over time to give a better sense of what to expect with future policy. Unfortunately, our sample selection connects respondent birth year directly to mother's age at birth. Thus, later cohorts were born to systematically older and less disadvantaged mothers. While this does not invalidate our results for the timeframe of our data, we recommend caution in applying our estimates to recent, large tax hikes, which would generally be out out-of-sample predictions. Future work could overcome this limitation with a more representative sample

of parents.

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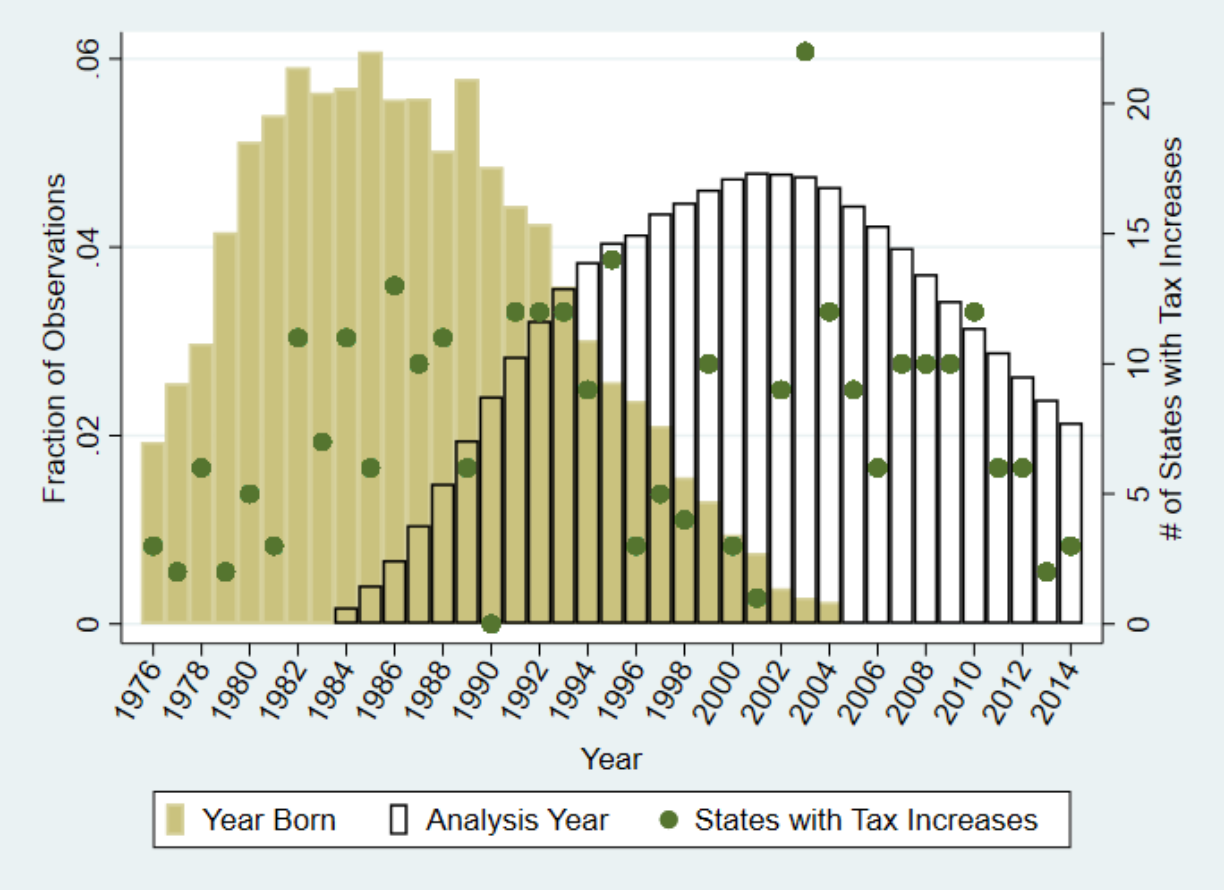
Tables & Figures

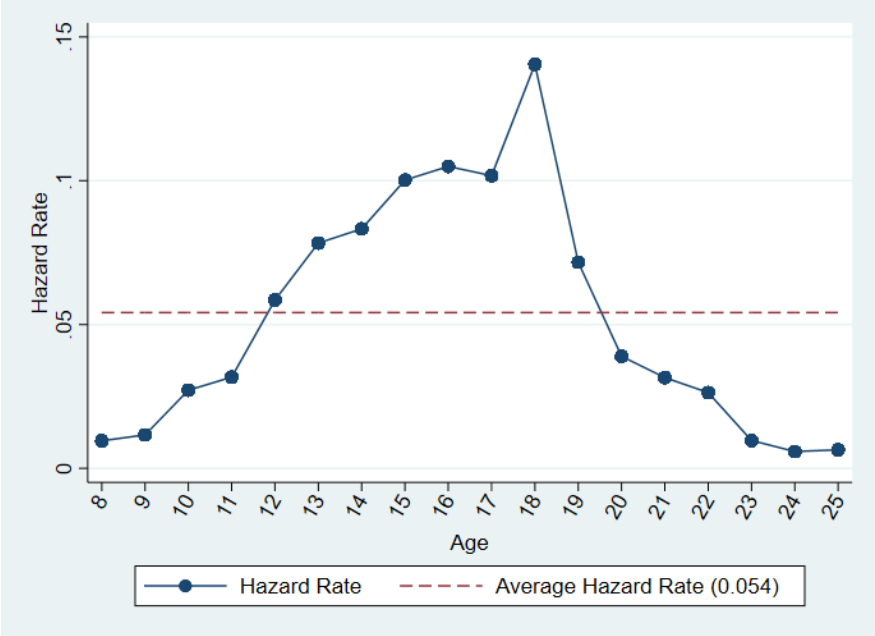
Figure 1: Sample Years and Timing of Cigarette Tax Increases



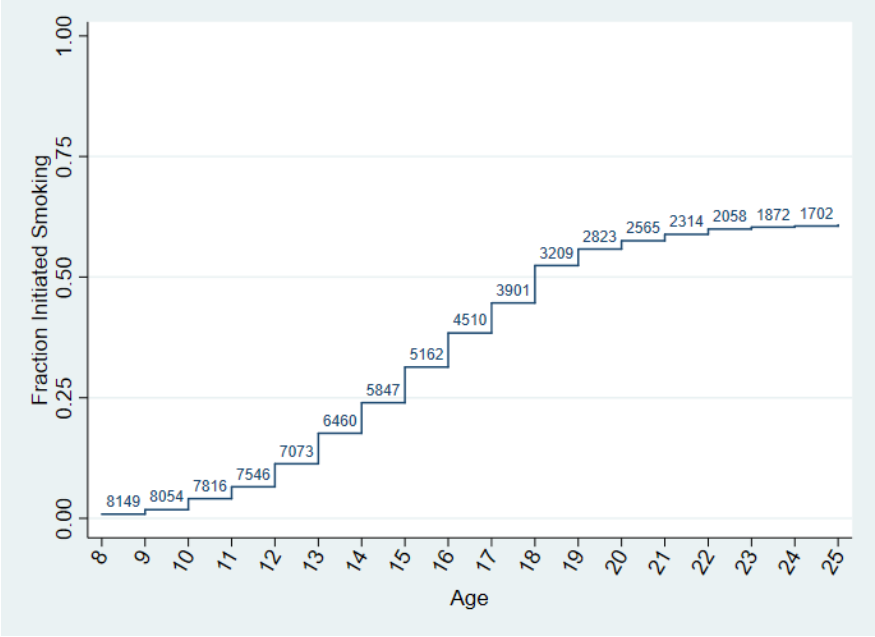
Notes: The y-axis on the left refers to the histograms of year born and year of analysis. The y-axis on the right corresponds to the scatter plot of states with tax increases in that year.

Figure 2: Baseline Smoking Initiation Hazard

A. Hazard Rate



B. Fraction Initiated Smoking



Notes: The hazard rate is the number of initiations at the given age divided by the number of individuals remaining in the sample. Panel B shows the fraction of of individuals we originally observe at age 8 who have initiated by a given age. The numbers on the graph are the number of individuals still at risk of initiating. The fraction of individuals that initiate by age 25 is 58 percent.

Table 1: Description of Smoking Initiation Hazard

	(1)	(2)	(3)	(4)	(5)
Age	# At Risk	# Failed	# Censored	Hazard Rate	Failure Function
8	8,228	79	0	0.010	0.010
9	8,149	95	0	0.012	0.021
10	8,054	219	0	0.027	0.048
11	7,816	248	19	0.032	0.078
12	7,546	442	22	0.059	0.132
13	7,073	554	31	0.078	0.199
14	6,460	538	59	0.083	0.264
15	5,847	586	75	0.100	0.336
16	5,162	542	99	0.105	0.401
17	4,510	459	110	0.102	0.457
18	3,901	548	150	0.140	0.524
19	3,209	230	144	0.072	0.552
20	2,823	110	156	0.039	0.565
21	2,565	81	148	0.032	0.575
22	2,314	61	170	0.026	0.582
23	2,058	20	195	0.010	0.585
24	1,872	11	166	0.006	0.586
25	1,702	11	1,691	0.006	0.588

Notes: Column (1) represents the number of individuals who are still in the sample and did not initiate by the given age. Column (2) reports the number of individuals who began smoking at the given age. Column (3) shows the number of individuals who left the sample before initiating. Column (4) is the hazard rate, which is calculated by dividing column (2) by column (1). Column (5) is the the fraction initiated, or the running sum of initiations divided by the original number at risk (8,228).

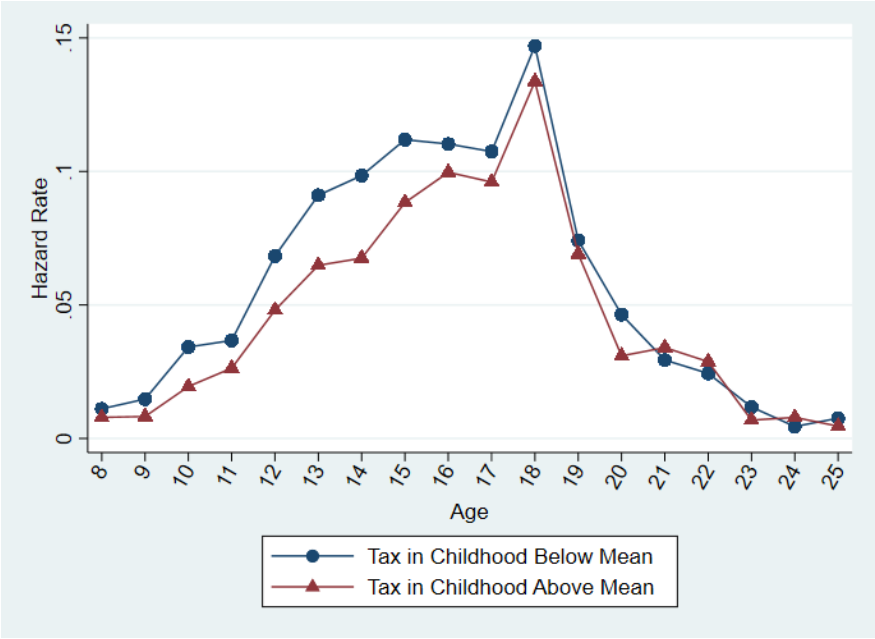
Table 2: Summary Statistics

	(1) Full Sample	(2) Mother Ever Smoked	(3) Mother Never Smoked
	A. Individual Level		
Initiated in Sample	0.58	0.66	0.48
Left Sample Without Initiating	0.42	0.34	0.52
Average Cigarette Tax ($): Birth to Age 7	0.45	0.45	0.46
Hispanic	0.08	0.07	0.09
Black	0.17	0.16	0.18
Other Race (Including White)	0.75	0.77	0.73
Male	0.51	0.51	0.51
Mother's Age at Birth	26.48	26.02	27.22
Birth Order	1.95	1.96	1.93
Mother Ever Smoked	0.59	1.00	0.00
Parent Education: Less Than High School	0.03	0.04	0.02
Parent Education: High School	0.27	0.31	0.20
Parent Education: Some College	0.49	0.48	0.49
Parent Education: BA or More	0.21	0.17	0.28
Family Income: 1st Quartile	0.18	0.23	0.11
Family Income: 2nd Quartile	0.23	0.26	0.19
Family Income: 3rd Quartile	0.32	0.30	0.35
Family Income: 4th Quartile	0.27	0.21	0.35
Individuals	8,228	4,642	3,537
	B. Individual-Age Level		
Current Cigarette Tax ($)	0.87	0.86	0.89
Smoking Initiation Hazard	0.054	0.065	0.041
Observations	89,289	47,330	41,910

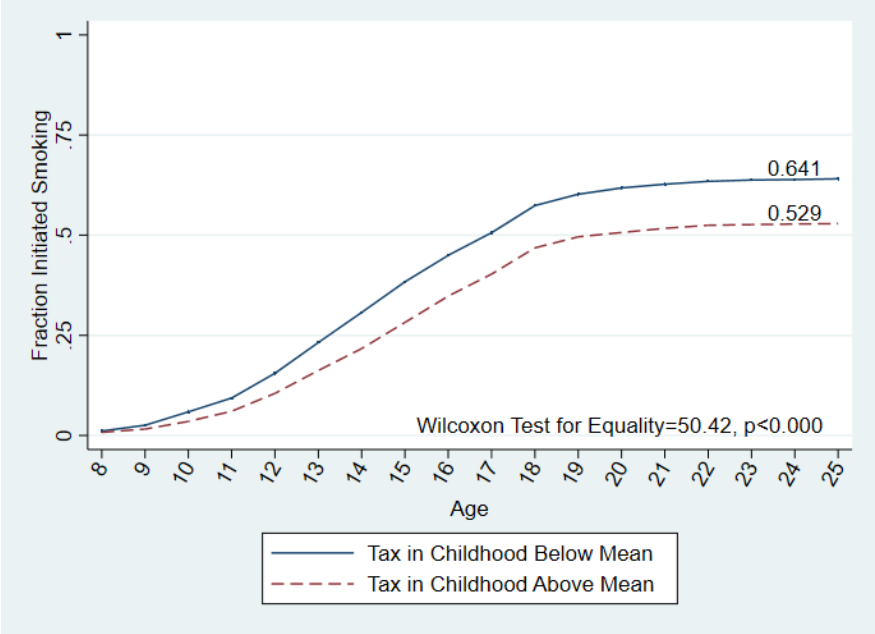
Notes: Means of each variable are reported. Data from the NLSCYA and weighted using NLSY79 weights for the mothers of those in our sample. Years of analysis range from 1984 to 2014. Income quartiles are the average quartile of total family income across sample years. Cigarette taxes are in real 2014 dollars.

Figure 3: Smoking Initiation Hazard for Cigarette Tax in Childhood Above and Below the Mean

A. Hazard Rate



B. Fraction Initiated Smoking



Notes: The hazard rate is the number of initiations at the given age divided by the number of individuals remaining in the sample. Panel B shows the fraction of of individuals we originally observe at age 8 who have initiated by a given age. The Wilcoxon test for equality is a chi

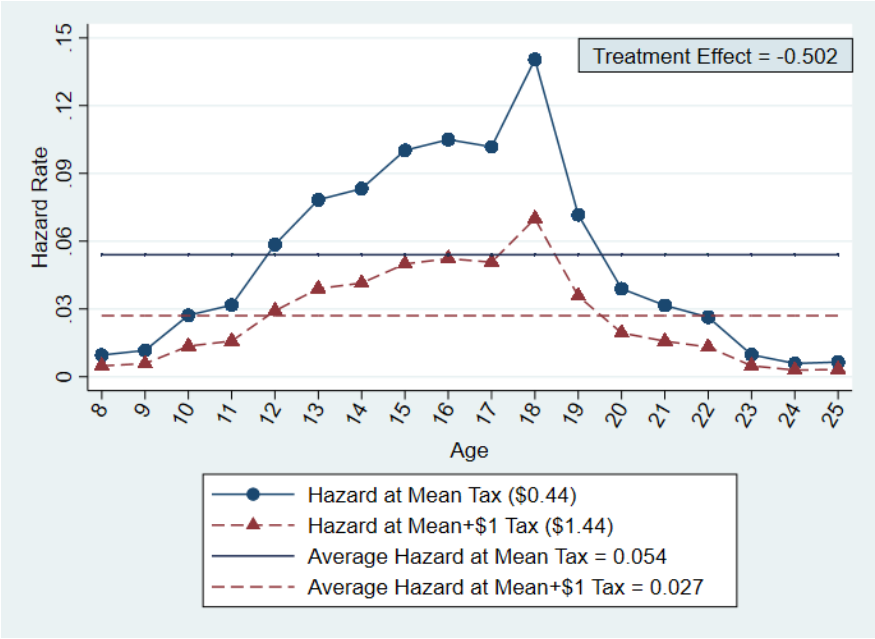
Table 3: Discrete-Time Hazard Model of Smoking Initiation

	(1) Full Sample	(2) Mother Ever Smoked	(3) Mother Never Smoked
A. Hazard Ratios ($H_0 : e^\beta = 1$)			
Average Cigarette Tax ($): Birth to Age 7	0.498**	0.449**	0.566**
	(0.080)	(0.087)	(0.122)
Current Cigarette Tax ($)	1.062	1.023	1.139
	(0.053)	(0.060)	(0.103)
B. Marginal Effects ($H_0 : (e^\beta - 1) \times 0.25 = 0$)			
Average Cigarette Tax ($): Birth to Age 7	-0.125**	-0.138**	-0.109**
	(0.020)	(0.022)	(0.031)
Current Cigarette Tax ($)	0.015	0.006	0.035
	(0.013)	(0.015)	(0.026)
Mean Smoking Initiation Hazard	0.054	0.065	0.041
Individuals	8,228	4,642	3,537
Observations	89,289	47,330	41,910

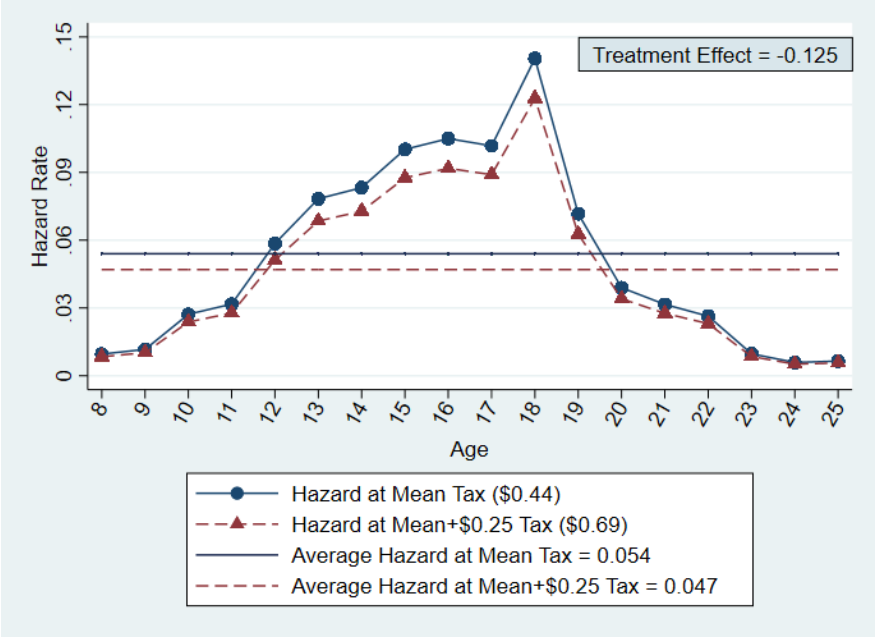
Notes: Robust standard errors clustered at the state level in parenthesis: $^{**}p < 0.05$, $^{*}p < 0.1$. Coefficients are estimated with a complementary log-log regression. All models include state, age, and year fixed effects as well as controls for sex, race, parent education, mother's age at birth, birth order, mother smoking history, and family income. Cigarette taxes are in real 2014 dollars. The age of initiation is the age at least half of retrospective reports indicate smoking by that age. Standard errors for the marginal effects are calculated using the delta method.

Figure 4: Effect of Increased Cigarette Tax in Childhood on Smoking Initiation Hazard

A. $1.00 Increase



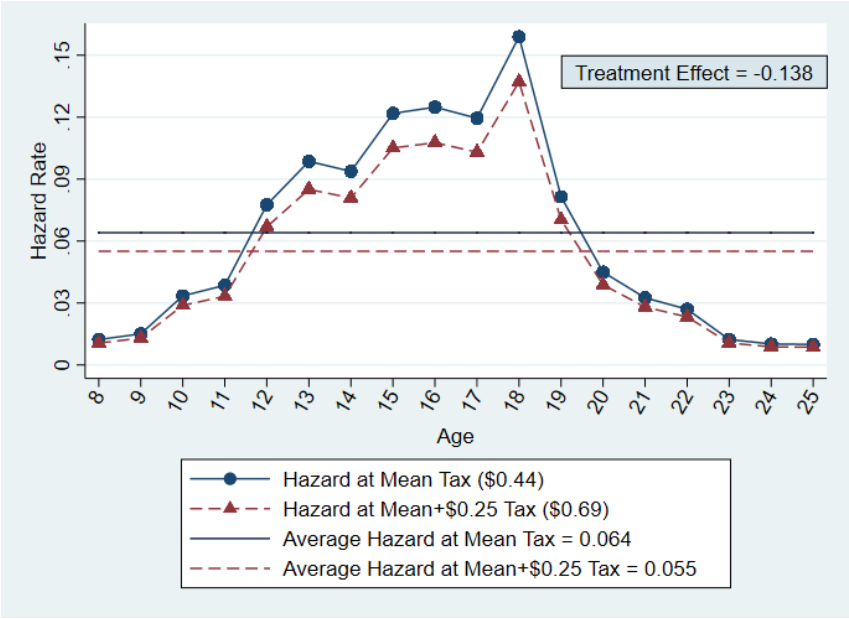
B. $0.25 Increase



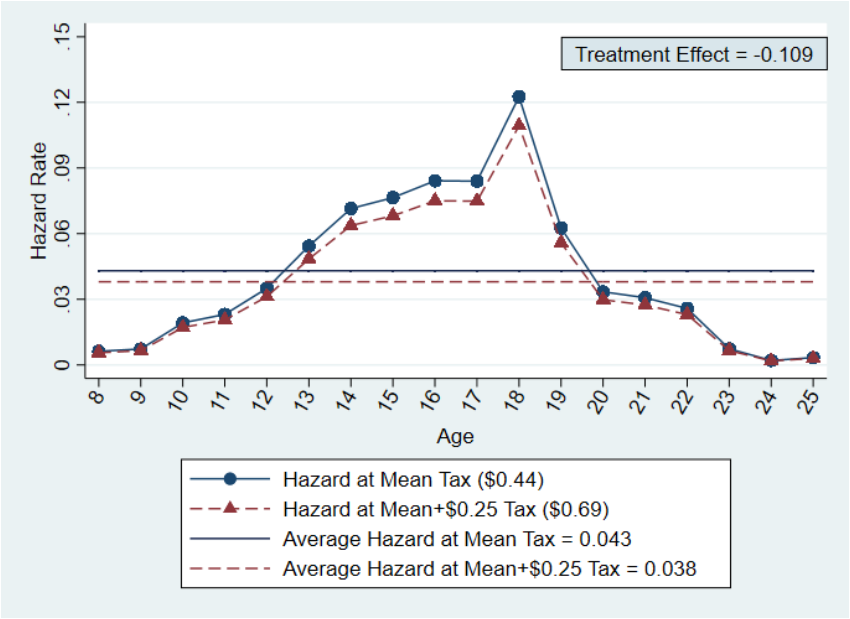
Notes: Results based on data from the NLSY Children and Young Adults (NLSCYA) in a discrete-time hazard model controlling for age, state, and year fixed effects as well as sex, race, parent education, family income, mother's age at birth, birth order, and whether mother ever smoked (see Section 3 for more details and Table 3 for full results). A 12.5 percent decrease in the hazard of smoking initiation corresponds to a 0.7 percentage point decrease off a base of 5.4 percent.

Figure 5: Effect of Increased Cigarette Tax in Childhood on Smoking Initiation Hazard by Mother Smoking History

A. Mother Ever Smoked ($0.25 Tax Increase)



B. Mother Never Smoked ($0.25 Tax Increase)



Notes: Results based on data from the NLSY Children and Young Adults (NLSCYA) in a discrete-time hazard model controlling for age, state, and year fixed effects, sex, race, parent education, family income, mother's age at birth, and birth order (see Section 3 for more details and columns (2) and (3) of Table 3 for full results). Treatment effects are a decrease of 0.95 percentage points if the mother ever smoked and 0.48 percentage points if the mother never smoked.

Table 4: Discrete-time Hazard Model of Smoking Initiation, Current Tax and Tax in Childhood Separately

	(1)	(2)	(3)	(4)
A. Hazard Ratios ($H_0 : e^\beta = 1$)				
Cigarette Tax in Childhood				0.519**
				(0.152)
Current Cigarette Tax	0.966	0.935**	1.014	
	(0.039)	(0.027)	(0.044)	
B. Marginal Effects ($H_0 : (e^\beta - 1) \times 0.25 = 0$)				
Cigarette Tax in Childhood				-0.120**
				(0.020)
Current Cigarette Tax	-0.009	-0.016**	0.004	
	(0.009)	(0.006)	(0.011)	
Demographics		X	X	X
State Fixed Effects			X	X
Individuals	8,229	8,228	8,228	8,228
Observations	89,305	89,299	89,299	89,358

Notes: Robust standard errors clustered at the state level in parenthesis: $^{**}p < 0.05$, $^{*}p < 0.1$. Demographic controls include sex, race, parent education, mother's age at birth, birth order, mother smoking history, family income, and age and year fixed effects. Cigarette taxes are in real 2014 dollars. The age of initiation is the age at least half of retrospective reports indicate smoking by that age. Standard errors for the marginal effects are calculated using the delta method.

Table 5: Discrete-Time Hazard Model of Smoking Initiation, Cigarette Taxes In Utero

	(1) Full Sample
A. Hazard Ratios ($H_0 : e^\beta = 1$)	
Cigarette Tax in Utero	0.692
	(0.275)
Cigarette Tax in Childhood	0.788
	(0.235)
Current Cigarette Tax	1.078
	(0.056)
B. Marginal Effects ($H_0 : (e^\beta - 1) \times 0.25 = 0$)	
Cigarette Tax in Utero	-0.077
	(0.069)
Cigarette Tax in Childhood	-0.053
	(0.059)
Current Cigarette Tax	0.019
	(0.014)
Mean Smoking Initiation Hazard	0.053
Individuals	7,610
Observations	82,862

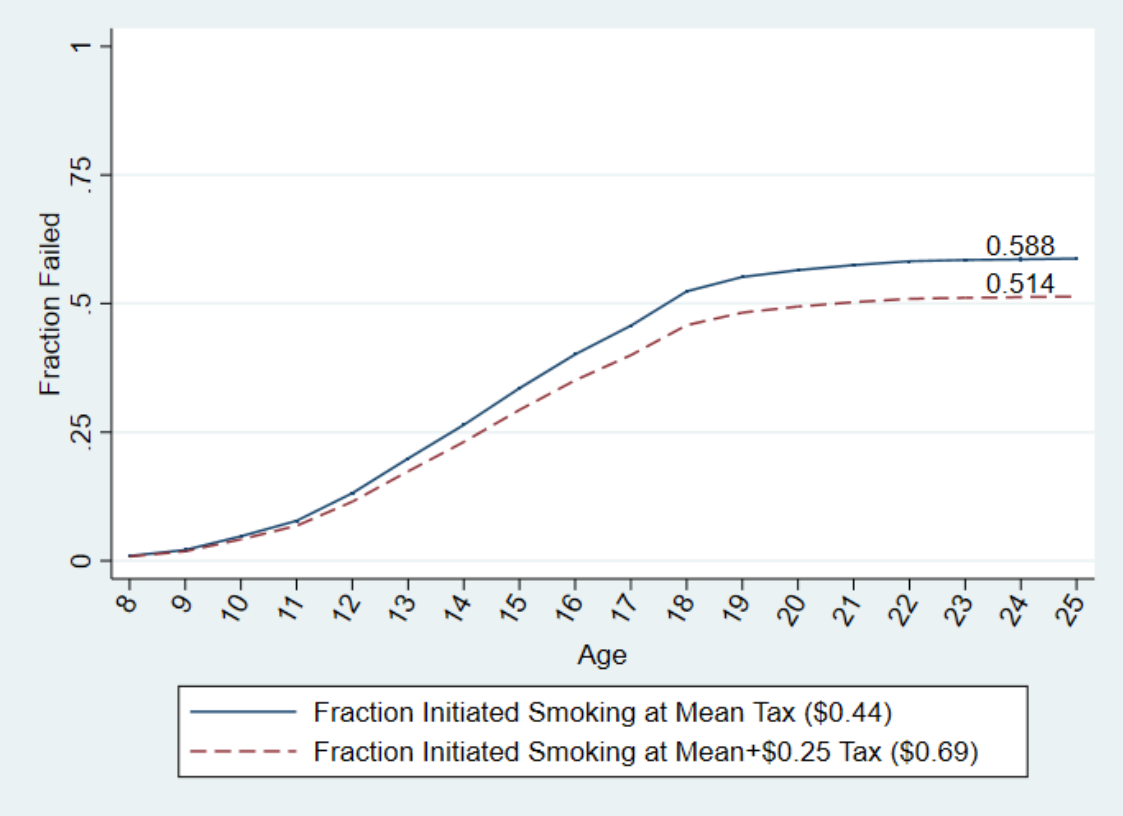
Notes: Robust standard errors clustered at the state level in parenthesis: $^{**}p < 0.05$, $^{*}p < 0.1$. All models include state, age, and year fixed effects as well as controls for sex, race, parent education, mother's age at birth, birth order, mother smoking history, and family income. Cigarette taxes are in real 2014 dollars. The age of initiation is the age at least half of retrospective reports indicate smoking by that age. Standard errors for the marginal effects are calculated using the delta method.

Table 6: First Stage Effect of Cigarette Taxes on Adult and Older Sibling Smoking

	(1) Male	(2) Female	(3) Male+Female	(4) Elasticity
	A. Adults (NLSY79)			
P(Current Smoker)	0.007	-0.012^{+}	-0.003	
	(0.009)	(0.007)	(0.005)	
Dep. Var. Mean	0.321	0.290	0.305	
N	27,591	28,797	56,388	
Number of Cigarettes	-0.280	-0.649**	-0.471**	-0.042*
	(0.312)	(0.190)	(0.192)	(0.018)
Dep. Var. Mean	13.12	11.64	12.40	2.16
N	7,471	7,102	14,573	14,573
	B. Older Siblings (NLSCYA)			
P(Current Smoker)	-0.012	-0.024**	-0.017*	
	(0.011)	(0.008)	(0.008)	
Dep. Var. Mean	0.28	0.21	0.24	
N	15,762	16,818	32,580	
Number of Cigarettes	0.01	-0.13	-0.02	-0.027
	(0.355)	(0.343)	(0.211)	(0.032)
Dep. Var. Mean	8.94	7.99	8.52	1.74
N	4,251	3,358	7,609	7,609

Notes: Robust standard errors clustered at the state level in parenthesis: ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$. All models include state and year fixed effects as well as controls for sex, race, and family income. Cigarette taxes are in real 2014 dollars.

Figure 6: Baseline and Treated Fraction Initiated



Notes: The solid blue line is evaluated with variables at their mean value and the red dashed line is evaluated with a $0.25 higher cigarette tax during childhood and all other variables at their means.

Online Appendix

Table A1: Discrete-time Hazard Model of Smoking Initiation with Alternative Start Ages

	(1) Age=6	(2) Age=7	(3) Age=8	(4) Age=9	(5) Age=10
A. Hazard Ratios ($H_0 : e^\beta = 1$)					
Cigarette Tax in Childhood	0.322**	0.360**	0.498**	0.514**	0.543**
	(0.064)	(0.068)	(0.080)	(0.080)	(0.079)
Current Cigarette Tax	1.082	1.078	1.062	1.061	1.058
	(0.058)	(0.056)	(0.053)	(0.056)	(0.058)
B. Marginal Effects ($H_0 : (e^\beta - 1) \times 0.25 = 0$)					
Cigarette Tax in Childhood	-0.169**	-0.160**	-0.125**	-0.122**	-0.114**
	(0.016)	(0.017)	(0.020)	(0.020)	(0.020)
Current Cigarette Tax	0.020	0.020	0.015	0.015	0.014
	(0.014)	(0.014)	(0.013)	(0.014)	(0.014)
Mean Smoking Initiation Hazard	0.046	0.050	0.054	0.059	0.064
Individuals	7,907	8,102	8,228	8,151	8,059
Observations	105,230	97,377	89,289	81,071	72,943

Notes: Robust standard errors clustered at the state level in parenthesis: $^{**}p < 0.05$, $^{*}p < 0.1$. All models include state, age, and year fixed effects as well as controls for sex, race, parent education, mother's age at birth, birth order, mother smoking history, and family income. Cigarette taxes are in real 2014 dollars. The age of initiation is the age at least half of retrospective reports indicate smoking by that age. Standard errors for the marginal effects are calculated using the delta method.

Table A2: Discrete-time Hazard Model of Smoking Initiation with Alternative Functional Form Assumptions

	(1) Complementary Log-log	(2) Logit	(3) Probit
A. Exponentiated Coefficients ($H_0 : e^\beta = 1$)			
Cigarette Tax in Childhood	0.498**	0.492**	
	(0.080)	(0.082)	
Current Cigarette Tax	1.062	1.068	
	(0.053)	(0.055)	
B. Marginal Effects			
Cigarette Tax in Childhood	-0.125**	-0.158**	-0.132**
	(0.020)	(0.037)	(0.035)
Current Cigarette Tax	0.015	0.015	0.016
	(0.013)	(0.011)	(0.010)
Individuals	8,228	8,228	8,228
Observations	89,289	89,289	89,289

Notes: Robust standard errors clustered at the state level in parenthesis: $^{**}p < 0.05$, $^{*}p < 0.1$. All models include state, age, and year fixed effects as well as controls for sex, race, parent education, mother's age at birth, birth order, mother smoking history, and family income. Cigarette taxes are in real 2014 dollars. The age of initiation is the age at least half of retrospective reports indicate smoking by that age. Standard errors for the marginal effects in columns (1)-(3) are calculated using the delta method. Exponentiated coefficients for column (1) are hazard ratios and odds ratios for column (2).

Table A3: Discrete-Time Hazard Model of Smoking Initiation for Additional Subsamples

	(1) Full Sample	(2) Ever Moved States	(3) Never Moved States	(4) Older Sibling	(5) No Older Sibling	(6) Born Before 1985	(7) Born in 1985 or After
			A. Hazard Ratios ($H_0 : e^\beta = 1$)				
Cigarette Tax in Childhood	0.498**	0.444**	0.485**	0.583**	0.387**	0.496**	0.659**
	(0.080)	(0.122)	(0.123)	(0.123)	(0.108)	(0.221)	(0.169)
Current Cigarette Tax ($)	1.062	1.065	1.054	1.035	1.098	1.326**	1.083
	(0.053)	(0.080)	(0.088)	(0.062)	(0.093)	(0.158)	(0.059)
			B. Marginal Effects ($H_0 : (e^\beta - 1) \times 0.25 = 0$)				
Cigarette Tax in Childhood	-0.125**	-0.139**	-0.129**	-0.104**	-0.153**	-0.126**	-0.085**
	(0.020)	(0.030)	(0.031)	(0.031)	(0.027)	(0.055)	(0.042)
Current Cigarette Tax ($)	0.015	0.016	0.014	0.009	0.024	0.082**	0.021
	(0.013)	(0.020)	(0.022)	(0.016)	(0.023)	(0.040)	(0.015)
Mean Smoking Initiation Hazard	0.054	0.055	0.054	0.053	0.056	0.077	0.044
Individuals	8,228	3,599	4,560	4,935	3,289	3,239	4,983
Observations	89,289	39,136	50,084	52,545	36,701	33,189	56,050

Notes: Robust standard errors clustered at the state level in parenthesis: $^{**}p < 0.05$, $^{*}p < 0.1$. Coefficients are estimated with a complementary log-log regression. All models include state, age, and year fixed effects as well as controls for sex, race, parent education, mother's age at birth, birth order, mother smoking history, and family income. Cigarette taxes are in real 2014 dollars. The age of initiation is the age at least half of retrospective reports indicate smoking by that age. Standard errors for the marginal effects are calculated using the delta method.

Table A4: Discrete-time Hazard Model of Smoking Initiation with Alternative Specifications

	(1) State-Time Trends	(2) Birth State	(3) State at Age 8	(4) Tax at Birth
A. Hazard Ratios ($H_0 : e^\beta = 1$)				
Cigarette Tax in Childhood (Birth to Age 7)	0.391**	0.487**	0.447**	0.626**
	(0.078)	(0.082)	(0.085)	(0.112)
Current Cigarette Tax	1.247**	1.058**	1.110**	1.066**
	(0.089)	(0.052)	(0.052)	(0.047)
B. Marginal Effects ($H_0 : (e^\beta - 1) \times 0.25 = 0$)				
Cigarette Tax in Childhood (Birth to Age 7)	-0.152**	-0.128**	-0.138**	-0.094**
	(0.020)	(0.020)	(0.021)	(0.028)
Current Cigarette Tax	0.062**	0.015	0.027**	0.016
	(0.022)	(0.013)	(0.013)	(0.012)
Mean Smoking Initiation Hazard	0.054	0.054	0.054	0.054
Individuals	8228	8,228	8,228	7,605
Observations	89289	85,313	85,313	82,815

Notes: Robust standard errors clustered at the state level in parenthesis: $^{**}p < 0.05$, $^{*}p < 0.1$. All models include controls for sex, race, parent education, and family income. Cigarette taxes are in real 2014 dollars. The age of initiation is the age at least half of retrospective reports indicate smoking by that age. Standard errors for the marginal effects are calculated using the delta method. Each model includes age fixed effects, column (1) includes state-specific linear time trends while columns (2)-(4) include state and year fixed effects. Columns (2) and (3) assume immobility in childhood where column (2) assigns the state of birth to ages 0 to 7 while column (3) assigns the state at age 8 to ages 0 to 7. Column (4) uses the tax in the year and state of birth as the tax during childhood instead of an average across the childhood years.

Table A5: Summary Statistics Without Sample Weights

	(1) Full Sample	(2) Mother Ever Smoked	(3) Mother Never Smoked	(4) Born Before 1985	(5) Born 1985 or After
A. Individual Level					
Initiated in Sample	0.59	0.66	0.50	0.74	0.49
Left Sample Without Initiating	0.41	0.34	0.50	0.26	0.51
Average Cigarette Tax ($): Birth to Age 7	0.44	0.44	0.44	0.35	0.50
Hispanic	0.22	0.19	0.26	0.24	0.21
Black	0.32	0.31	0.33	0.39	0.28
Other Race (Including White)	0.46	0.50	0.40	0.37	0.51
Male	0.51	0.51	0.50	0.50	0.51
Mother's Age at Birth	25.76	25.38	26.39	20.41	29.23
Birth Order	2.03	2.06	2.01	1.61	2.31
Mother Ever Smoked	0.56	1.00	0.00	0.61	0.53
Parent Education: Less Than High School	0.06	0.07	0.05	0.08	0.05
Parent Education: High School	0.29	0.33	0.24	0.37	0.24
Parent Education: Some College	0.48	0.47	0.48	0.45	0.49
Parent Education: BA or More	0.17	0.13	0.22	0.10	0.22
Family Income: 1st Quartile	0.30	0.35	0.22	0.39	0.23
Family Income: 2nd Quartile	0.26	0.26	0.25	0.28	0.24
Family Income: 3rd Quartile	0.26	0.24	0.30	0.22	0.29
Family Income: 4th Quartile	0.18	0.14	0.24	0.10	0.24
Individuals	8,228	4,642	3,537	3,239	4,983
B. Individual-Age Level					
Current Cigarette Tax ($)	0.56	0.55	0.57	0.39	0.67
Smoking Initiation Hazard	0.010	0.012	0.006	0.013	0.007
Observations	89,289	47,330	41,910	33,189	56,050

Notes: Means of each variable are reported. Data from the NLSCYA. Years of analysis range from 1984 to 2014. Cigarette taxes are in real 2014 dollars.

Table A6: Discrete-time Hazard Model of Smoking Initiation with No Sample Weights

	(1) Full Sample	(2) Mother Ever Smoked	(3) Mother Never Smoked
A. Hazard Ratios ($H_0 : e^\beta = 1$)			
Cigarette Tax in Childhood (Birth to Age 7)	0.630**	0.566**	0.734
	(0.113)	(0.109)	(0.169)
Current Cigarette Tax	1.007	0.998	1.037
	(0.053)	(0.054)	(0.088)
B. Marginal Effects ($H_0 : (e^\beta - 1) \times 0.25 = 0$)			
Cigarette Tax in Childhood (Birth to Age 7)	-0.093**	-0.108**	-0.067
	(0.028)	(0.027)	(0.042)
Current Cigarette Tax	0.002	-0.001	0.009
	(0.013)	(0.014)	(0.022)
Mean Smoking Initiation Hazard	0.010	0.012	0.006
Individuals	8,228	4,642	3,537
Observations	89,289	47,330	41,910

Notes: Robust standard errors clustered at the state level in parenthesis: $^{**}p < 0.05$, $^{*}p < 0.1$. All models include state, age, and year fixed effects as well as controls for sex, race, parent education, mother's age at birth, birth order, mother smoking history, and family income. Cigarette taxes are in real 2014 dollars. The age of initiation is the age at least half of retrospective reports indicate smoking by that age. Standard errors for the marginal effects are calculated using the delta method.

Table A7: Discrete-time Hazard Model of Smoking Initiation with No Sample Weights

	(1) Full Sample	(2) Ever Moved States	(3) Never Moved States	(4) Older Sibling	(5) No Older Sibling	(6) Born Before 1985	(7) Born in 1985 or After
	A. Hazard Ratios ($H_0 : e^\beta = 1$)						
Cigarette Tax in Childhood	0.630**	0.536**	0.743	0.760	0.504**	0.546**	0.808
	(0.113)	(0.132)	(0.198)	(0.171)	(0.122)	(0.221)	(0.192)
Current Cigarette Tax	1.007	1.015	1.002	0.965	1.085	1.202	1.027
	(0.053)	(0.066)	(0.073)	(0.049)	(0.098)	(0.160)	(0.070)
	B. Marginal Effects ($H_0 : (e^\beta - 1) \times 0.25 = 0$)						
Cigarette Tax in Childhood	-0.093**	-0.116**	-0.064	-0.060	-0.124**	-0.114**	-0.048
	(0.028)	(0.033)	(0.049)	(0.043)	(0.031)	(0.055)	(0.048)
Current Cigarette Tax	0.002	0.004	0.000	-0.009	0.021	0.051	0.007
	(0.013)	(0.016)	(0.018)	(0.012)	(0.024)	(0.040)	(0.018)
Mean Smoking Initiation Hazard	0.010	0.010	0.009	0.010	0.009	0.013	0.007
Individuals	8,228	3,599	4,560	4,935	3,289	3,239	4,983
Observations	89,289	39,136	50,084	52,545	36,701	33,189	56,050

Notes: Robust standard errors clustered at the state level in parenthesis: $^{**}p < 0.05$, $^{*}p < 0.1$. All models include state, age, and year fixed effects as well as controls for sex, race, parent education, mother's age at birth, birth order, mother smoking history, and family income. Cigarette taxes are in real 2014 dollars. The age of initiation is the age at least half of retrospective reports indicate smoking by that age. Standard errors for the marginal effects are calculated using the delta method.

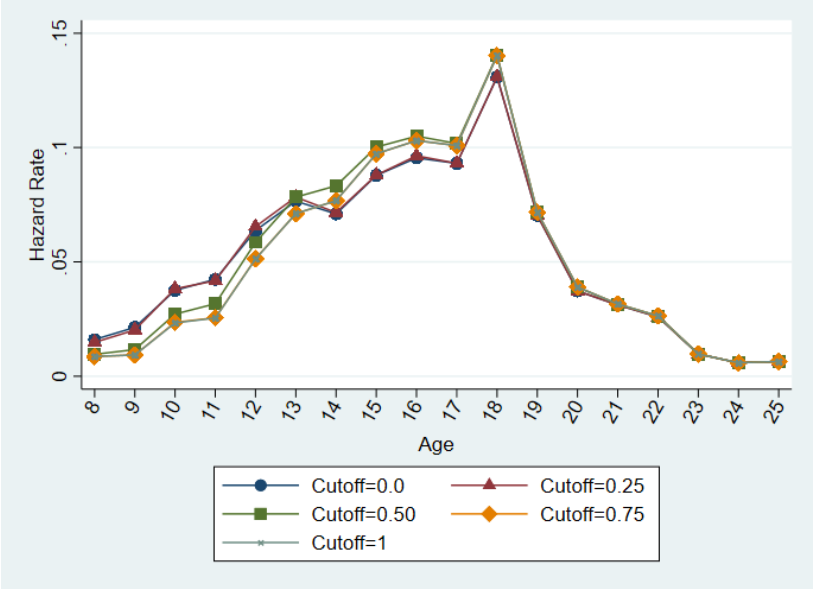
Table A8: Summary Statistics, In and Out of the Estimation Sample

	(1) In Sample	(2) Out of Sample
A. Individual Level		
Initiated in Sample	0.58	0.65
Left Sample Without Initiating	0.42	0.35
Average Cigarette Tax ($): Birth to Age 7	0.45	0.45
Hispanic	0.08	0.07
Black	0.17	0.13
Other Race (Including White)	0.75	0.80
Male	0.51	0.53
Mother's Age at Birth	26.48	25.35
Birth Order	1.95	1.81
Mother Ever Smoked	0.59	0.58
Parent Education: Less Than High School	0.03	0.09
Parent Education: High School	0.27	0.32
Parent Education: Some College	0.49	0.43
Parent Education: BA or More	0.21	0.17
Family Income: 1st Quartile	0.18	0.25
Family Income: 2nd Quartile	0.23	0.27
Family Income: 3rd Quartile	0.32	0.25
Family Income: 4th Quartile	0.27	0.23
Individuals	8,228	3,278
B. Individual-Age Level		
Current Cigarette Tax ($)	0.87	1.01
Smoking Initiation Hazard	0.054	0.016
Observations	89,289	17,387

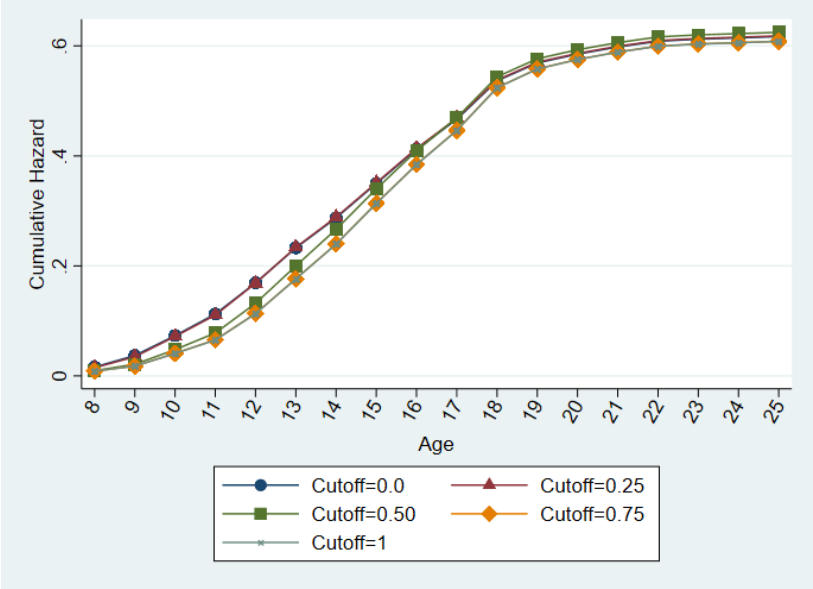
Notes: Means of each variable are reported. Data from the NLSCYA and weighted using NLSY79 weights for the mothers of those in our sample. Years of analysis range from 1984 to 2014. Cigarette taxes are in real 2014 dollars.

Figure A1: Hazard Comparison for Several Failure Cutoffs

A. Hazard Rate



B. Fraction Initiated Smoking



Notes: Failure is defined as whether the fraction of reports of age first started smoking are above a certain cutoff. A cutoff of 0 corresponds to using the minimum age reported to define initiation and a cutoff of 1 corresponds to using the maximum age reported.

Table A9: Discrete-time Hazard Model of Smoking Initiation with Alternative Failure Cutoffs

	(1) Cutoff at 0	(2) Cutoff at 0.25	(3) Cutoff at 0.5	(4) Cutoff at 0.75	(5) Cutoff at 1	(6) No Discrepancy
			A. Hazard Ratio ($H_0 : e^\beta = 1$)			
Cigarette Tax in Childhood	0.462**	0.465**	0.498**	0.525**	0.530**	0.501**
	(0.068)	(0.068)	(0.080)	(0.087)	(0.089)	(0.098)
Current Cigarette Tax	1.056	1.056	1.062	1.064	1.061	1.087
	(0.052)	(0.051)	(0.053)	(0.051)	(0.051)	(0.061)
			B. Marginal Effects ($H_0 : (e^\beta - 1) \times 0.25 = 0$)			
Cigarette Tax in Childhood	-0.134**	-0.134**	-0.125**	-0.119**	-0.117**	-0.125**
	(0.017)	(0.017)	(0.020)	(0.022)	(0.022)	(0.024)
Current Cigarette Tax	0.014	0.014	0.015	0.016	0.015	0.022
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.015)
Mean Smoking Initiation Hazard	0.055	0.055	0.054	0.051	0.051	0.047
Individuals	8,123	8,143	8,228	8,237	8,237	7,256
Observations	86,707	86,910	89,289	89,939	89,973	83,048

Notes: Robust standard errors clustered at the state level in parenthesis: $^{**}p < 0.05$, $^{*}p < 0.1$. All models include state, age, and year fixed effects as well as controls for sex, race, parent education, mother's age at birth, birth order, mother smoking history, and family income. Cigarette taxes are in real 2014 dollars. The age of initiation is the age at least half of retrospective reports indicate smoking by that age. Standard errors for the marginal effects are calculated using the delta method.

Table A10: Discrete-time Hazard Model of Smoking Initiation, Only Those Observed Until Age 25

	(1) Full Sample
A. Hazard Ratios ($H_0 : e^\beta = 1$)	
Cigarette Tax in Childhood (Birth to Age 7)	0.511**
	(0.141)
Current Cigarette Tax	1.076
	(0.101)
B. Marginal Effects ($H_0 : (e^\beta - 1) \times 0.25 = 0$)	
Cigarette Tax in Childhood (Birth to Age 7)	-0.122**
	(0.035)
Current Cigarette Tax	0.019
	(0.025)
Mean Smoking Initiation Hazard	0.066
Individuals	5,545
Observations	60,441

Notes: Robust standard errors clustered at the state level in parenthesis: ** $p < 0.05$, * $p < 0.1$. All models include state, age, and year fixed effects as well as controls for sex, race, parent education, mother's age at birth, birth order, mother smoking history, and family income. Cigarette taxes are in real 2014 dollars. The age of initiation is the age at least half of retrospective reports indicate smoking by that age. Standard errors for the marginal effects are calculated using the delta method.

Table A11: Discrete-time Hazard Model of Smoking Initiation, All Demographic Coefficients

	(1) Full Sample	(2) Mother Ever Smoked	(3) Mother Never Smoked
Marginal Effects ($H_0 : (e^{\beta} - 1) \times 0.25 = 0$)			
Cigarette Tax in Childhood	-0.125**	-0.138**	-0.109**
	(0.020)	(0.022)	(0.031)
Current Cigarette Tax ($)	0.015	0.006	0.035
	(0.013)	(0.015)	(0.026)
Mother's Age at Birth	-0.007**	-0.010**	-0.001
	(0.002)	(0.003)	(0.005)
Birth Order	0.025**	0.026**	0.020**
	(0.007)	(0.008)	(0.010)
Mother Ever Smoked	0.114**	0.000	0.000
	(0.016)	(0.000)	(0.000)
Male	0.050**	0.026**	0.104**
	(0.011)	(0.012)	(0.018)
Black	-0.111**	-0.121**	-0.093**
	(0.008)	(0.009)	(0.017)
Hispanic	-0.042**	-0.058**	-0.012
	(0.010)	(0.011)	(0.019)
Income, 2nd Quartile	-0.006	0.002	-0.028
	(0.015)	(0.025)	(0.023)
Income, 3rd Quartile	-0.053**	-0.049**	-0.068**
	(0.016)	(0.020)	(0.022)
Income, 4th Quartile	-0.068**	-0.075**	-0.066**
	(0.015)	(0.020)	(0.022)
Parent Education: High School	-0.013	-0.025	0.040
	(0.020)	(0.027)	(0.048)
Parent Education: Some College	-0.014	-0.023	0.044
	(0.019)	(0.026)	(0.044)
Parent Education: BA or More	-0.048**	-0.052*	-0.013
	(0.018)	(0.027)	(0.036)
Mean Smoking Initiation Hazard	0.054	0.065	0.041
Individuals	8,228	4,642	3,537
Observations	89,289	47,330	41,910

Table A12: Summary Statistics for Additional Subsamples

	(1) Ever Moved States	(2) Never Moved States	(3) Older Sibling	(4) No Older Sibling	(5) Born Before 1985	(6) Born in 1985 or After
			A. Individual Level			
Initiated in Sample	0.59	0.58	0.56	0.62	0.76	0.49
Left Sample Without Initiating	0.41	0.42	0.44	0.38	0.24	0.51
Average Cigarette Tax ($): Birth to Age 7	0.45	0.46	0.48	0.42	0.35	0.51
Hispanic	0.06	0.09	0.09	0.07	0.10	0.07
Black	0.15	0.18	0.18	0.15	0.23	0.14
Other Race (Including White)	0.78	0.73	0.73	0.78	0.67	0.79
Male	0.52	0.50	0.52	0.50	0.50	0.51
Mother's Age at Birth	26.50	26.59	28.06	24.28	20.85	29.50
Birth Order	1.94	1.96	2.63	1.00	1.55	2.16
Mother Ever Smoked	0.59	0.58	0.59	0.59	0.65	0.55
Parent Education: Less Than High School	0.02	0.05	0.04	0.02	0.05	0.02
Parent Education: High School	0.21	0.31	0.27	0.26	0.36	0.22
Parent Education: Some College	0.50	0.48	0.48	0.49	0.47	0.50
Parent Education: BA or More	0.27	0.16	0.21	0.23	0.12	0.26
Family Income: 1st Quartile	0.16	0.19	0.20	0.16	0.26	0.14
Family Income: 2nd Quartile	0.26	0.20	0.23	0.23	0.29	0.20
Family Income: 3rd Quartile	0.32	0.32	0.31	0.33	0.28	0.34
Family Income: 4th Quartile	0.26	0.28	0.26	0.28	0.17	0.33
Individuals	3,599	4,560	4,935	3,289	3,239	4,983
			B. Individual-Age Level			
Current Cigarette Tax ($)	0.83	0.91	0.95	0.78	0.51	1.05
Smoking Initiation Hazard	0.055	0.054	0.053	0.056	0.077	0.044
Observations	39,136	50,084	52,545	36,701	33,189	56,050

Notes: Means of each variable are reported. Data from the NLSCYA and weighted using NLSY79 weights for the mothers of those in our sample. Years of analysis range from 1984 to 2014. Cigarette taxes are in real 2014 dollars.

Table A13: First Stage Effect of Cigarette Taxes on Adult and Older Sibling Smoking – State-Time Trends

	(1) Male	(2) Female	(3) Male+Female	(4) Elasticity
	A. Adults (NLSY79)			
P(Current Smoker)	0.013^{+}	-0.004	0.004	
	(0.007)	(0.007)	(0.005)	
Dep. Var. Mean	0.321	0.290	0.305	
N	27,591	28,797	56,388	
Number of Cigarettes	-4.677**	-4.197**	-4.456**	-0.581**
	(0.956)	(0.818)	(0.883)	(0.112)
Dep. Var. Mean	13.12	11.65	12.40	2.16
N	7,471	7,102	14,573	14,573
	B. Older Siblings (NLSCYA)			
P(Current Smoker)	-0.018	-0.039**	-0.028**	
	(0.012)	(0.011)	(0.010)	
Dep. Var. Mean	0.281	0.207	0.243	
N	15,762	16,818	32,580	
Number of Cigarettes	-0.15	-0.40	-0.23	-0.060^{+}
	(0.343)	(0.384)	(0.217)	(0.036)
Dep. Var. Mean	8.94	7.99	8.52	1.74
N	4,251	3,358	7,609	7,609

Notes: Robust standard errors clustered at the state level in parenthesis: ** $p < 0.01$, * $p < 0.05$, $^{+}$ $p < 0.1$. All models include state-specific linear time trends as well as controls for sex, race, and family income. Cigarette taxes are in real 2014 dollars.