Taxing for Health: The Enduring Benefits of In-Utero Cigarette Tax Exposure on Adult Health

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Abstract*: Cigarette taxes have been shown to reduce maternal smoking and enhance birth outcomes. However, it is still uncertain whether these effects persist into adulthood. This study investigates the long-term effects of exposure to higher in-utero cigarette taxes on health outcomes in adulthood. Utilizing a generalized difference-in-differnce methodology and analyzing a rich dataset spanning births from 1968 to 1994, I find that a 10-cent increase in in-utero cigarette tax leads to a significant 1.8-percentage-points reduction in the likelihood of ever experiencing health conditions such as asthma, lung disease, heart disease, and heart attacks for individuals aged 25 to 35. The examination of mechanisms underscores pathways through parental smoking behavior during pregnancy, birth outcomes, childhood health, smoking behavior, cognitive ability, educational attainment, and age at first childbirth. The study contributes to the burgeoning literature on early-life determinants of health and enriches our understanding of the complex interplay between cigarette policies and long-term health, with implications for policymakers and public health interventions.*

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JEL classification: H25, H71, I12, J13

Maternal smoking and exposure to second-hand smoke during pregnancy have long been known to be harmful to unborn babies. Tobacco smoke is a deadly mix of more than 7,000 chemicals and can damage the growing brain, lungs, arteries, and other delicate tissues (United States Department of Health and Human Services (USDHHS), 2010). It is also the largest preventable cause for low birth weight, which is one of the best predictors for later life health (Black et al., 2007; Case et al., 2005; Currie, 2009; McEvoy and Spindel, 2017). Governments have adopted a series of policies and regulations such as cigarette taxes, smoke bans in public places, youth-access restrictions,

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warning labels on tobacco packaging, and bans on advertising, to fight against smoking and improve public health. Among them, cigarette taxes are viewed to be the single most effective policy (WHO, 2015).

Researchers have found causal evidence that cigarette taxes reduce maternal smoking during pregnancy (Adams et al., 2012; Bradford, 2003; Colman et al., 2003; Lien and Evans, 2005), and in utero exposure to cigarette taxes improves infant health and health in childhood (Evans and Ringel, 1999; Lien and Evans, 2005; Tominey, 2007; Patrick et al., 2016; Simon, 2016). Yet very little is known about the effect of in-utero exposure to cigarette taxes on long-term human capital accumulation. Since smoking is a behavior commonly linked to low socioeconomic status and cigarette smoke could be one channel of the intergenerational transmission, the long-term effect of in-utero exposure to cigarette tax has profound implications for policymakers and public health interventions.

This paper explores the impact of in-utero exposure to cigarette taxes on adult health. I employ a general difference-in-difference approach allowing me to control for unobserved heterogeneity at both the year and state level. In addition, I apply an event study on a specific period to show the discrete impact of in utero exposure to cigarette tax hikes. Considering the recent critique on two-way fixed effect estimator that it could be biased in the case of heterogeneous treatment effect (Callaway et al. 2021; De Chaisemartin and D'Haultfoeuille, 2020), I adopt a staggered DID estimator that valid in the presence of heterogeneity treatment effect (De Chaisemartin and D'Haultfoeuille, 2020) to estimate the effect of exposure to different discrete in-utero cigarette tax levels on adult health.

I make use of the Panel Study of Income Dynamics (PSID) data spanning from 1968 to 2019. This dataset offers vital information on family backgrounds at the year of birth, childhood health and ability assessment, smoking behavior in adolescent and adulthood, and various other adult outcomes. I investigate the underlying mechanisms behind long-term health effects such as the impact on parental smoking behavior during pregnancy, childhood cognitive ability and noncognitive ability, smoking behavior, educational attainment, and the age of first childbirth. To investigate the underlying mechanisms, I also make use of the PSID-Child Development Supplements (PSID-CDS) data and the public use Vital Statistics Natality files.

I find that exposure to higher in-utero cigarette taxes significantly improves health in adulthood. A tax increase of 10 cents at birth reduces the probability that individuals have any of the following health conditions: asthma, lung disease, heart disease or heart attack for individuals aged 25-35 by around two percentage points. This effect corresponds to eight percent of the mean, indicating a substantial reduction in the population who suffer from any of the aforementioned health conditions. Furthermore, the results suggest that the size of the beneficial health effect is increasing as people age. The results of the event study show that even the third trimester exposure to cigarette tax hike alone improves the long-term health significantly. The results from the staggered DID estimator also support my finding. The results are stable across subgroups along key dimensions of demographic characteristics, family background, and different cohorts. The findings are also robust to a number of specification tests.

I proceed to explore the underlying mechanisms behind the long-term health effects. Using the PSID, I find that higher cigarette taxes reduce the probability of parental smoking, especially for parents who are about to have a baby, a result I then confirm using the Natality data. Moreover, higher in-utero cigarette taxes improve birth outcomes measured using average birth weight, average gestational age, average APGAR score, very low birth weight rate, preterm delivery rate, and low APGAR score rate. In addition, higher in-utero cigarette taxes are associated with better physical and mental health in childhood (between ages 6 and 12), higher cognitive ability, a higher likelihood of obtaining a college or above degree, and a lower probability of smoking and reduced smoke intensity for smokers both in teens and in adulthood. Lastly, I offer evidence that higher in-utero cigarette taxes are associated with postponed age of first childbirth, which is positively correlated with better health (Lee and Park, 2020; Shadyab et al., 2017).

To my best knowledge, this paper is the first to investigate the *long-run* impact of early-life exposure to cigarette tax on health. Most of previous studies in the field focus on contemporaneous impact of cigarette taxes, such as the association between cigarette taxes and pregnant women's smoking behavior (Adams et al., 2012; Bradford, 2003; Colman et al., 2003; Lien and Evans, 2005), the association between cigarette taxes in early-life and infants' and childhood health (Evans and Ringel, 1999; Lien and Evans, 2005; Patrick et al., 2016; Simon, 2016), and the association between cigarette taxes in early life and educational attainment of adolescents (Settele and Ewijk, 2018). In the study most closely related to mine, Hoehn-Velasco et al. (2021) find that exposure to early-life cigarette taxes reduces the probability of pre-pregnancy and prenatal smoking and the probability of being overweight or obese during pregnancy for grown-up females. These are the only health outcomes or behaviors in adulthood of which I are aware that have been studied in terms of the effects of early-life exposure to cigarette taxes.

This paper also contributes to the literature on the long-run impact of early life environment[2]. These studies provide evidence that early life environments are critical for the development of human capital. In the early stage, much of this literature exploits variation from natural disaster and disease (Almond, 2006; Barreca, 2010; Lindeboom et al. 2010). More recently, studies have looked at policy experiments such as the Earned Income Tax Credit (EITC), food stamp, the special supplemental nutrition program for Women, Infant and Children (WIC), and alcohol availability (Bastian and Michelmore, 2018; Hoynes et al., 2016; Hwang, 2019; Nilsson, 2017). I extend the literature by examining the impact of a policy that is inexpensive to implement and generates new revenues. Moreover, most policy experiments usually happen within a short period of time, but people are exposed to cigarette taxes for a much longer duration, which allows us to compare the effect of exposure to cigarette tax at different period of the lifecycle. The finding reveals that in utero exposure to cigarette taxes has a greater impact on adult health compared to exposure to cigarette taxes in childhood or in adulthood.

Finally, this study has important policy implications. First, this research underscores the enduring impact of early-life policy interventions, so policymakers might consider focusing not just on immediate outcomes but also on the longer-term effects when evaluating the benefits of various interventions. Second, given that in-utero cigarette taxes are found to have significant long-term health benefits, governments could consider revisiting these taxes. Third, the link between higher in-utero cigarette taxes and improved physical and mental health, cognitive ability, higher education, and reduced smoking in both adolescence and adulthood suggests that such tax policies

[2] See, e.g., Currie (2009) and Almond and Currie (2011) for reviews of this literature.

should be a critical component of broader public health strategies. Lastly, my findings suggest that early-life environments play a crucial role in the development of human capital. Policymakers therefore might investigate other potential early-life interventions that could yield similar long-term benefits. For example, there could be potential in studying the long-term effects of taxes on other harmful substances, such as alcohol or sugary beverages, and their association with health and developmental outcomes.

The remainder of the paper is structured as follows. Section I summarizes the medicine science literature on the effect of exposure to tobacco smoke during pregnancy and economic literature on the cigarette tax effects. Section II presents the theoretical framework. Section III describes the data and Section IV presents the empirical model. Section V shows the results. I conclude in Section H.

I. Background and Previous Research

Maternal smoking during pregnancy is known to be harmful for unborn babies. According to the Surgeon General's reports, "the nicotine in cigarettes may cause constrictions in the blood vessels of the umbilical cord and uterus, thereby decreasing the amount of oxygen available to the fetus. Nicotine also may reduce the amount of blood in the fetal cardiovascular system" (USDHHS, 2004, p.564). Moreover, smoking during pregnancy can cause tissue damage in the unborn baby, particularly in the lung and brain (USDHHS, 2010). Maternal smoking during pregnancy leads to worse birth outcomes. Infants born to mother who smoke during pregnancy are more likely to be small for gestational age and have a lower average birth weight than infants born to women who do not smoke during pregnancy while low birth weight is associated with increased risk for neonatal, perinatal, and infant morbidity and mortality. Environmental tobacco smoke (ETS) is also harmful to the fetus. Comparing to infants born to women who are not exposed to ETS , infants born to women who are exposed to ETS during pregnancy may have a small decrease in birth weight and a slightly increased risk for intrauterine growth retardation. The timing of exposure is important. Smoking in the third trimester is particularly detrimental while infants of mothers who stop smoking by the first trimester have birth weights and body measurements comparable with those of mothers who do not smoke (USDHHS , 2001).

Some studies further suggest that maternal smoking during pregnancy is associated with health and behavior problems in later life. Children whose mothers smoked during pregnancy are at a higher risk for a wide range of problems such as overweight, asthma, lung disease, attention deficit hyperactivity disorder and conduct problems (Gilliland et. al., 2000; Gilliland et. al., 2001; Milberger et. al. 1996; Oken et. al., 2008). Association between maternal smoking during pregnancy and substance abuse and criminal outcomes in adulthood is also found (Brennan et. al., 1999).

Moreover, maternal smoking during pregnancy, after controlling for postnatal smoking, increases the risk of smoking and developing nicotine dependence for children when they grow up (Biederman et. al., 2017; Kandel et. al., 1994; Lieb et. al., 2003). Smoking leads to health problems and harms nearly every organ of the body (USDHHS, 2014). Young people who smoke are at the risk of addiction to nicotine, reduced lung growth and lung function, and early cardiovascular damage (CDC, 2012). The risk increases when smoking continues for many years and can cause more severe health conditions such as lung disease, heart disease, stroke, cancer, diabetes, and chronic obstructive pulmonary disease, and increases risk for tuberculosis, certain eye diseases, and problems of the immune system (USDHHS, 2014).

However, maternal smoking during pregnancy is preventable. Prevention policies such as cigarette taxes, smoking bans in public places, youth-access restrictions, and warnings about the dangers of tobacco have been adopted by governments. Among them, raising taxes on tobacco is the single most effective way to reduce tobacco use for the following reasons: higher tobacco taxes and prices reduce consumption and promote quitting; it is inexpensive to implement; it is especially effective in reducing tobacco use by young people who is very price sensitive; it generates new revenues which can support tobacco control and other health initiatives (WTO, 2015).

Economic literature has provided causal evidence that cigarette taxes improve children's health at birth. Using data from the 1989-1992 Natality files, Evans and Ringel (1999) find that a one-cent increase (in 1982-4 dollar) in real cigarette tax during the conception month leads to a reduction of around 0.08 percentage points in the smoking rate for pregnant women and an increase of around

0.21 grams in birth weight, a finding largely supported by the literature (Adams et al., 2012; Bradford, 2003; Colman et al., 2003; Lien and Evans, 2005; Patrick et al., 2016).

Moreover, economists have found that cigarette tax during pregnancy has impact on children in later life. For the medium-term effect, using data from National Health Interview Survey (NHIS), Simon (2016) finds that a one-dollar increase in real in-utero tax during the first month of the third trimester leads to a 10-percent decrease in sick days from school and an around 5-percent decrease in having two or more doctor visits for children born from 1988 to 2009. Settele and Ewijk (2018) find that higher cigarette taxes during pregnancy improve educational attainment for children born between 1988 and 1998 with mothers who have less than high school education. These studies suggest that the effect of cigarette tax during pregnancy on health in childhood and educational attainment in adolescence can be mediators for long-term health effects. For the long-run effect, Hoehn-Velasco et al. (2021) find that a one-percent increase in in-utero cigarette taxes reduces the probability of any smoking prior to conception for pregnant women by 0.21% and reduces the probability of prenatal smoking by 0.24%. They also find that higher cigarette taxes are associated with a lower pre-pregnancy BMI and a lower likelihood of developing diabetes before or during pregnancy.

My work makes important contributions to this literature by providing the first empirical evidence on the *long-term* health effects of exposure to higher in-utero cigarette taxes.

II. Theoretical Framework

Cunha and Heckman (2007) provides a theoretical framework for the production of an individual's human capital. Their model provide theoretical evidence how cigarette taxes in prenatal period could have long-term health impact on health. Human capital refers to cognitive ability, noncognitive ability and health condition. Denote individual's human capital at period t as $\theta_t \equiv (\theta_t^C, \theta_t^N, \theta_t^H)$, where θ^C refers to cognitive ability, θ^N refers to noncognitive ability, and θ^H refers to health condition. Based on Cunha and Heckman (2007)'s theory, I model human capital as a production of parental characteristics, investment, and environment (I add the environment to the original Cunha-Heckman model for the convenience of understanding the impact of cigarette tax).

Each period's human capital depend on the capital in the previous stage, investment in human capital and the environmental quality in the previous stage and the parental characteristics. Let h denotes parental characteristics, I_t denote the investment at period t, and E_t denote the environmental quality at period t. The human capital at period *t+1* is presented by

$$\theta_{t+1} = f_t(h, \theta_t, I_t, E_t). \qquad (1)$$

The human capital θ_{t+1} increases with investment and environment in the last period, that is, $\frac{\partial f_t}{\partial I_t} > 0$ and $\frac{\partial f_t}{\partial E_t} > 0$. Substituting Equation (1) for θ_{t-1}, θ_{t-2},…, repeatedly, the human capital at period *t+1* can be written as a function of parental characteristics, initial human capital, environment quality and investments in all the past periods from in-utero period to period *t*.

$$\theta_{t+1} = m(h, \theta_1, E_1, \dots, E_t, I_1, \dots, I_t). \qquad (2)$$

This framework captures three features: "sensitive and critical period", "self-productivity", and "dynamic complementarity" in the development of children's human capital (Cunha and Heckman, 2007).

"Sensitive period" refers to period that are more effective in producing some human capital than other periods. "Critical period" refers to that one period alone is effective in producing some kind of human capital. For example, the prenatal period is a sensitive period for the development of brain and lungs and other organs for human beings. It implies that the in-utero environment has a larger effect on human capital development than the later-life environment, i.e. $\frac{\partial f_t}{\partial E_1} > \frac{\partial f_t}{\partial E_s}$ where $s > 1$.

"Self-productivity" suggests that individuals with higher human capital are more productive and accumulate more capabilities. For example, emotionally stable children are more focused on learning activities and accumulate more human capital, i.e., $\frac{\partial f_t}{\partial \theta_t} > 0$. This characteristics indicate that the difference in human capital expands over time with all the other controls stay the same.

Another feature of capability development captured by the model is "dynamic complementarity". That is, individuals with higher human capital gain higher return from investment and environmental improvement. For example, healthy children can be more productive in learning activities compared to children with attention deficit/hyperactivity disorder (ADHD), i.e., $\frac{\partial^2 f_t}{\partial \theta_t \partial I} > 0$. This feature indicates that the difference in human capital expands faster with investment or environment improvement.

Cigarette taxes can lead to two distinct outcomes. On the one hand, they tend to decrease smoking behaviors. On the other hand, for individuals heavily addicted to cigarettes with a reduced response to cigarette taxes, higher taxes may result in increased expenditures on cigarettes. Consequently, whether exposure to higher cigarette taxes during pregnancy is beneficial is a question that requires empirical investigation. Previous studies indicate that, generally, the first effect, which is the reduction in smoking, prevails. Research has demonstrated that higher cigarette taxes reduce smoking behavior for pregnant women, thus leading to an improved uterine environment during pregnancy. Denote in-utero period to be period 1, that is $\frac{\partial E_1}{\partial CigTax_1} > 0$. Uterine environment would have strong effect on the development of critical organs such as brain and lung and also the general health of the fetus. That is, cigarette taxes during pregnancy strongly affect individuals' human capital in early life directly, i.e. $\frac{\partial \theta_2}{\partial CigTax_1} = \frac{\partial f_1}{\partial E_1} \cdot \frac{\partial E_1}{\partial CigTax_1} > 0$. The effect lasts with age because individuals with higher early-life human capital are more productive in accumulating later-period capability according to "self-productivity". The corresponding inequality is $\frac{\partial \theta_t}{\partial CigTax_1} = \frac{\partial f_{t-1}(\theta_{t-1}, I_{t-1}, E_{t-1}, G)}{\partial CigTax_1} = \frac{\partial f_{t-1}}{\partial \theta_{t-1}} \cdot \frac{\partial \theta_{t-1}}{\partial CigTax_1} = \frac{\partial f_{t-1}}{\partial \theta_{t-1}} \cdot \frac{\partial f_{t-2}}{\partial \theta_{t-2}} \cdots \frac{\partial f_1}{\partial \theta_1} \cdot \frac{\partial \theta_1}{\partial CigTax_1} > 0$. The effects could even be strengthened as individuals with higher early-life human capital gain higher return from investment and environmental improvement according to "dynamic complementarity", i.e. $\frac{\partial^2 \theta_t}{\partial CigTax_1 \partial I_s} = \frac{\partial f_{t-1}}{\partial \theta_{t-1}} \cdot \frac{\partial f_{t-2}}{\partial \theta_{t-2}} \cdots \frac{\partial f_s}{\partial I_s} \cdot \frac{\partial f_s}{\partial \theta_s} \cdots \frac{\partial f_1}{\partial \theta_1} \cdot \frac{\partial \theta_1}{\partial CigTax_1} > 0$. Moreover, in-utero cigarette taxes may affect the investment in later periods indirectly in the case that poor initial health increase money and time spending on health care and reduce the budget and time spending on capability investment (I). The theoretical model implies that increasing cigarette taxes in early life period affects individuals' initial human capital, and the effect can last long into the adulthood and could get stronger with age.

Cigarette tax in later life period such as childhood, adolescent, and early adulthood may also have effect on health in adulthood. However, the effect should be smaller than the effect of in-utero cigarette tax according to the "sensitive period" theory, i.e. $\frac{\partial f_t}{\partial CigTax_1} = \frac{\partial f_t}{\partial E_1} \cdot \frac{\partial E_1}{\partial CigTax_1} > \frac{\partial f_t}{\partial Cigtax_s} = \frac{\partial f_t}{\partial E_s} \cdot \frac{\partial E_s}{\partial CigTax_s}$, assuming that the effect of cigarette taxes on environment does not change over time, i.e. $\frac{\partial E_1}{\partial CigTax_1} = \frac{\partial E_s}{\partial CigTax_s}$.

I borrowed Cunha and Heckman (2007)'s theoretical framework for exploring how cigarette taxes might affect the long-term human capital accumulation. The framework yields three primary forecasts. Firstly, exposure to in-utero cigarette taxes improves the environment and enhances human capital in early life directly. Moreover, the early life effect persists into the adulthood and may expands over time due to the property of self-productivity and dynamic complementarity of human capital. Lastly, as in-utero period is an important sensitive period for physiological development, exposure to cigarette taxes in this period exhibits a larger impact on human capital accumulation than cigarette taxes in later life period.

III. Data

A. Cigarette Taxes

Cigarette taxes can be implemented by federal, state, and municipal governments. Because federal cigarette tax rarely changes and municipal cigarette taxes are not common, I focus on state excise taxes. Figure 1 shows the variation of state cigarette tax between 1968 and 1994. Some states on the tobacco belt such as North Carolina, Virginia, Kentucky, and South Carolina have the lowest state cigarette taxes. Conversely, states like Connecticut, New Jersey, Minnesota, Florida, and Massachusetts tend to impose relatively high state cigarette taxes. I trim the states with very high or low average state cigarette taxes to test the robustness of the results. During the sample period, the average *nominal* state cigarette tax increased from \$0.08 in 1968 to \$0.27 in 1994. The smallest increment was 1 cent, and the largest increment was 33 cents in Washington D.C. in 1993. The average *real* state cigarette taxes in 2020 dollar[3] in this period varies between \$0.37 and \$0.71. There were 186 increment in real state cigarette tax happened in the period. Among them, 63%

[3] All the dollar values below are 2020 dollars without further notation.

were equal to or greater than 10 cents. The largest change was an increase from 31 cents in 1992 to 90 cents in 1993 in Washington D.C. The average cigarette tax during 1968 and 1994 is 50 cents while the average price for a pack of cigarette before taxation is $2.5.

B. *Panel Study of Income Dynamics (PSID)*

PSID is a longitudinal household survey which started in 1968 with a nationally representative sample of around 5,000 families in the United States. It surveys household heads and spouses and their offspring annually from 1968 to 1997 and then biennially from 1997 on.

Three unique features of the PSID make it the perfect dataset for this study. Firstly, for respondents in PSID, I have detailed family background information including the educational level of the mother, whether the age of mother is greater than 35, gender and marital status of the household head, number of children in the family, and family income-Census needs standard ratio[4] at the year of birth. Moreover, in 1999, the PSID started collecting health information and therefore can provide detailed information on health status and health behavior for the household heads and spouses. Other than health in adulthood, I also have other adult performance information such as education and fertility for the individuals I study.

C. *PSID-Child Development Supplement Data*

I utilize PSID's Child Development Supplement (CDS) data for the analysis of the effect of cigarette tax on health and cognitive ability in childhood, and smoking behavior in adolescent. PSID's Child Development Supplement (CDS) is available for years 1997, 2001, 2007, 2014, and 2019, providing various valuable information on child development for children aged 0 to 17. I can therefore use the CDS data to explore the effect of early-life exposure to cigarette tax on childhood development as one potential underlying mechanism. The CDS started in 1997, and children aged between 0 and 12 were interviewed. For each PSID family, at most two eligible children were interviewed for CDS. These children were interviewed in the following surveys (2001, 2007) until they turned 18. In the CDS ongoing waves in 2013 and 2019, all the children in

[4] According to PSID codebook, Census needs standard is a poverty threshold by size of family, the number of persons in the family under 18, and the age of householder; it is taken from Census Bureau's website. The ratio can be seen as an adjusted measure of family income.

the PSID families aged 0 to 17 were interviewed. CDS collects information on physical chronic conditions includes anemia, allergies, asthma, diabetes, ear disease, hear difficulty, eye disease, and obesity [5] and mental chronic conditions includes convulsion, autism, speech problem, retardation, emotional disturbance, and hyperactivity for children between age 0 to 18. I generate four health indices based on these health conditions: 1) whether the child has any physical chronic condition; 2) whether the child has any mental chronic condition; 3) how many physical (mental) chronic conditions the child has; and 4) how many mental chronic conditions the child has. CDS also collect cognitive ability information includes scores of Woodcock-Johnson tests taken by children between ages 6 and 18, and collect information on smoking behavior for adolescent between ages 12 and 18.

D. *Vital Statistics Natality Files*[6]

I also use the US Natality birth data maintained by National Center for Health Statistics (NCHS) from 1969 to 1994 to study the effect of cigarette tax during pregnancy on maternal smoking rate[7] (the data on smoking behavior during pregnancy is not availabl until 1989) and birth outcomes including average birth weight, very low birth weight rate (birth weight < 1500 gram), average gestational age, preterm delivery rate (gestational age < 28 weeks), average APGAR score and low APGAR score rate (APGAR score < 7). I do not include data from 1968 since limited information are recorded in 1968. Natality birth data record information collected from state birth certificates including birth year, birth month, birth state, birth parity of the baby, the age, race, marital status, and educational level of mother. I generate cell-level outcome variables following Baughman and Dickert-Conlin (2009).

E. *Sample Selection*

The main sample consists of household heads and spouses aged 25-35 who were born to PSID families between 1968 and 1994.[8] This age range was selected based on several considerations: most respondents assume the roles of household heads or spouses post the age of 25. Moreover,

[5] The question about obesity was not asked in 1997.

[6] The individual level Natality birth data from 1969-1994 can be downloaded from the website: https://www.nber.org/research/data/vital-statistics-natality-birth-data.

[7] The data on smoking behavior during pregnancy is not available until 1989 in the Natality Files.

[8] Other members of the households are not included because the PSID only collects health information from the household heads and spouses.

individuals born in 1968 would first be posed this health-related question at the age of 31 in 1999 (when the PSID started collecting health information and household heads and their spouses were first queried about whether a medical professional had ever diagnosed them with specific health conditions), so any upper age limit below 31 would exclude the 1968 cohort. By setting the upper limit at 35, I ensure that this 1968 cohort has three opportunities to participate in the survey between the ages of 25 and 35. This flexibility is also crucial given that some become household heads or spouses after the age of 31 and may not consistently participate in the PSID survey annually. This relatively narrow age range is chosen so I can focus on an age group where health conditions exhibit limited variability. However, I have conducted robustness checks with different age ranges and the results are robust.

Only individuals born to PSID families after 1968 (the first year of the PSID data) are included in the sample because I need information on birth state and family background at birth. Additionally, because the latest released PSID survey at the time of writing this paper is the 2019 wave, individuals born after 1994 and therefore younger than 25 in 2019 are excluded from the main sample.

In the process of refining the sample, I adhered to a systematic series of steps to ensure the most relevant observations were included. Initially, I retained observations of household heads and spouses born to families in the 1968 sample between the years 1968 and 1994, who were between the ages of 25 and 35. This resulted in a sample size comprising 5,791 unique IDs. Further refinement involved removing those observations that were not a part of at least one survey conducted by PSID during their ages of 1 to 18, narrowing the sample to 5,645 unique IDs. Next, any observation lacking a complete record of their state of residence between the ages of 1 to 18 was excluded. The primary rationale behind this was the inability to ascertain the cigarette tax during their birth year even if I assume that they did not relocate before turning 18. This step led to a slight reduction in the sample size to 5,644 unique IDs. Essential demographic information was also crucial for the analysis. Hence, observations were excluded if data on their race, the age of their mother at birth, or their mother's educational background were unavailable. This brought the sample down to 5,609 unique IDs. As health conditions were integral to my study, observations lacking information on specific health conditions, namely asthma, heart attack, heart disease, and lung conditions, were removed, resulting in 5,418 unique IDs. Finally, to ensure the accuracy and relevance of the data, observations without clear information on their state of residence between the ages of 25 and 35 were dropped. Consequently, the final sample encompassed 5,402 unique IDs originating from 1,494 families surveyed in 1968.

The CDS sample consists of children born between 1989 and 2013. I exclude those born after 2013, as they were under the age of six during the most recent CDS survey conducted in 2019. On the other end of the spectrum, children born prior to 1989 were not considered for the study either, primarily because the question concerning obesity was introduced only in the 2001 survey. By that time, those born before 1989 were already older than 12. The analysis specifically targets the health conditions observed between ages 6 to 12, aiming to focus on a period wherein health conditions are relatively consistent across the age group.

F. Sample Statistics

Table 1 offers a comprehensive view of the weighted summary statistics for the estimation sample. Each observation in the sample is a unique individual. Upon analyzing the data, it becomes evident that approximately 24% of the sampled individuals experienced at least one of the health conditions, such as asthma (18%), lung disease (7%), heart disease (2%), or heart attack (1%), when they were surveyed between the ages of 25 and 35.

Demographically, the sample paints a diverse picture. Nearly half, or 48%, of the sample are male. The racial composition predominantly consists of white individuals, accounting for 81%, followed by black individuals at 17%. When examining the age at which they were last surveyed during the 25 to 35 age bracket, the average emerges as 32 years. From a familial perspective, 18% were born to mothers aged over 35. Maternal education also provides interesting insights: 21% of the sampled individuals were born to mothers who hadn't completed high school. In contrast, 60% had mothers with educational attainments spanning from high school to some college, and 19% had mothers with a college degree or a more advanced educational background.

Diving deeper into familial structures, 14% hailed from female-headed households, whereas a substantial 84% were born into two-parent families. The order of birth also plays a role in the analysis: 59% represent the eldest child in their family, 24% hold the position of the second child, and the remaining 18% are either the third child or born later in the birth order. As for the financial metrics, the average family income, gauged against the Census needs standard ratio at the time of their birth, stood at 3.56.

Shifting the focus to policy and economic indicators, several data points emerge. The average in-utero cigarette tax, which is determined either at the close of the third trimester or at the birth month, is calculated at $0.50. By the time these individuals reached 25, the average cigarette tax increased to $1.21. Concurrently, the average state minimum legal age for tobacco product purchases was 17.89.

Economic indicators during the year of birth reveal that the state beer tax per 31 gallons was $53.28, the state wine tax per gallon was $2.51, and the state spirit tax per gallon was $31.20. The state minimum wage, on average, equaled $5.75. Other financial parameters include an average income marginal tax rate of 5.63%, a per capita GDP of 38.83 thousand dollars, and an array of benefits: the average maximum EITC benefit was approximately $1402, the CDCTC benefit hovered around $2530, and the AFDA/TANF benefit was roughly $907. The health infrastructure, as represented by the average number of hospital beds, was 48.56 thousand. Lastly, the average welfare vendor payment for medical stood at about 2807 thousand dollars.

IV. Empirical Strategy

A. Difference-in-difference

We utilize a generalized difference-in-difference approach with continuous treatment. The main specification for the baseline model is as follows:

$$y_{isym} = \alpha + \delta_1 CigTax_{sym} + \delta_2 CigTax_{s,age25} + X_{isym}\beta_1 + Z_{sy}\beta_2 + \lambda_y + \eta_s + \varepsilon_{isym}. \quad (3)$$

The term y_{isym} refers to the health outcomes, measured during adulthood, for individual *i* born in state *s* in year *y* and month *m*. The main explanatory variable is $CigTax_{sym}$ which captures the real state cigarette tax in state *s* at birth. Birth time refers to the birth year-month, as medical literature has shown that cigarette smoking has the strongest effect on birth outcome during the last trimester of pregnancy (England et al., 2001; Bernstein et al., 2005). $CigTax_{s,age25}$ captures the real cigarette tax in individual i's state of residence when s/he is 25.

The term X_{isy} represents a vector of individual-level characteristics, including gender, race (white and nonwhite), and age square at survey year, and family background at birth year, including the educational level of the mother (dropout, high school or some college, college and beyond), whether the mother was over 35 when giving birth to the individual, gender of the household head, marital status of the household head, number of children in the family, and family income-Census needs standard ratio.

The term Z_{sy} represents a vector of state-level covariates at birth year, including minimum legal age for purchasing tobacco products, alcohol taxes (including tax rates for beer, spirit, and wine), social welfare benefits (including EITC benefit, CDCTC benefit, AFDC/TANF benefits), economic status and policies (including the minimum wage, the maximum income marginal tax rate, and per capita GDP), and health care investment (including state welfare vendor payment for medical and the number of hospital beds). These state-level covariates also affect children's early-life environment and long-term health outcomes.

The terms λ_y and η_s are birth year and birth state fixed effects, respectively. Birth year fixed effect controls for factors which change each year such as the size of the cohort and public awareness about the harm of cigarette smoking. State fixed effect controls for the (relatively) time-invariant state characteristics such as state culture and climate.

I use the average PSID longitudinal weights during ages 1 to 18 in the estimation and cluster the standard errors by state of birth to account for unobserved correlation of the error terms within states.

The analysis relies on two sources of variation: cross-state variation in cigarette taxes in a particular year and within state temporal changes in cigarette taxes over time. We use state-level cigarette taxes as the treatment variable for several reasons. Firstly, state-level cigarette tax affect the cost of consuming cigarettes in a given state, which could, in turn, influence the smoking behavior or exposure to secondhand smoke of pregnant women. Thus, there is a plausible causal relationship between state-level cigarette taxes and in utero exposure to tobacco smoke. Secondly, the variation in cigarette taxes at the state level is exogenous to the specific individual within states. Finally, a TWFE approach enables us to control for unobserved heterogeneity at both the year and state level. This helps to address potential sources of bias, such as omitted variabel bias, which could arise if we only examined the relationship between parental smoking behavior or tobacco smoke in the environment during pregnancy and adult health for the growing-up children at the individual level. However, it is still possible that the cigarette taxes are endogenous and could bias the results. We address these issues in the next section.

B. Threat to Identification

The identification depends on the exogeneity of cigarette taxes, conditional on those individual-level and state-level controls. Literature has explore what drives the rise of cigarette taxes. Legislatures typically enacted tobacco taxes primarily to boost state revenue. As the public awareness of the harm of smoking and second-hand smoking grow, states have also employed taxes to reduce cigarette consumption (Gruber, 2001). However, considering that the legislation and the amendment process for cigarette tax usually take years to happen, it is unlikely that cigaretta tax is correlated with the sudden shift of public awareness (Gruber and Köszegi, 2001).

Another potential concern is whether changes in state cigarette taxes are influenced by state demographics, economic policies, or economic conditions that also impact health conditions. For example, if states with more high educated people tends to adopt higher cigarette tax and cigarette taxes tend to have an larger impact on higher educated people, then estimates of the effect of cigarette tax on health would be biased upward; if states with higher per capita GDP tend to adopt higher cigarette tax while cigarette taxes tend to have an smaller impact on people with high level income, then estimates of the effect of cigarette tax on health would be biased downward; if states raise cigarette tax to finance public health care or public welfare programs which improve public health condition, then estimates of the effect of cigarette tax on health would be biased upward.

To address this concern, on one hand, I conduct formal tests to examine the correlation between state cigarette taxes and state demographics, economic policies, and economic conditions. Table 2 presents the results of regressing the cigarette tax on the state-by-year characteristics (including percent male, percent white, percent married, percent high school or some college, percent with college or higher education, average age, state per capita GDP, state minimum wage, state income marginal tax rate, maximum AFDC/TANF benefit, maximum EITC benefit, maximum CDCTC benefit, number of hospital beds, state welfare vendor payment for medical, state beer/wine/spirit excise tax, and minimum legal age for purchasing tobacco products) controlling the state fixed effect and year fixed effect. Overall, the results suggest that state cigarette excise tax is correlated with state beer excise tax at 10% level but is not correlated with other state covariates and these state-level variables cannot predict state cigarette taxes.[9] On the other hand, considering that all these factors may be correlated with public health condition, I control for them in the models to mitigate any potential biases.

Another source of threat to identification is sample selection bias. If cigarette tax affects fertility or the probability of entering the sample, the health effect could be endogenous. That is, the health effect could be a result of the fertility effect or the special sample I use instead of less exposure to smoking due to higher in-utero cigarette tax. Table 3 shows that cigarette tax is not statistically significantly correlated with the probability that a woman aged 20 to 39 would give birth to a baby in the same year or the following year, regardless of the gender of the baby. Table 4 further shows that for all the individuals born to PSID families between 1968 and 1994, in-utero cigarette tax is not statistically significantly correlated with the probability of being included in the sample. These results suggest that selection bias, the potential bias due to the sample being endogenously selected by cigarette tax, is unlikely to be an issue for this study.

In addition, the effect of in-utero cigarette tax could be upward biased if cigarette taxes are correlated, that is in-utero cigarette taxes can be correlated with cigarette taxes people are exposed to in later years. To mitigate this concern, I control for cigarette taxes at age 25 in the baseline model as well. I further conduct various specification tests including controlling for cigarette taxes from other periods in later life, and the results are robust.

C. Event Study

[9] I also did another check to regress each state covariate in time $t+1$ on cigarette tax at time t while controlling the full set of other state-level covariates to see if cigarette tax affect future state-year-characteristics. The results show that state cigarette tax does not have significant effect on state-year-characteristics in the next year. Please see detailed results in table A1.

I did a event study to access the impact of early life exposure to tax hike on adult health. The equation corresponds to the event study is

$$y_{isym} = \alpha + \delta_1 \sum_{j=-J}^{J} e_{sj} + \delta_2 CigTax_{s,age25} + X_{isy}\beta_1 + Z_{sy}\beta_2 + \lambda_y + \eta_s + \varepsilon_{isym} \quad (4)$$

e_{sj} equals one when an observation is j periods away from the event. The other variables are the same with equation (1). Event time is defined in quarters. Period 0 presents the year-quarter that the event happened.

As the majority of the states in my sample experienced multiple tax hikes during 1968-1994, making it difficult to analyze each tax hike separately. Furthermore, event studies tend to be most effective at identifying divergent trends when many events takes place within a shared time frame. Therefore, I defined a discrete tax event as any tax hike exceeding the fiftieth percentile ($1.34) of all hikes and selected the "high-frequency" tax period of 1968-1976 following Simon (2016). Under this criterion, almost all the state have only one discrete event in the time frame. In the event study sample, only states that experience an event are included. I also balance the event study such that events are only included if it is the only event in the state in three full years in both the pre-period and post-period.

D. De Chaisemartin and D'Haultfoeuille (2020) DID Estimator

Given the potential for bias in the presence of heterogeneous treatment effects for the difference-in-difference with continuous treatment with two-way fixed effect estimator (Callaway et al., 2021), I have opted to utilize the Differences-in-Differences estimator named DID_M proposed by De Chaisemartin and D'Haultfoeuille (2020). This estimator maintains its validity even when treatment effects vary across time or different groups. However, it does come with certain limitations.

Firstly, there is a bias-variance trade-off between DID_M and the Two-Way Fixed Effect (TWFE) estimator. Secondly, the DiD estimator necessitates that, for each pair of consecutive dates, there exist groups whose treatment remains constant act as control groups. Consequently, it cannot accommodate treatments such as the real cigarette tax that fluctuates from year to year. To address this, I have opted for a discrete treatment approach, specifically using cigarette tax bins rather than real cigarette tax values. It's important to strike a balance in the number of discrete levels—having too many would demand a larger sample size, while too few might result in limited transitions between these levels. In my scenario, I create eight distinct tax tiers for cigarettes. The baseline tier ranges from 0 to 10 cents, while the subsequent tiers go from 11 to 30 cents, then from 31 to 50, and so on, with the highest tier cigarette tax spanning from 131 to 150 cents. Furthermore, it assumes that there is no treatment effect for the lowest discrete treatment level. Therefore, people should be careful to define the lowest discrete treatment level. In our case, this implies that there is no treatment effect for cigarette tax when it's between 0-10 cents. Lastly, there is a constraint on the number of control variables that can be included in the model. Excessive control variables can inflate the standard error, which may affect the model's reliability.

While the DiD estimator is resilient against heterogeneous treatment effects, it's important to recognize the bias-variance trade-off, the requirement for groups with constant treatment within consecutive dates, the assumption of no treatment effect for the lowest discrete level, and other constraints necessitate cautious consideration. By including the DiD estimator as a robustness check, I aim to ensure the reliability of my findings and assess the consistency of results between the TWFE and the new DiD approaches. This dual approach allows for a comprehensive evaluation of treatment effects while acknowledging the strengths and limitations of each method.

V. Results

I start by presenting the results on the instantaneous effect of cigarette tax on smoking behavior. I then present the main results on the effects of changes in cigarette tax during childhood on health as adults, followed by heterogeneity of the effect and robustness tests. I further investigate the potential mechanisms/mediators and, lastly, I discuss the size of the effect.

A. Impact of Cigarette Tax on Smoking

Because smoking behavior was surveyed in 1986 and from 1999 and on in the PSID, I use data from these years to estimate the effects of cigarette tax on smoking rate for household heads and spouses in the reproductive ages from 20 to 39, and the results are shown in Table 5. Note that observations in this sample are not necessarily parents of individuals in the main sample. Column 1 of Table 5 shows that a 10-cent increase in cigarette tax reduces the probability of smoking by 2 percentage points, which is significant at the 10% level and around 8% of the mean.

The sample for column 2 of Table 5 is a subsample of that for column 1 and consists of household heads and spouses who were aged 20-39 and have a newborn within two years when the question on smoking behavior was asked. Column 2 shows that a 10-cent increase in cigarette tax reduces the probability of smoking by 2.9 percentage points, which is significant at the 5% level and corresponds to 15% of the mean. This result indicates that the tax effect could be even stronger for household heads and spouses who were to have a baby within two years.

The sample for column 3 is a subsample of column 1 and only contains parents of individuals in the main sample. The result shows that a 10-cent increase in cigarette tax reduces the probability of smoking by 10 percentage points which corresponds to 35% of the mean. The relatively large magnitude (comparing to columns 1 and 2 in Table 5) could be because around one-fifth of the sample are from 1986 when both the price of cigarettes and cigarette tax were relatively low, and people are more sensitive to the increase of cigarette tax at that time.

Estimates with Natality data support this finding. Column 5 of Table 11 shows that a 10-cent increasing in in-utero cigarette tax is associated with a decrease of 1.6 percentage points in the smoking rate of mother during pregnancy which corresponding to 9% of the mean.

B. Main Results

Table 6 presents the effect of exposure to in-utero cigarette tax on health condition in adulthood. I use two health outcome indices as the main measures of long-term health in adulthood. Health outcome index A is the binary variable that equals one if the individual has any of the following conditions: asthma, lung disease, heart disease and heart attack. I choose these four health conditions because respiratory and cardiovascular conditions are the main problems caused by exposure to cigarette smoking (USDHHS, 2001; 2004).[10] Health outcome index B is the number of aforementioned health conditions individuals have. Columns in Table 6 progressively add controls from birth year and birth state fixed effects to demographics to family background at birth to different state-level covariates. The results are stable, with the coefficients ranging from -1.3 to

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[10] Health conditions available in PSID include high blood pressure, diabetes, heart attack, heart disease, stroke, arthritis, cancer, psychosis, mental problem, obesity, lung disease, asthma, learning disorder, and other diseases.

-1.8 percentage points for health outcome index A and -0.018 to -0.021 for health outcome index B. With the full set of controls, the result shows that a 10-cent increase in in-utero cigarette tax reduces the probability of having any of those conditions between age 25 and 35 by around 1.8 percentage points and reduces the number of conditions the individual has during age 25 and 35 by around 0.02. Effects on both indices correspond to 7-8% of their means, respectively, indicating a substantial reduction in the probability of suffering from the four health conditions which are most related to exposure to smoking. The prefered model is the model corresponding to the last column.

Once in-utero cigarette tax is controlled for, cigarette tax at age 25 has a much smaller effect on adult health. For example, a 10-cent increase in cigarette tax at age 25 decreases the probability of having any of those four health conditions during age 25 and 35 by around 0.2 percentage point which counts for only around 1% of the mean. And its effect on the number of health conditions is statistically significant at the 10% level.

Table 7 shows the regression results for the individual components of the two indices and the effect on adult health status in different age ranges. The results show that the magnitude of the health effect increases as individuals age. For health status during age 35 to 45, a 10-cent increase in the in-utero cigarette tax reduces the probability of having any of those four health conditions by 2.8 percentage points and reduces the number of health conditions by 0.04, both estimates larger than their counterparts for ages 25 to 35. For ages 25 to 35, the main driver is the effect on asthma, while for ages 35 to 45, the main drivers are effects on asthma and lung disease. Table A2 further shows that the magnitude of the beneficial effect of in-utero cigarette tax on health status grows with age when I examine age ranges from 25 to 30, 30 to 35, 35 to 40, to 40 to 45.

Figure 3 shows the event study for long-term health condition at the fiftieth percentile cut off. I use the cohort born in the quarter just before the quarter tax hike happened as reference group. For example, in the case that there is only one tax hike in the sample: in Colorado in the third quarter of 1973, the reference cohort would be the children born in Colorado in the second quarter of 1973, and they expose to the tax hike in the quarter after the quarter of birth (the third quarter of 1973), which means the effect on long-term health for this cohort could be due to the tax hike reduces secondhand smoke exposure since then.The coefficient for pre-period *j* presents the effect of exposure to tax hike since the *j*th quarter after birth comparing to exposure to tax hike since the 1st quarter after birth. The post-period coefficients reflect the effect of exposure to tax hike since the *j*th quarter before birth comparing to exposure to tax hike since the 1st quarter after birth. Figure 3 shows that there is no significant pretrend effect but significant posttrend effects. Exposure to tax hike in the third trimester in pregnancy or earlier does improve the long-term health comparing to exposure to tax hike after birth. I conducted a robustness check using the seventy-fifth percentile, and the result yielded a similar pattern (Figure A1).

Table 8 shows the results from the De Chaisemartin and D'Haultfoeuille (2020) DID_M Estimator. One level increasing in in-utero cigarette tax (20 cents increase on average) cause a 3.9 percentage point reduction in the probability of having any of the four health conditions. It is close to value from the TWFE estimation that 10 (20) cent increase in in-utero cigarette tax is associated with a 1.8 (3.6) percentage points reduction in the probability of ever had any health conditions. Figure 3 shows the comparison between TWFE estimation and the DID estimator after adjusting the unit of cigarette tax to 20 cents per pack for TWFE estimation.

C. *Heterogeneity*

As socioeconomic status (Ekblad et al. 2014; Rumrich et al., 2019) and educational attainment (Gould et al., 2017) are primary predictors for smoking during pregnnacy, and the effect of early life enviroment may different across gender (Nilsson, 2017), I explore the heterogeneity of cigarette tax effects by the respondents' race, gender, their mother's education, family economic status, and their parents' marital status at the time of their birth. Table 9 and Figure 4 shows the heterogeneity of cigarette tax. The result is largely robust across subgroups. The effect is relatively larger for male relative to femal, which is consistent with literatures that male suffer more from early life adverse environment (Nilsson, 2017). There is an opposing effect observed within the subgroup born to single-parent family, where a higher in-utero cigarette tax is associated with an increased likelihood of experiencing health conditions in later life. This phenomenon may be attributed to persistent nicotine addiction for single pregnancy mothers. The coefficient for the subgroup born to mothers with the college or above educational level comes with wide confidence interval, likely because of the very small size of this group[11].

D. Robustness Checks

Column 2 and 6 in Table 10 shows the robustness of the health effect of in-utero cigarette tax while controlling for cigarette tax in the later life. Because Friedson (2021) finds that increasing the average cigarette tax in adolescents (between ages 14 and 17) reduces the probability of adult smoking which could improve health status in adulthood, I control for average cigarette taxes in adolescents. The result shows that controlling for average cigarette tax in adolescents does not change the baseline results on the health effects of exposure to in-utero cigarette tax, and average cigarette tax in adolescents does improve health status in adulthood, as is shown by Friedson (2021), although the effect is insignificant in the empirical setting. In column 3 and 7, I control for both average cigarette tax between ages 1 and 13 and average cigarette tax between ages 14 and 17. The effect of in-utero cigarette tax is the same as in baseline model, and the two average cigarette taxes in childhood periods improve health status in adulthood although the effects are insignificant.

As the timeframe in the study lasts for more than two decades, I further check if the effect is constant over time by dividing the sample to two subsamples by the median birth cohort: people born between 1968 and 1980 and people born between 1981 and 1994. The results in column 4 and 8 show that there is no significant difference in the health effect of in-utero cigarette tax for people born in these different decades.

Medical literature shows that the effect of exposure to cigarette smoking is strongest in the third trimester (USDHHS, 2001). Figure 5 shows that the results are robust if I change the explanatory variable from in-utero cigarette tax at the end of the third trimester to cigarette tax at the beginning of the third trimester (as in Simon (2016)), the average cigarette tax during the third trimester, or the average cigarette tax during the whole period. In Figure 5, I also compare the effects of in-utero cigarette tax at the end of the third trimester, the average cigarette tax in the first two years of life, and the average cigarette tax in the first six years of life. Compared to in-utero cigarette

[11] The sample size for the subgroup born to mother with college or above degree is 754.

tax, increasing the average cigarette tax in the first two years of life or that in the first six years of life has about the same effect on health in adulthood. It indicates that the effect of the average cigarette taxes in the first several years of life could be mainly driven by the effect of in-utero cigarette tax. However, I should be cautious in interpreting this result because an increase in cigarette tax in birth year usually means the cigarette tax remains high in the following years.

One concern regarding our specification is the potential influence of outlier states, specifically those with exceptionally high or low levels of cigarette taxes within our sample. We assess the robustness of our coefficient estimates concerning this aspect by progressively excluding states with average cigarette taxes at both the upper and lower extremes of the distribution, in increments of five percentiles, up to a maximum of twenty-five percentiles. Consequently, this process retains the middle 90 percentiles when trimming the top and bottom percentiles, and the middle 50 percentiles when trimming the top and bottom percentiles. In Figure 6, the first coefficient estimate in red represents our preferred specification, which is the largest. The coefficient remains relatively stable in the trimming process. However, the confidence interval expands as this exercise mechanically constrains the variation in casualties required to estimate the coefficient of interest. Nevertheless, even with this limitation, the coefficient estimate remains statistically significant when we exclude the top and bottom 25 percentiles.

Table A3 shows that the results are robust across different sampling weights. I further test the robustness of the baseline model to include state specific linear time trends. In this way, the identifying variation in cigarette tax comes from tax changes within states over time that deviate from the linear trend. Table A4 shows that the results are robust when controlling the state-specific linear time trends.

Table A5 compares the estimated coefficients and the corresponding odds ratio from OLS regression and logit/ordered logit regression. The odds ratio from two regression is similar and further supporting the robustness of the results.[12] The results from logistic regression show that the odds ratio of having any health condition over having no health condition associated with a 10 cent increasing in cigarette tax is 0.9 times the corresponding odds ratio without the 10 cent

[12] The convergence is not achieved for heart attack.

increasing in cigarette tax, or people has 10% ($0.9 - 1 = 0.1$) less odds of having any health condition with a 10 cent increasing in cigarette tax.

E. Effect of Discrete Level of Cigarette Taxes

I use cigarette tax bins instead of continuous cigarette tax to explore the effect of discrete level of cigarette taxes. The estimation model is

$$y_{isym} = \alpha + \sum_j \delta_j \, Cigtax\ bin_{sym,j} + \gamma Cigtax_{s,age25} + X_{isy}\beta_1 + Z_{sy}\beta_2 + \lambda_y + \eta_s + \epsilon_{isym} \quad (5)$$

where $Cigtax\ bin_{sb,j}$ is equal to 1 if in-utero cigarette tax month falls in the jth bin. The bins range from \$0 to \$1.5 with an increment of \$0.30 (cigarette taxes range from \$0 to \$1.31). Other variables are the same as in Equation (3).

Figure 7 shows the effects of discrete in-utero cigarette tax. It shows that the magnitude of the in-utero cigarette tax effect on the two health indices is increasing with the cigarette tax levels, which indicates that the health effect increase in cigarette tax at least within the range of \$0 to \$1.31.

F. Mechanisms

1) Effect on Birth Outcomes

Birth weight is one of the best proxies for infant health (Conley et al., 2006). It is also one of the best predictors for later life health (Black et al., 2007; Case et al., 2005; Currie, 2009), educational and labor market outcomes (Johnson and Schoeni, 2007; Behrman and Rosenzweig, 2004; Currie and Hyson, 1999), and life expectancy (Van den Berg et al., 2006; Oreopoulos et al., 2008). Public health professionals have identified maternal smoking during pregnancy as the largest risk factor for low birth weight that can be modified by behavior (Almond et al., 2005; Kramer, 1987; Shiono and Behrman, 1995) and cigarette tax can effectively reduce the likelihood that infants are born with low birth weight (Almond et al.,2005; Evans and Ringel, 1999; Lien and Evans, 2005).

Because not every individual in the PSID has information on birth weight, I use the Natality birth data from 1969 to 1994[13] to estimate the effect of in-utero cigarette tax on birth outcomes. Natality birth data not only provide birth weight, but also information on other measures of birth outcomes

[13] We do not use data from 1968 because it does not have information on marital status and education.

such as gestational age, Apgar score, and maternal smoking behavior during pregnancy. Following Baughman and Dickert-Conlin (2009), I divide birth records into cells by state, year, the birth parity of the child, and the age range, race, educational level, and marital status of the mothers.[14] The birth outcomes I measure are average birth weight, average gestational age, average Apgar score, rate of very low birth weight (<1500g), rate of preterm delivery (gestational weeks<28), rate of low Apgar score (<6), and rate of maternal smoking for each cell. The results in Table 11 show that cigarette tax in the year of birth improving all the aforementioned birth outcomes although the effects on average birth weight and gestational age are statistically insignificant.

2) Health in Childhood

Table 12 provides suggestive evidence that exposure to in-utero cigarette tax affects health outcomes in adulthood through affecting the health status in childhood. The sample consists of 4,260 children born between 1989 and 2013 and surveyed by the CDS. The result shows that a 10-cent increase in in-utero cigarette tax reduces the probability of having any physical health condition out of anemia, allergies, asthma, diabetes, ear disease, hear difficulty, eye disease, or obesity by 0.4 percentage points, reduces the number of those physical health conditions by 0.010, reduces the probability of having any mental health condition out of convulsion, autism, speech problem, retardation, emotional disturbance, or hyperactivity by 0.3 percentage points (albeit statistically insignificant), and reduces the number of mental health conditions by 0.008 for children between age 6 and 12. These effects count for no more than 3 percent of the mean, smaller than those on adult health status, indicating that the positive health effect of exposure to higher in-utero cigarette tax increases with age. However, I should be careful in interpreting these results because the sample used for the analysis on health effects in childhood is different from that used in the main analysis on the health effects in adulthood and the outcome measures are not exactly the same.[15]

3) Smoking behavior in later life

[14] Baughman and Dickert-Conlin (2009) does not use the marital status of mothers to generate the cells, possibly because she studies the effects of the EITC on fertility and EITC likely influences marital decisions. She does, however, conduct subgroup analysis by marital status.

[15] Only 629 individuals are in both samples.

The medical literature has found that maternal smoking during pregnancy increases the risk of smoking and developing nicotine dependence for the grow-up children (Biederman et. al., 2017; Kandel et. al., 1994; Lieb et. al., 2003). The findings are consistent with the literature and show that higher in-utero cigarette taxes indeed reduce smoking behavior in later life. Columns 1 and 2 in Table 13, using the CDS data, show that a 10-cent increase in in-utero cigarette tax reduces the probability of smoking by 0.5 percentage points for adolescents aged between 12 and 18 and reduces the frequency of smoking in the month before the interview by around 4 days for those adolescents who smoke, which count for 6% and 23% of the means, respectively.

The results also show that the in-utero cigarette tax reduces smoking behavior in adulthood (Table 13, columns 3 and 4, based on the main PSID data). A 10-cent increase in in-utero cigarette tax reduces the probability of ever smoking by 1.6 percentage points and reduces the number of cigarettes smoked per day by 0.66 for smokers at age 35, both coefficients corresponding to around 5% of their means.[16]

However, reducing smoking behavior is not the only channel that in-utero cigarette tax affects health in adulthood. Table 14 shows that higher in-utero cigarette taxes reduce health problems in adulthood even for people who never smoke, whether I look at the probability of having any of those health conditions, the number of those health conditions, or the probabilities of having each of those health conditions, although the magnitude of these effects is smaller than that for the whole sample which include both smokers and nonsmokers.

4) Cognitive ability and Educational Attainment

In-utero cigarette tax can affect health outcomes in adulthood through the channel of affecting cognitive ability and educational attainment as well.

Table 15 provides suggestive evidence that higher in-utero cigarette tax improves cognitive ability in childhood. Cognitive ability is measured by scores of Woodcock-Johnson tests taken by children

[16] When the information at age 35 is not available, we use data from an age closest to 35. Figure A2 shows the heterogeneous effect on smoke behavior in adulthood. Similar to the heterogeneous effect on the health condition indexes, the effect on smoke behavior in adulthood is also relatively larger for white, male, those from families that are not in poverty at the time of their birth, and those with married parents, than for their counterparts.

between ages 6 and 18. The scores are comparable between different ages. The first three columns show that a 10-cent increase in in-utero cigarette tax statistically significantly reduces the probability of getting a low score in reading by 0.7 percentage points and improves the probability of getting a medium score by 0.8 percentage points. The last three columns show that a 10-cent increase in in-utero cigarette tax statistically significantly reduces the probability of getting a low score in math by 0.7 percentage points and improves the probability of getting a high score by 0.7 percentage points.

Columns 1 and 2 of Table 16 report estimates for the highest grade completed and the probability of having a college or above degree. A 10-cent increase in in-utero cigarette tax increases the highest grade completed by 0.04 and increases the probability of having college or above degree by around 1.4 percentage points, although only the latter is statistically significant.

5) Age at First Childbirth

Table 17 shows that a 10-cent increase in in-utero cigarette tax delays the age at first childbirth by 0.17 years. Evidence shows that there is a positive correlation between the postponed age at first childbirth and health (e.g., Einiö et al., 2019; Lee and Park, 2020; Shadyab et al., 2017), which indicates that the finding that higher in-utero cigarette taxes delay the age at first childbirth could potentially explain some of the main results on health in adulthood I reported above. However, there is no significant effects for the male subsample and female subsample.

G. Discussion on the Effect Size

The main results indicate that a 10-cent increase in in-utero cigarette tax, which is about 20% of the mean, reduces the probability of ever had any of the following health conditions: asthma, lung disease, heart disease, and heart attack, by 1.8 percentage points which corresponds to an effect of 8% of the means, reduces the probability of ever had asthma by 1.7 percentage points which corresponds to an effect of 9% of the means, and reduces the probability of ever had lung disease by 0.7 percentage points which corresponds to an effect of 6% of the means, for adults during age 25 and 35.

The finding is in line with previous literature. Table A6 presents a detailed comparison of the estimated effect sizes with scaled effect sizes in previous literature that are comparable to the results. Hoehn-Velasco et al. (2021) is the only study that investigated the long-term effect of in-utero cigarette tax. It shows that a 10 cents increase in in-utero cigarette tax significantly reduces the probability of being overweight or obese during pregnancy by 0.4 percentage points, which corresponds to an effect of 1% of the mean, for growing-up girls. Simon (2016) estimated the effect of in-utero cigarette tax on the health conditions in childhood, and a 10 cents increase in in-utero cigarette tax significantly reduces the probability of having asthma by 0.8 percentage points which corresponds to an effect of 14% of the mean for children ages 2 to 17. Giving that the outcome variables are not the same or measured at different age, and the difference in sample characteristics and average cigarette tax, it is safe to say that the finding is consistent with previous literature although the effect sizes are not exactly the same.

I want to emphasize that the estimates are based on relatively modest cigarette tax rates between 1968 and 1994, with an average tax of 0.50. Therefore, I cannot straightforwardly extend the estimates to predict the impact of cigarette taxes outside of this tax rate range.

I also compare the estimated long-term effects of in-utero cigarette tax with the long-term effects of change in other kinds of in-utero enviroment. Hoynes et al. (2016) finds that access to food stamps program in childhood (from no exposure to full exposure in utero to age five) reduces metabolic syndrome by 0.3 standard deviation, while my study finds that 10 cent increase in in-utero cigarette taxes reduce the probability of having health conditions out of asthma, lung disease, heart disease or heart attack by 0.04 standard deviation. Hwang (2019) finds that one year exposure to the WIC program in early life reduces the probability of ever had asthma in adulthood by 3.7 percentage points, while my study finds that 10 cent increase in in-utero cigarette taxes reduce the probability of having asthma by 1.8 percentage points. With a linear extrapolate, a 10 cent increase in in-utero cigarette tax is equivalent to about half-year exposure to food stamps program or WIC program.

H. Conclusion and Discussion

In this study, I investigate the effects of in-utero cigarette tax on long-term health outcomes in adulthood. I find that exposure to higher in-utero cigarette taxes leads to better health in adulthood and the effects strengthen with age. My findings resonate with a robust body of literature that underscores the effects of early-life exposures on a spectrum of health parameters in the long run.

By delving into the multifaceted mechanisms at play, I have established a compelling case for the role of birth outcomes, health in childhood, smoking behavior in later life, cognitive ability, educational attainment, and age at first childbirth as pathways through which in-utero cigarette taxes affect health in adulthood.

The significance of my study lies in its comprehensive approach to unraveling the intricate web of effects stemming from early-life exposure to higher cigarette taxes. The identification of various mechanisms and their interconnectedness showcases the complexity of the relationship between exposure at birth and adult health, offering valuable insights for both researchers and policymakers.

Yet, my research is not without its limitations. The main sample spans birth cohorts from 1968 to 1994, a period marked by relatively modest year-to-year fluctuations in state tax rates. As such, the estimates may not fully encapsulate the repercussions of more recent and substantial tax hikes. This presents an avenue for future exploration—to scrutinize the long-term ramifications of significant tax increases in the modern context and in a larger range, thereby enhancing my understanding of the dynamic interplay between tax policies and health outcomes.

In conclusion, my study provides a comprehensive and illuminating assessment of the profound and enduring consequences of higher in-utero cigarette taxes on health outcomes in adulthood. By further uncovering the underlying mechanisms, my research contributes to the evolving discourse on early-life policy interventions and their far-reaching implications for public health and well-being.

Reference

Adams, E. K., Markowitz, S., Kannan, V., Dietz, P. M., Tong, V. T., & Malarcher, A. M. (2012). Reducing Prenatal Smoking: The Role of State Policies. *American Journal of Preventive Medicine*, *43*(1), 34-40.

Almond, D. (2006). Is the 1918 Influenza Pandemic Over? Long-term Effects of In Utero Influenza Exposure in the Post-1940 US Population. *Journal of Political Economy*, *114*(4), 672-712.

Almond, D., Chay, K. Y., & Lee, D. S. (2005). The Costs of Low Birth Weight. *The Quarterly Journal of Economics*, *120*(3), 1031-1083.

Bastian, J., & Michelmore, K. (2018). The Long-term Impact of the Earned Income Tax Credit on Children's Education and Employment Outcomes. *Journal of Labor Economics*, *36*(4), 1127-1163.

Baughman, R., & Dickert-Conlin, S. (2009). The Earned Income Tax Credit and Fertility. *Journal of Population Economics*, *22*, 537-563.

Behrman, J. R., & Rosenzweig, M. R. (2004). Returns to Birthweight. *Review of Economics and Statistics*, *86*(2), 586-601.

Bharadwaj, P., Johnsen, J. V., & Løken, K. V. (2014). Smoking Bans, Maternal Smoking and Birth Outcomes. *Journal of Public Economics*, *115*, 72-93.

Biederman, J., Martelon, M., Woodworth, K. Y., Spencer, T. J., & Faraone, S. V. (2017). Is Maternal Smoking During Pregnancy a Risk Factor for Cigarette Smoking in Offspring? A Longitudinal Controlled Study of ADHD Children Grown Ip. *Journal of Attention Disorders*, *21*(12), 975-985.

Black, S. E., Devereux, P. J., & Salvanes, K. G. (2007). From the Cradle to the Labor Market? The Effect of Birth Weight on Adult Outcomes. *The Quarterly Journal of Economics*, *122*(1), 409-439.

Bradford, W. D. (2003). Pregnancy and the Demand for Cigarettes. *American Economic Review*, *93*(5), 1752-1763.

Brennan, P. A., Grekin, E. R., & Mednick, S. A. (1999). Maternal Smoking During Pregnancy and Adult Male Criminal Outcomes. *Archives of General Psychiatry*, *56*(3), 215-219.

Callaway, B., Goodman-Bacon, A., & Sant'Anna, P. H. (2021). Difference-in-differences with a continuous treatment. *arXiv preprint arXiv:2107.02637*.

Case, A., Fertig, A., & Paxson, C. (2005). The Lasting Impact of Childhood Health and Circumstance. *Journal of Health Economics*, *24*(2), 365-389.

C.D.C. Fact Sheet. Smoking and Youth. 2012. https://www.cdc.gov/tobacco/sgr/50th-anniversary/pdfs/fs_smoking_youth_508.pdf

Child Development Supplement to the Panel Study of Income Dynamics, public use dataset. Produced and distributed by the Survey Research Center, Institute for Social Research, University of Michigan, Ann Arbor, MI (2023).

Colman, G., Grossman, M., & Joyce, T. (2003). The Effect of Cigarette Excise Taxes on Smoking Before, During and After Pregnancy. *Journal of Health Economics*, 22(6), 1053-1072.

Conley, D., Strully, K. W., & Bennett, N. G. (2006). Twin Differences in Birth Weight: The Effects of Genotype and Prenatal Environment on Neonatal and Post-neonatal Mortality. *Economics & Human Biology*, *4*(2), 151-183.

Cornfield, J., Haenszel, W., Hammond, E. C., Lilienfeld, A. M., Shimkin, M. B., & Wynder, E. L. (1959). Smoking and Lung Cancer: Recent Evidence and a Discussion of Some Questions. *Journal of the National Cancer Institute*, *22*(1), 173-203.

Cunha, F., & Heckman, J. (2007). The Technology of Skill Formation. *American Economic Review*, *97*(2), 31-47.

Currie, J. (2009). Healthy, Wealthy, and Wise: Socioeconomic Status, Poor Health in Childhood, and Human Capital Development. *Journal of Economic Literature*, *47*(1), 87-122.

Currie, J., & Almond, D. (2011). Human Capital Development Before Age Five. In *Handbook of Labor Economics* (Vol. 4, pp. 1315-1486). Elsevier.

Currie, J., & Hyson, R. (1999). Is the Impact of Health Shocks Cushioned by Socioeconomic Status? The Case of Low Birthweight. *American Economic Review*, *89*(2), 245-250.

Dave, D., Hoehn-Velasco, L., Pesko, M. F., & Phillips, S. (2022). The Long-Term Impact of Early-Life Cigarette Taxes on Adult Pre-Pregnancy and Prenatal Smoking. ASHEcon 2022 Conference.

De Chaisemartin, C., & d'Haultfoeuille, X. (2020). Two-way Fixed Effects Estimators with Heterogeneous Treatment Effects. *American Economic Review*, *110*(9), 2964-2996.

De Chaisemartin, C., & D'haultfœuille, X. (2023). Two-way Fixed Effects and Differences-in-differences Estimators with Several Treatments. *Journal of Econometrics*, *236*(2), 105480.

Doll, R., & Hill, A. B. (1950). Smoking and Carcinoma of the Lung. *British Medical Journal*, *2*(4682), 739.

Einiö, E., Goisis, A., & Myrskylä, M. (2019). Is the Relationship Between Men's Age at First Birth and Midlife Health Changing? Evidence from two British Cohorts. *SSM-Population Health*, *8*, 100458.

Ekblad, M., Gissler, M., Korkeila, J., & Lehtonen, L. (2014). Trends and risk groups for smoking during pregnancy in Finland and other Nordic countries. *The European Journal of Public Health*, *24*(4), 544-551.

English, J. P., Willius, F. A., & Berkson, J. (1940). Tobacco and Coronary Disease. *Journal of the American Medical Association*, *115*(16), 1327-1329.

Evans, W. N., & Lien, D. S. (2005). The Benefits of Prenatal Care: Evidence from the PAT Bus Strike. *Journal of Econometrics*, *125*(1-2), 207-239.

Evans, W. N., & Ringel, J. S. (1999). Can Higher Cigarette Taxes Improve Birth Outcomes? *Journal of Public Economics*, *72*(1), 135-154.

Friedson, A., Li, M., Meckel, K., Rees, D. I., & Sacks, D. W. (2023). Cigarette Taxes, Smoking, and Health in the Long Run. *Journal of Public Economics*, *222*, 104877.

Gilliland, F. D., Berhane, K., McConnell, R., Gauderman, W. J., Vora, H., Rappaport, E. B., . . . Peters, J. M. (2000). Maternal Smoking During Pregnancy, Environmental Tobacco Smoke Exposure and Childhood Lung Function. *Thorax*, *55*(4), 271-276.

Gilliland, F. D., Li, Y.-F., & Peters, J. M. (2001). Effects of Maternal Smoking During Pregnancy and Environmental Tobacco Smoke on Asthma and Wheezing in Children. *American Journal of Respiratory and Critical Care Medicine*, *163*(2), 429-436.

Goodwin, R. D., Pagura, J., Spiwak, R., Lemeshow, A. R., & Sareen, J. (2011). Predictors of persistent nicotine dependence among adults in the United States. *Drug and alcohol dependence*, *118*(2-3), 127-133.

Gould, G. S., Patten, C., Glover, M., Kira, A., & Jayasinghe, H. (2017). Smoking in pregnancy among Indigenous women in high-income countries: a narrative review. *Nicotine & Tobacco Research*, *19*(5), 506-517.

Gruber, J., & Köszegi, B. (2001). Is Addiction "Rational"? Theory and Evidence. *The Quarterly Journal of Economics*, *116*(4), 1261-1303.

Heckman, J. J. (2007). The Economics, Technology, and Neuroscience of Human Capability Formation. *Proceedings of the National Academy of Sciences*, *104*(33), 13250-13255.

Hiscock, R., Bauld, L., Amos, A., Fidler, J. A., & Munafò, M. (2012). Socioeconomic status and smoking: a review. *Annals of the New York Academy of Sciences*, *1248*(1), 107-123.

Hoynes, H., Schanzenbach, D. W., & Almond, D. (2016). Long-run Impacts of Childhood Access to the Safety Net. *American Economic Review*, *106*(4), 903-934.

Johnson, R. C., & Schoeni, R. F. (2007). Early-Life Origins of Adult Disease: The Significance of Poor Infant Health and Childhood Poverty. *UC Berkeley Unpublished Manuscript*, 1-42.

Kandel, D. B., Wu, P., & Davies, M. (1994). Maternal Smoking During Pregnancy and Smoking by Adolescent Daughters. *American Journal of Public Health*, *84*(9), 1407-1413.

Kramer, M. S. (1987). Determinants of Low Birth Weight: Methodological Assessment and Meta-analysis. *Bulletin of the World Health Organization*, *65*(5), 663.

Lee, S., & Park, S. (2020). Age at First Childbirth in Relation to Oral Health Later in Life. *Menopause*, *27*(10), 1104-1109.

Lieb, R., Schreier, A., Pfister, H., & Wittchen, H.-U. (2003). Maternal Smoking and Smoking in Adolescents: A Prospective Community Study of Adolescents and Their Mothers. *European Addiction Research*, *9*(3), 120-130.

Lindeboom, M., Portrait, F., & Van den Berg, G. J. (2010). Long-run Effects on Longevity of a Nutritional Shock Early in Life: the Dutch Potato Famine of 1846–1847. *Journal of Health Economics*, *29*(5), 617-629.

McEvoy, C. T., & Spindel, E. R. (2017). Pulmonary effects of maternal smoking on the fetus and child: effects on lung development, respiratory morbidities, and life long lung health. *Paediatric respiratory reviews*, *21*, 27-33.

Milberger, S., Biederman, J., Faraone, S. V., Chen, L., & Jones, J. (1996). Is Maternal Smoking During Pregnancy A Risk Factor for Attention Deficit Hyperactivity Disorder in Children? *The American Journal of Psychiatry*.

National Center for Health Statistics. Natality Detail File (1969-1994). National Center for Health Statistics, Hyattsville, MD.

Nesson, E., Hoehn-Velasco, L., Pesko, M. F., & Phillips, S. (2022). The Long-Term Impact of Early-Life Cigarette Taxes on Adult Pre-Pregnancy and Prenatal Smoking. ASHEcon 2022 Conference,

Nilsson, J. P. (2017). Alcohol Availability, Prenatal Conditions, and Long-term Economic Outcomes. *Journal of Political Economy*, *125*(4), 1149-1207.

Oken, E., Levitan, E., & Gillman, M. (2008). Maternal Smoking During Pregnancy and Child Overweight: Systematic Review and Meta-analysis. *International Journal of Obesity*, *32*(2), 201-210.

Oreopoulos, P., Stabile, M., Walld, R., & Roos, L. L. (2008). Short-, Medium-, and Long-term Consequences of Poor Infant Health: An Analysis Using Siblings and Twins. *Journal of Human Resources*, *43*(1), 88-138.

Orzechowski, W. and R. Walker, The Tax Burden on Tobacco, Historical Compilation, vol. 49, Orzechowski and Walker, Economic Consulting Firm, 2014.

Panel Study of Income Dynamics, public use dataset. Produced and distributed by the Survey Research Center, Institute for Social Research, University of Michigan, Ann Arbor, MI (2020).

Patrick, S. W., Warner, K. E., Pordes, E., & Davis, M. M. (2016). Cigarette Tax Increase and Infant Mortality. *Pediatrics*, *137*(1).

Ponicki, W. R. (2004) Statewide Availability Data System II: 1933 - 2003. National Institute on Alcohol Abuse and Alcoholism Research Center Grant P60-AA006282-23. Berkeley, CA: Pacific Institute for Research and Evaluation, Prevention Research Center.

Ross, C. E., & Wu, C. L. Education, Age, and the Cumulative Advantage in Health. Journal of Health and Social Behavior, 1996.3(7), 104-120.

Rumrich, I. K., Vähäkangas, K., Viluksela, M., Gissler, M., Surcel, H. M., Korhonen, A., ... & Hänninen, O. (2019). Smoking during pregnancy in Finland–trends in the MATEX cohort. *Scandinavian journal of public health*, *47*(8), 890-898.

Satcher, D., Thompson, T. G., & Koplan, J. P. (2002). Women and Smoking: A Report of the Surgeon General. Centers for Disease Control and Prevention, 4(1), 7-20.

Settele, S., & Van Ewijk, R. (2018). Can Cigarette Taxes During Pregnancy Mitigate the Intergenerational Transmission of Socioeconomic Status? *Labour Economics*, *55*, 130-148.

Shadyab, A. H., Gass, M. L., Stefanick, M. L., Waring, M. E., Macera, C. A., Gallo, L. C., . . . LaCroix, A. Z. (2017). Maternal Age at Childbirth and Parity as Predictors of Longevity Among Women in the United States: The Women's Health Initiative. *American Journal of Public Health*, *107*(1), 113-119.

Shiono, P. H., & Behrman, R. E. (1995). Low Birth Weight: Analysis and Recommendations. *The Future of Children*, 4-18.

Simon, D. (2016). Does Early Life Exposure to Cigarette Smoke Permanently Harm Childhood Welfare? Evidence from Cigarette Tax Hikes. *American Economic Journal: Applied Economics*, *8*(4), 128-159.

Tominey, E. (2007). Maternal Smoking During Pregnancy and Early Child Outcomes. (CEP Discussion Papers CEPDP8). Centre for Economic Performance (CEP), The London School of Economics and Political Science (LSE): London, UK.

United States Department of Health and Human Services (2004). *The Health Consequences of Smoking: A Report of the Surgeon General.* Centers for Disease Control and Prevention.

United States Department of Health and Human Services (2001). *Women and Smoking: A Report of the Surgeon General* (Vol. 1). Centers for Disease Control and Prevention.

United States Department of Health and Human Services (2010). *How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease: A Report of the Surgeon General.* Centers for Disease Control and Prevention.

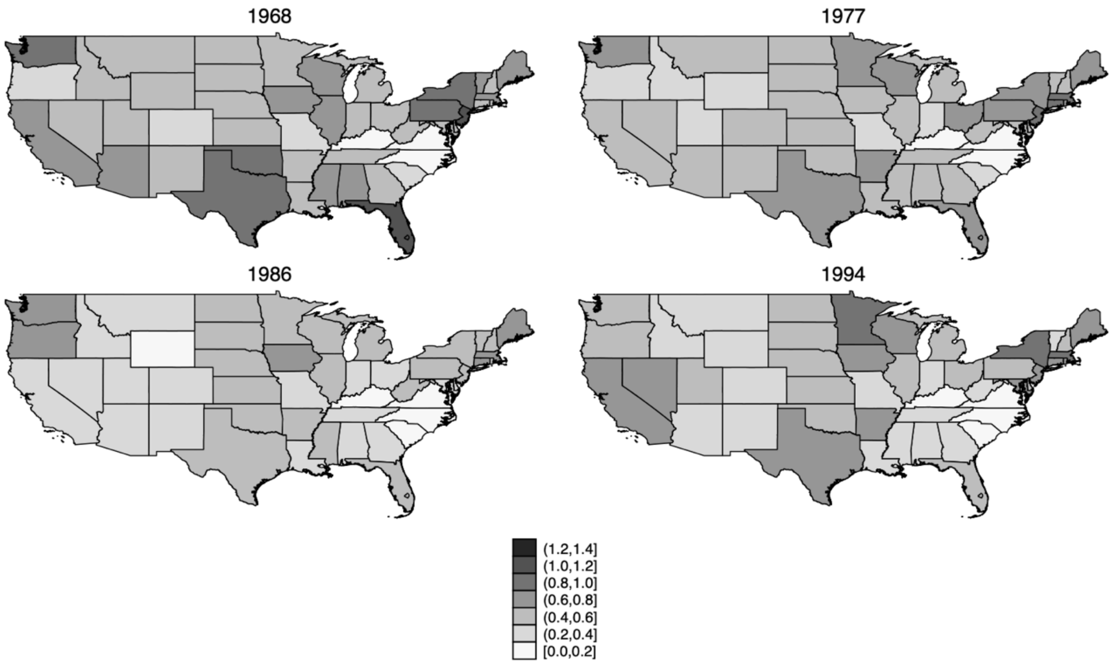
United States Department of Health and Human Services (2012). *Preventing Tobacco Use Among Youth and Young Adults: A Report of the Surgeon General.* Centers for Disease Control and Prevention.

Van den Berg, M., Birnbaum, L. S., Denison, M., De Vito, M., Farland, W., Feeley, M., .Haws, L. (2006). The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds. *Toxicological Sciences*, *93*(2), 223-241.

W.H.O. (2015). *WHO Report on the Global Tobacco Epidemic 2015: Raising Taxes on Tobacco*. World Health Organization.

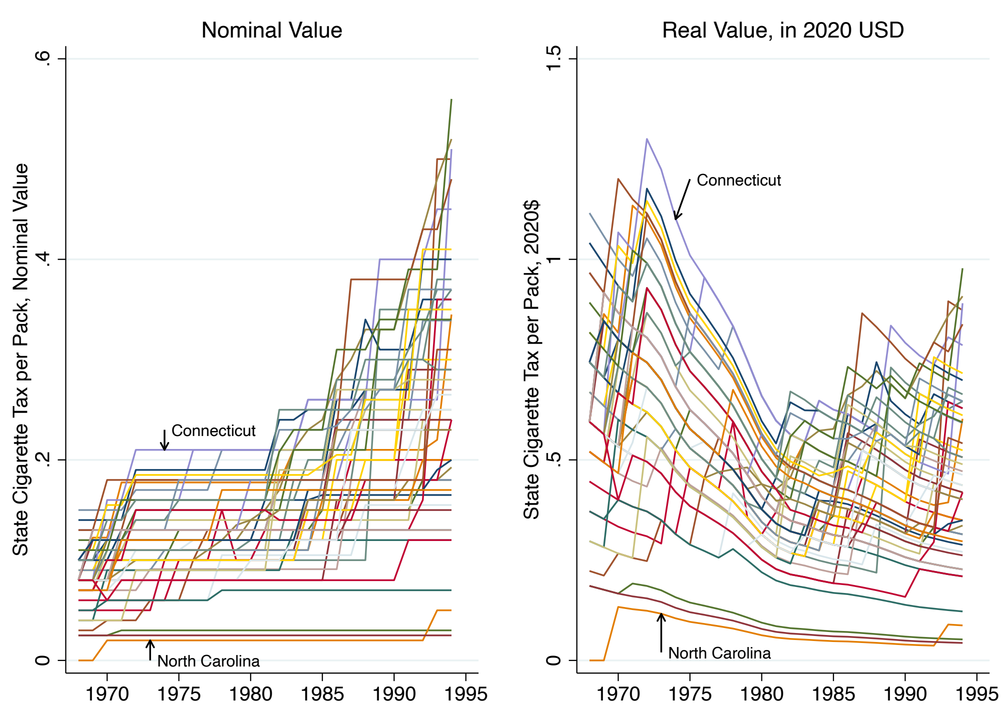
Figure 1: State Cigarette Taxes per Pack

(a) Real Value over Time



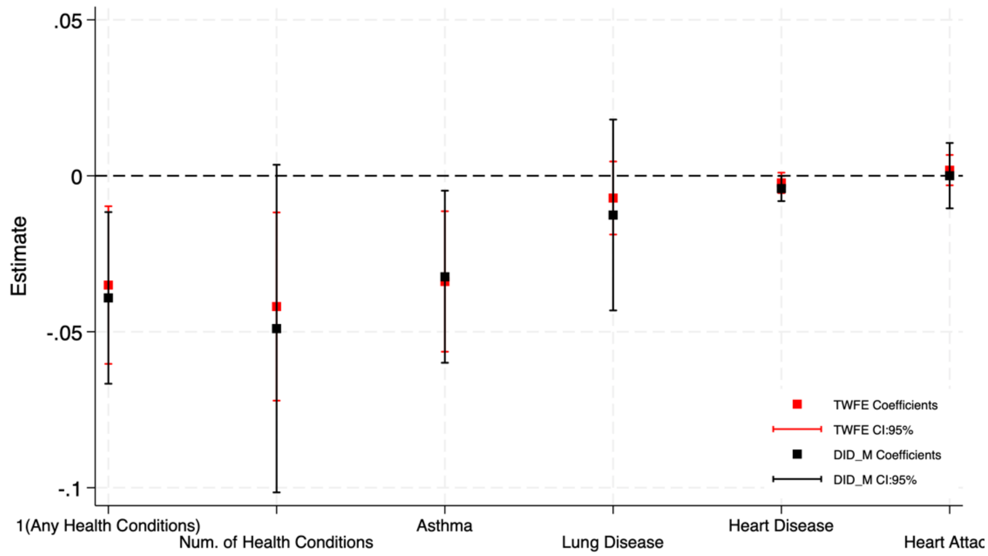
Source: Author's calculation. Data of cigarette taxes is collected from *The Tax Burden on Tobacco* and CPI data is from the U.S. Bureau of Labor Statistics.
Note: Figure shows the state cigarette tax per pack in 2020 dollar for 48 US continental states and District of Columbia.

(b) Cigarette Tax per Pack, 1968 to 1994, Nominal Value and Real Value in 2020 Dollar



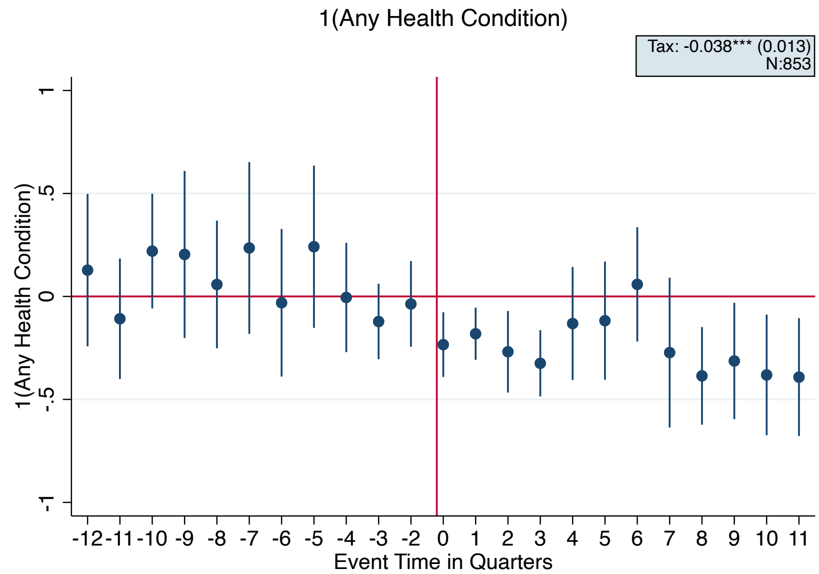
Source: Author's calculation. Data of cigarette taxes is collected from *The Tax Burden on Tobacco* and CPI data is from the U.S. Bureau of Labor Statistics.
Note: Figure shows the state cigarette tax per pack for 50 states and District of Columbia.

Figure 2: Compare Two-way Fixed Effect Estimation and DID Estimation Proposed by De Chaisemartin and D'Haultfoeuille (2020)

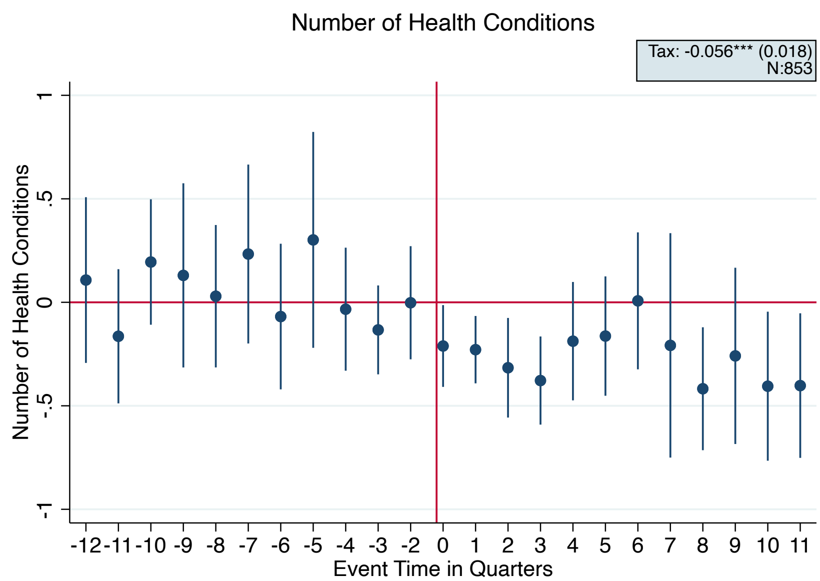


Note: Each marker is from one estimation. For the convenience of comparison, the unit of cigarette tax is adjusted to 20 cents. Confidence interval at 90%.

Figure 3: Event Study of In-utero Exposure to a Large Cigarette Tax Hike on Long-term Health Condition
(a) Any Health Condition = 1

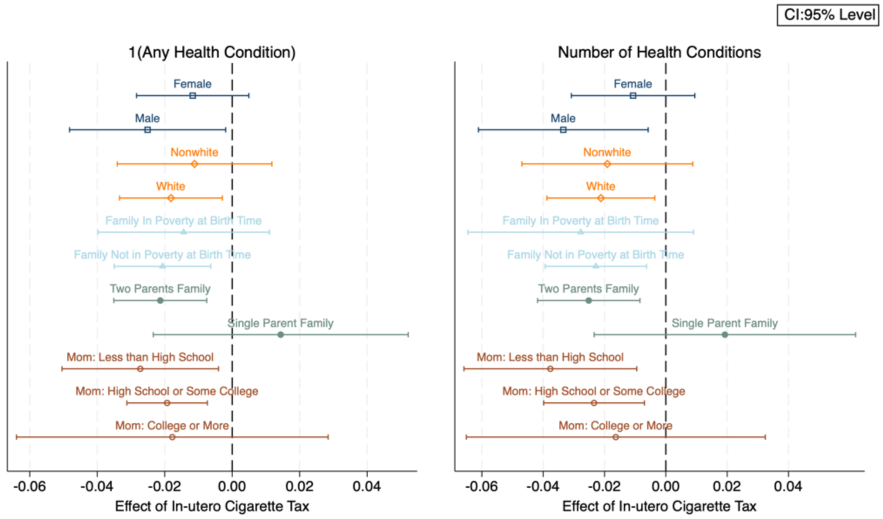


(b) Number of Health Conditions



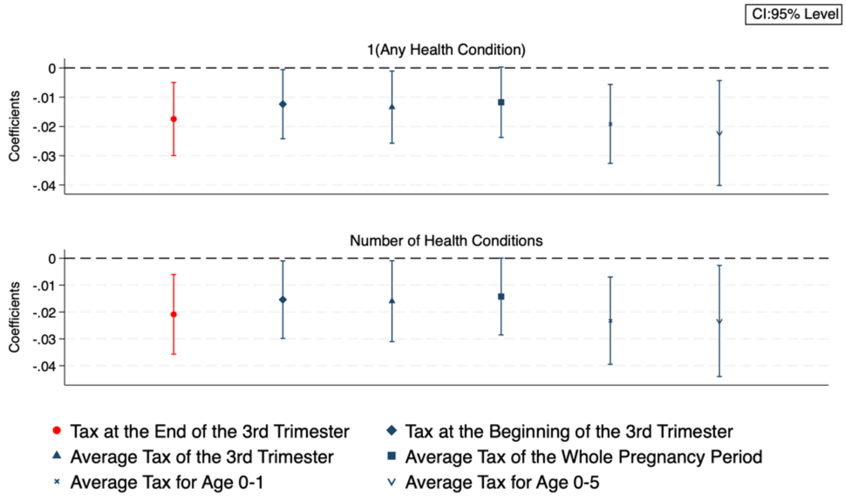
Note: Each figure is from one estimation. Event is defined as any tax hike greater than the 50 percentile of all hikes during 1968-1994. Event time is defined in quarters. Event time 0 presents the cohort born in the year-quarter that the tax hike happened. Only states that experience an event are included in the event study sample. I also balance the event study such that events are only included if there are two full years in both the pre-period and post-period. The sample consists of individuals born to PSID families between the "high frequency" tax period of 1968-1976 and became household heads or spouses during age 25-35 in later PSID survey. Estimates are weighted using the average PSID longitudinal weights during age 1-18. Outcome variables are individuals' health status during age 25-35. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Age is the age of the individual at the last year he/she showed up in PSID survey during his/her age 25-35. Family background at birth includes the educational level of mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors are clustered by state of birth. Confidence interval at 95%.

Figure 4: Heterogeneous Effects



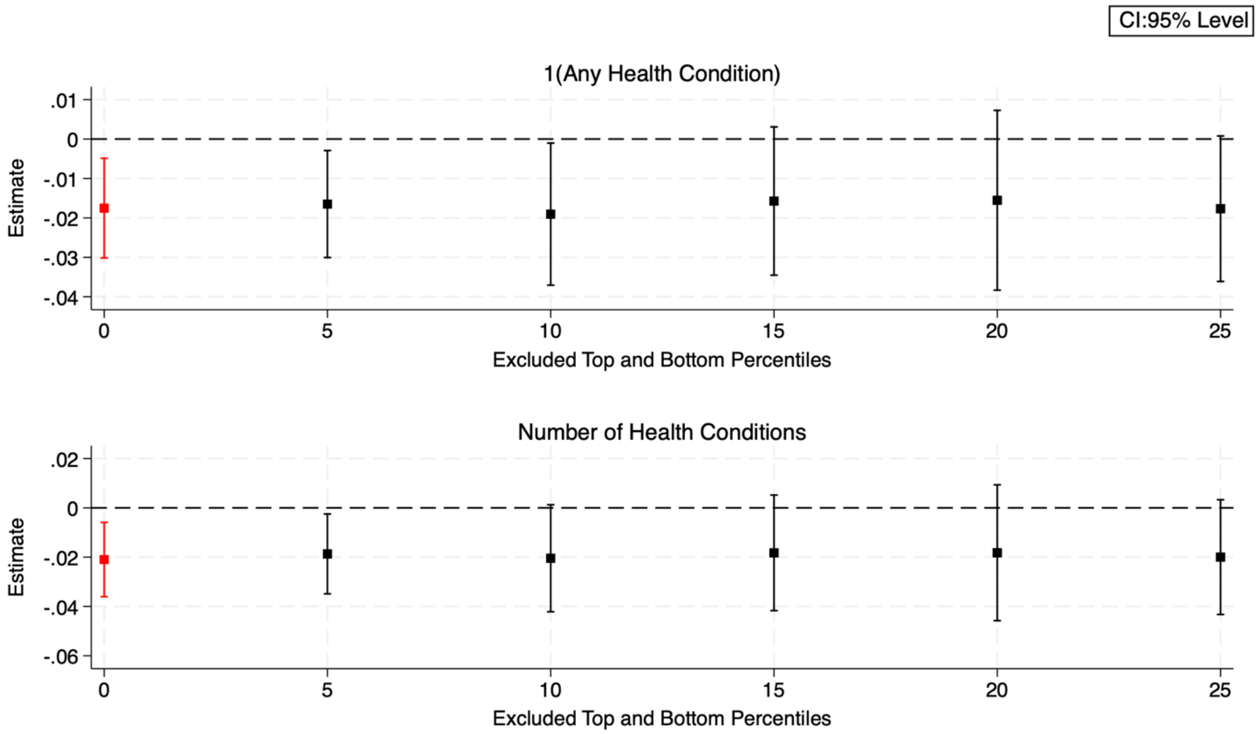
Note: Each coefficient is from a separate regression. The sample consists of individuals born to PSID families between 1968-1994 and became household heads or spouses during age 25-35 in later PSID survey. Estimates are weighted using the average PSID longitudinal weights during age 1-18. For the educational level of mother subgroups, we define the educational level as less than high school if the highest grade is less than 12, as high school or some college is the highest grade between 12 and 15, and as college or above if the highest grade is more than or equal to 16. For the economic status subgroups, we define in poverty family as families with income less than or equal to 1.5 times Census need standard. Outcome variables are health status and smoke behabior during age 25-35. Cigarette tax at birth month is the state cigarette tax in the birth state at birth month. Cigarette tax at age 25 is the state cigarette tax in the resident state at age 25. Both taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Age is the age of the individual at the last year he/she showed up in PSID survey during his/her age 25-35. Family background at birth includes the educational level of mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors are clustered by state of birth. Confidence interval at 90%.

Figure 5: Robustness Check, Difference Measures for Cigarette Tax



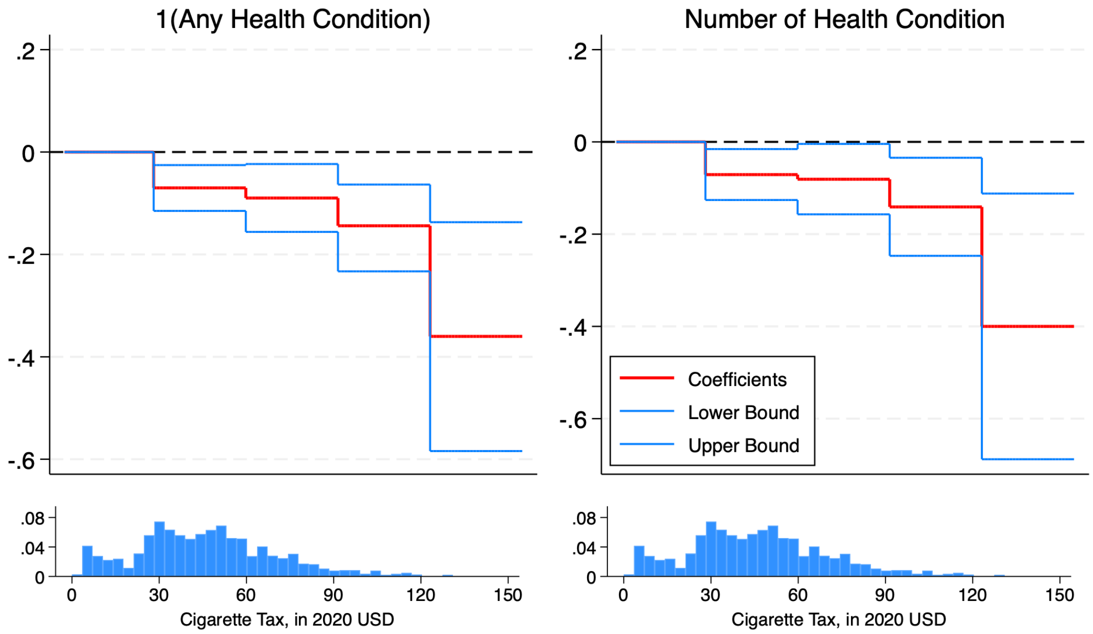
Note: Each coefficient is from a separate regression. The sample consists of individuals born to PSID families between 1968-1994 and became household heads or spouses during age 25-35 in later PSID survey. Estimates are weighted using the average PSID longitudinal weights during age 1-18. Outcome variables are individuals' health status during age 25-35. Taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Age is the age of the individual at the last year he/she showed up in PSID survey during his/her age 25-35. Family background at birth includes the educational level of mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors are clustered by state of birth. Confidence interval at 95%.

Figure 6: Robustness Check, Trimming Percentiles from the State Excise Cigarette Tax



Note: Coefficient estimates and 90% confidence bands from estimating equation 3 using OLS where we sequentially trim states with the bottom and top percentiles average cigarette taxes during 1968 to 1994. Coefficient estimates can be roughly interpreted as the impact of 10 cent increase in cigarette tax on the long-term health outcome. Standard errors are clustered by state of birth.

Figure 7: Nonlinear Effect



Note: Each figure is from a separate regression. The sample consists of individuals born to PSID families between 1968-1994 and became household heads or spouses during age 25-35 in later PSID surveys. Estimates are weighted using the average PSID longitudinal weights during age 1-18. Outcome variables are individuals' health status during age 25-35. The explanatory variables are four cigarette tax bins (=1 if cigarette tax is between 30-60/60-90/90-120/120-150 cents) with the base bin being 0-30 cents. Cigarette taxes are cpi-adjusted and reported in 2020 dollars. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Age is the age of the individual at the last year he/she showed up in PSID survey during his/her age 25-35. Family background at birth includes the educational level of mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors are clustered by state of birth. Confidence interval at 95%.
Note: we've tried 20-cent bins and results are robust.

Table 1: Summary Statistics

	Mean	Std. Dev.	Min	Max
Health outcomes during age 25-35				
Any health condition = 1[a]	0.24	0.43	0	1
# of Health condition[b]	0.28	0.53	0	3
Asthma = 1	0.19	0.39	0	1
Lung disease = 1	0.07	0.25	0	1
Heart disease = 1	0.02	0.14	0	1
Heart attack = 1	0.00	0.07	0	1
Demographics				
Birth year	1981.20	7.20	1968	1994
Male	0.48	0.5	0	1
White	0.81	0.39	0	1
Black	0.17	0.37	0	1
Other race	0.03	0.16	0	1
Age	32.43	2.97	25	35
Family background at birth year				
Mother's age > 35	0.18	0.39	0	1
Mother less than high school education	0.21	0.41	0	1
Mother high school or some college education	0.60	0.49	0	1
Mother college or above education	0.19	0.39	0	1
Female-headed household	0.14	0.35	0	1
Married parents	0.84	0.37	0	1
First kid	0.59	0.49	0	1
Second kid	0.24	0.43	0	1
Second+ kid	0.18	0.38	0	1
Income to needs ratio	3.56	2.66	0	25.05
Taxes and regulations				
In-utero Cigarette tax (2020$)	0.50	0.23	0	1.31
Cigarette tax at age 25 (2020$)	1.21	0.98	0.04	5.00
Minimum legal age for purchasing tobacco products	17.89	0.86	15	24
Substitutes				
State-level beer tax per 31 gallon (2020$)	53.28	28.71	20.28	231.37
State-level wine tax per gallon (2020$)	2.51	3.44	0.34	47.21
State-level spirit tax per gallon (2020$)	31.20	28.71	0	107.83
Economic, welfare and medical policie/conditions				
Minimum wage (2020$)	5.75	3.49	0	13.42
Maximum income marginal tax rate	5.63	4.10	0	21.8

Per capita GDP (1,000, 2020$)	38.83	7.65	21.00	148.47
EITC benefit (2020$)	1,402.32	912.53	0	6,621.93
CDCTC benefit (2020$)	2,530.95	1,575.97	0	7,483.37
AFDC/TANF benefit (2020$)	907.03	380.11	171.11	2158.94
Number of hospital beds (1,000)	48.56	37.47	1.30	206.4
Welfare vendor payment for medical (1,000,2020$)	2807.07	3467.70	0	24999.96
# Observations	5402			

Note: Author's tabulations of 1968-2019 PSID. Main sample consists of individuals born to PSID families between 1968-1994 and became household heads or spouses during age 25-35 in later PSID survey.State-level cigarette taxes are from *the Tax Burden on Tobacco*. The minimum legal age for purchasing tobacco products is collected through Nexis Uni database. Alcohol taxes are from the Alcohol Policy Information System. The minimum wage is from the U.S. Department of Labor. The maximum income marginal tax rate is from the Council of State Governments. The per capita GDP is calculated with state GDP from the U.S. Bureau of Economic Analysis and state population from the U.S. Census Bureau and Fred Economic Data. The EITC benefit is from the National Bureau of Economic Research. The CDCTC benefit is collected through the Nexis Uni database and Hein Online database. The AFDC/TANF benefit is from legislative history references from U.S. Government Publishing Office. The number of hospital beds and welfare vendor payment for medical are from the U.S. Census Bureau.

[a] 1(Any health condition) = 1 if the individual has any of the following diseases: asthma, lung disease, heart disease, and heart attack.

[b] # of health condition = the number of diseases the individual has out of asthma, lung disease, heart disease, and heart attack.

Table 2: Correlation between State Cigarette Taxes and State-Level Demographic, State Economic Policies, and State Economic Conditions

	Cigarette Tax at time *t*	Cigarette Tax at time *t*+1	Cigarette Tax at time *t*+2
	(1)	(2)	(3)
State Covariates at time *t*			
Male	-0.009	-0.025	-0.032
	(0.067)	(0.061)	(0.062)
White	-0.025	0.001	0.002
	(0.086)	(0.080)	(0.079)
Married	0.049	0.037	0.015
	(0.034)	(0.035)	(0.035)
High School or Some College	0.005	-0.051	-0.052
	(0.080)	(0.080)	(0.086)
College or Higher Education	-0.014	-0.069	-0.087
	(0.086)	(0.101)	(0.105)
Age	-0.000	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
State per capita GDP	0.000	0.001	0.002
	(0.002)	(0.002)	(0.002)
State Min. Wage	0.000	-0.000	0.000
	(0.003)	(0.003)	(0.003)
State Income MTR	-0.003	-0.004	-0.004
	(0.004)	(0.005)	(0.004)
State Max. AFDC/TANF Benefit	0.030	0.057	0.079
	(0.055)	(0.056)	(0.060)
State Max. EITC	-0.007	0.007	0.008
	(0.028)	(0.038)	(0.047)
State Max. CDCTC	0.016	0.019	0.025
	(0.019)	(0.018)	(0.017)
State Hospital Beds	0.001	0.000	-0.000
	(0.002)	(0.002)	(0.002)
State Welfare Vendor Payment for Medical	-0.004	-0.001	0.000
	(0.011)	(0.011)	(0.011)
State Beer Excise Tax	0.002*	0.002*	0.002*
	(0.001)	(0.001)	(0.001)
State Wine Excise Tax	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
State Spirit Excise Tax	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
Minimum legal age for purchasing tobacco products	0.007	0.008	0.006
	(0.008)	(0.009)	(0.010)
R-squared	0.814	0.812	0.806
Prob>F	0.332	0.143	0.191
State Fixed Effect	Y	Y	Y
Year Fixed Effect	Y	Y	Y
N		1281	

Note: Each column is a separate model. All the covariates are aggregated to the state-year level. We use data from 1968-1994. State FE and State FE are controlled in the model. Standard errors clustered on state are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table 3: Endogeneity Check I, Cigarette Tax Effect on Fertility

	1(Have a Newborn in Year t/t+1)	1(Have a Boy in Year t/t+1)	1(Have a Girl in Year t/t+1)
	(1)	(2)	(3)
Cigarette Tax, *t* (10 cents)	0.027	0.020	0.006
	(0.022)	(0.020)	(0.015)
Observations	68,259	68,259	68,259
R-squared	0.107	0.062	0.069
Y-mean	0.254	0.150	0.149
Std. Dev. Of Y	(0.435)	(0.357)	(0.356)
Birth Year FE	Yes	Yes	Yes
Birth State FE	Yes	Yes	Yes
Interview Year FE	Yes	Yes	Yes
Individual Controls	Yes	Yes	Yes
State Controls at Time *t*	Yes	Yes	Yes

Note: Each column is from a separate regression. We use PSID data from 1968-1994. The sample consists of females aging 20-39. Estimates are weighted using the PSID family longitudinal weights. Cigarette tax is the cpi-adjusted cigarette tax in the resident state and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect, birth state fixed effect and interview year FE. Individual demographic controls include gender, race, marital status, educational level, number of kids, age of youngest kid, and age square. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at year *t*. Standard errors clustered on state of birth are in parentheses. Significance levels: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table 4: Endogeneity Check II, Selection Bias

	1(Be a Household Head/Spouse during Age 25-35)
In-utero Cigarette Tax (10 cents)	-0.003
	(0.006)
Observations	11,148
R-squared	0.089
Y-mean	0.586
Std. Dev. Of Y	(0.493)
Cigarette Tax at Age 25	Yes
Birth Year FE	Yes
Birth State FE	Yes
Individual Controls	Yes
Family Background at Birth	Yes
State Controls	Yes

Note: The sample consists of individuals born to PSID families between 1968-1994. Estimates are weighted using the average PSID longitudinal weights during age 1-18. Outcome variable is if the individual becomes a household head or spouse during age 25-35, in other word, if the individual is in our main sample. Cigarette tax at birth month is the state cigarette tax in the birth state at birth month. Cigarette tax at age 25 is the state cigarette tax in the resident state at age 25. Both taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender and race. Family background at birth includes the educational level of mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors clustered on state of birth are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table 5: Cigarette Tax Effect on Smoking Behavior

	1(Smoke Now)		
	Individuals Aged 20-39	Individuals Aged 20-39 and with Newborns in year *t/t+1*	Individuals Aged 20-39 Whose Children in Main Sample
	(1)	(2)	(3)
Cigarette Tax, *t* (10 cents)	-0.020*	-0.029**	-0.095***
	(0.011)	(0.012)	(0.023)
Observations	37,036	6,155	4,140
R-squared	0.136	0.184	0.174
Y-mean	0.246	0.199	0.270
Std. Dev. Of Y	(0.431)	(0.399)	(0.444)
Year FE	Yes	Yes	Yes
Birth State FE	Yes	Yes	Yes
Individual Controls	Yes	Yes	Yes
Family Background at Birth Year	Yes	Yes	Yes
State Controls at Time *t*	Yes	Yes	Yes
Smoke Bans at Time *t*	Yes	Yes	Yes
Educational Level	Yes	Yes	Yes

Note: Each column is from a separate regression. The sample of first column consists of household heads and spouses aged 20-39 in PSID survey in 1986 or from 1999 to 2019 (smoking behavior is only surveyed in these years). The sample of the second and third column is subsample to the sample of first column. The sample of the second column contains household heads and spouses who had newborn at year *t/t+1* and aged 20-39 in PSID survey in 1986 or during 1999 to 2019. The sample of the third column contains household heads and spouses aged 20-39 whose children contained in our main sample in PSID survey in 1986 or during 1999 to 2019. Estimates are weighted using the PSID longitudinal weight. Outcome variables are smoke behavior of individuals. Cigarette tax is the state cigarette tax in the individual's resident state. It is cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include interview year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, educational level, and age square. Family background at birth includes the educational level of mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include smoke bans, the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at year *t*. Standard errors clustered on state of residence are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table 6: Effects of In-utero Cigarette Taxes on Adult Health

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome:1(Any Health Condition)								
In-utero Cigarette Tax (10 cents)	-0.013*	-0.014*	-0.014*	-0.014**	-0.013**	-0.014**	-0.015**	-0.018***
	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Cig. Tax at Age 25 (10 cents)	-0.002**	-0.002**	-0.002**	-0.002**	-0.002**	-0.002**	-0.002*	-0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	5,402	5,402	5,402	5,402	5,402	5,402	5,402	5,402
R-squared	0.035	0.041	0.046	0.047	0.047	0.047	0.047	0.049
Y-Mean	0.240	0.240	0.240	0.240	0.240	0.240	0.240	0.240
Std. Dev. Of Y	(0.427)	(0.427)	(0.427)	(0.427)	(0.427)	(0.427)	(0.427)	(0.427)
Outcome: # of Health Conditions								
In-utero Cigarette Tax (10 cents)	-0.018**	-0.018**	-0.018**	-0.018**	-0.017**	-0.018**	-0.018**	-0.021***
	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
Cig. Tax at Age 25 (10 cents)	-0.002*	-0.002*	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	5,402	5,402	5,402	5,402	5,402	5,402	5,402	5,402
R-squared	0.035	0.043	0.048	0.049	0.05	0.05	0.05	0.051
Y-Mean	0.279	0.279	0.279	0.279	0.279	0.279	0.279	0.279
Std. Dev. Of Y	(0.530)	(0.530)	(0.530)	(0.530)	(0.530)	(0.530)	(0.530)	(0.530)
Birth Year FE, Birth State FE	X	X	X	X	X	X	X	X
Gender, Race, Age Square		X	X	X	X	X	X	X
Family Background at Birth Year			X	X	X	X	X	X
Tax Rate for Beer, Wine & Spirit				X	X	X	X	X
Minimum Legal Purchasing Age for Tobacco					X	X	X	X
AFDC, EITC, CDCTC Benefit						X	X	X
Per Capita Hospital Beds and State Welfare Vendor Payment for Medical							X	X
Minimum Wage, Max income MTR, and Per Capita GDP								X

Note: Each column of each panel is from a separate regression. The sample consists of individuals born to PSID families between 1968-1994 and became household heads or spouses during age 25-35 in later PSID survey. Estimates are weighted using the average PSID longitudinal weights during age 1-18. Outcome variables are individuals' health status during age 25-35. 1(Any health condition) = 1 if the individual has any disease out of asthma, lung disease, heart disease and heart attack. # of health condition = the number of disease the individual has out of asthma, lung disease, heart disease and heart attack. Cigarette tax at birth month is the state cigarette tax in the birth state at birth month. Cigarette tax at age 25 is the state cigarette tax in the resident state at age 25. Both taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Standard errors clustered on state of birth are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table 7: Effects of In-utero Cigarette Taxes on Specific Health Conditions in Adulthood

	1(Any Health condition)	# of Health condition	Asthma	Lung Disease	Heart Attack	Heart Disease
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A, Baseline, Outcome Variable = Health Status for Persons Age 25-35						
In-utero Cigarette Tax (10 cents)	-0.018***	-0.021***	-0.017***	-0.004	-0.001	0.001
	(0.006)	(0.008)	(0.006)	(0.003)	(0.001)	(0.001)
Cigarette Tax at Age 25 (10 cents)	-0.002*	-0.002	-0.001	0	0	0
	(0.001)	(0.001)	(0.001)	(0.001)	0.000	0.000
Observations	5,402	5,402	5,402	5,402	5,402	5,402
R-squared	0.049	0.051	0.047	0.045	0.036	0.035
Y-Mean	0.240	0.279	0.185	0.070	0.005	0.019
Std. Dev. Of Y	(0.427)	(0.530)	(0.388)	(0.254)	(0.071)	(0.137)
Panel B, Outcome Variable = Health Status for Persons Age 35-45						
In-utero Cigarette Tax (10 cents)	-0.028***	-0.047***	-0.022**	-0.014**	-0.005	-0.007
	(0.010)	(0.015)	(0.009)	(0.006)	(0.003)	(0.005)
Cigarette Tax at Age 35 (10 cents)	0.000	0.001	0.000	0.001	0.000	0.000
	(0.001)	(0.002)	(0.001)	(0.001)	0.000	0.000
Observations	2,983	2,983	2,983	2,983	2,983	2,983
R-squared	0.06	0.064	0.052	0.061	0.043	0.05
Y-Mean	0.223	0.283	0.170	0.064	0.017	0.032
Std. Dev. Of Y	(0.416)	(0.587)	(0.376)	(0.245)	(0.129)	(0.176)
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Birth State FE	Yes	Yes	Yes	Yes	Yes	Yes
Individual Controls	Yes	Yes	Yes	Yes	Yes	Yes
Family Background at Birth Year	Yes	Yes	Yes	Yes	Yes	Yes
State Controls at Birth Year	Yes	Yes	Yes	Yes	Yes	Yes

Note: Each column in each panel is from a separate regression. For the baseline model in panel A, the sample consists of individuals born to PSID families between 1968-1994 and became household heads or spouses during age 25-35 in later PSID survey. The sample for Panel B consists of individuals born to PSID families between 1968-1984 and became household heads or spouses during age 35-45 in later PSID survey. Estimates are weighted using the average PSID longitudinal weights during age 1-18. Outcome variables are individuals' health status during age 25-35. Cigarette tax at birth month is the state cigarette tax in the birth state at birth month. Cigarette tax at age 25 is the state cigarette tax in the resident state at age 25. Both taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Age is the age of the individual at the last year he/she showed up in PSID survey during his/her age 25-35. Family background at birth includes the educational level of mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors clustered on state of birth are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table 8: Effects estimated with De Chaisemartin and D'Haultfoeuille (2020) DID Estimator with Continuous Treatment

	1(Any Health condition) (1)	# of Health condition (2)	Asthma (3)	Lung Disease (4)	Heart Attack (5)	Heart Disease (6)
Panel A, Baseline, Outcome Variable = Health Status during Age 25-35						
Discrete In-utero Cigarette Tax Level	-0.039***	-0.049**	-0.032***	-0.013	-0.004	0.000
	(0.015)	(0.021)	(0.012)	(0.014)	(0.002)	(0.006)
Observations	3669	3669	3670	3670	3670	3669
Num of Switchers	1040	1040	1040	1040	1040	1040
Panel B, Outcome Variable = Health Status during Age 35-45						
Discrete In-utero Cigarette Tax Level	-0.064***	-0.072***	-0.055***	-0.009	-0.005	-0.003
	(0.020)	(0.023)	(0.016)	(0.015)	(0.008)	(0.009)
Observations	1936	1936	1936	1936	1936	1936
Num of Switchers	627	627	627	627	627	627

Note: Results from De Chaisemartin and D'Haultfoeuille (2020) DID Estimator. Each column in each panel is from a separate regression. The sample consists of individuals born to PSID families between 1968-1994 and became household heads or spouses during age 25-35 in later PSID survey. Estimates are weighted using the average PSID longitudinal weights during age 1-18. Outcome variables are individuals' health status during age 25-35. In-utero cigarette tax are divided into eight distinct tax tiers. The baseline tier ranges from 0 to 10 cents, while the subsequent tiers go from 11 to 30 cents, then from 31 to 50, and so on, with the highest tier cigarette tax spanning from 130 to 150 cents.

Table 9: Heterogeneous Effects

	Gender		Race		Family's Economic Status at Birth Time		Parent's Marital Status at Birth Time		Mother's Educational Level at Birth Time		
	Female	Male	Nonwhite	White	In Poverty	Not in Poverty	Married	Single Parent	Less than High School	High School or Some College	College or above
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Outcome: 1(Any Health Condition)											
In-utero Cigarette Tax (10 ¢)	-0.012	-0.025**	-0.008	-0.019**	-0.009	-0.022***	-0.022***	0.009	-0.023**	-0.020***	-0.019
	(0.008)	(0.012)	(0.011)	(0.008)	(0.012)	(0.007)	(0.007)	(0.018)	(0.011)	(0.006)	(0.024)
Observations	2,894	2,508	2,379	3,023	1,611	3,791	4,349	1,053	1,542	3,106	754
R-squared	0.075	0.057	0.145	0.055	0.159	0.053	0.051	0.179	0.136	0.07	0.148
Y-Mean	0.27	0.208	0.254	0.237	0.304	0.225	0.232	0.29	0.262	0.236	0.229
Std. Dev. Of Y	(0.444)	(0.406)	(0.435)	(0.425)	(0.460)	(0.417)	(0.422)	(0.454)	(0.440)	(0.424)	(0.421)
Outcome: # of Health Condition											
In-utero Cigarette Tax (10 ¢)	-0.011	-0.034**	-0.016	-0.022**	-0.02	-0.024***	-0.025***	0.013	-0.034**	-0.024***	-0.018
	(0.010)	(0.014)	(0.013)	(0.009)	(0.017)	(0.009)	(0.008)	(0.021)	(0.014)	(0.009)	(0.025)
Observations	2,894	2,508	2,379	3,023	1,611	3,791	4,349	1,053	1,542	3,106	754
R-squared	0.076	0.064	0.151	0.056	0.156	0.052	0.051	0.199	0.126	0.075	0.137
Y-Mean	0.316	0.239	0.316	0.27	0.369	0.257	0.265	0.364	0.326	0.27	0.251
Std. Dev. Of Y	(0.558)	(0.496)	(0.589)	(0.515)	(0.604)	(0.508)	(0.513)	(0.617)	(0.595)	(0.518)	(0.483)
Cigarette Tax at Age 25	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Family Background at Birth Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Controls at Birth Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Each column of each panel is from a separate regression. The sample consists of individuals born to PSID families between 1968-1994 and became household heads or spouses during age 25-35 in later PSID survey. Estimates are weighted using the average PSID longitudinal weights during age 1-18. For the educational level of mother subgroups, we define the educational level as less than high school if the highest grade is less than 12, as high school or some college is the highest grade between 12 and 15, and as college or above if the highest grade is more than or equal to 16. For the economic status subgroups, we define in poverty family as families with income less than or equal to 1.5 times Census need standard. Outcome variables are health status and smoke behabior during age 25-35. Cigarette tax at birth month is the state cigarette tax in the birth state at birth month. Cigarette tax at age 25 is the state cigarette tax in the resident state at age 25. Both taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Age is the age of the individual at the last year he/she showed up in PSID survey during his/her age 25-35. Family background at birth includes the educational level of mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors clustered on state of birth are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table 10: Robustness Check

	1(Any Health condition)				# of Health condition			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
In-utero Cigarette Tax (10 ¢)	-0.018***	-0.018***	-0.016**		-0.021***	-0.021***	-0.020**	
	(0.006)	(0.006)	(0.007)		(0.008)	(0.007)	(0.007)	
Avg. Cig. Tax during Age 1-13			-0.04				-0.034	
			(0.092)				(0.099)	
Avg. Cig. Tax during Age 14-17		-0.043	-0.035			-0.036	-0.03	
		(0.034)	(0.037)			(0.039)	(0.043)	
Cig. Tax at Age 25	-0.002*	-0.002*	-0.002**		-0.002	-0.002	-0.002	
	(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)	
In-utero Cigarette Tax (10 ¢)*Born in 1968-1980				-0.017***				-0.021***
				(0.006)				(0.008)
Difference in Cig. Tax Effect bewteen Born in 1968-1980 and Born in 1981-1994				-0.002				0.001
				(0.007)				(0.010)
N	5,402	5,402	5,402	5,402	5,402	5,402	5,402	5,402
R-squared	0.049	0.049	0.049	0.049	0.051	0.052	0.052	0.051
Y-mean		0.240				0.279		
Std. Dev. Of Y		(0.427)				(0.530)		
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Family Background at Birth Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Controls at Birth Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Each column is from a separate regression. The sample consists of individuals born to PSID families between 1968-1994 and became household heads or spouses during age 25-35 in later PSID survey. Estimates are weighted using the average PSID longitudinal weights during age 1-18. Outcome variables are health status during age 25-35. Cigarette taxes are the state cigarette tax in the birth state. Taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Age is the age of the individual at the last year he/she showed up in PSID survey during his/her age 25-35. Family background at birth includes the educational level of mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors clustered on state of birth are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table 11: Cigarette Tax Effect on Birth Outcomes and Maternal Smoking Behavior, Estimated with Natality Data

	Average Birth Weight	Very Low Birth Weight Rate (<1500g)	Average Gestational Age	Preterm Delivery Rate (Weeks< 28)	Average Apgar Score	Low Apgar Score Rate (< 6)	Smoke Rate of Mothers
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cigarette Tax, *t* (10 ¢)	9.038	-0.001**	0.028	-0.000*	0.064*	-0.002***	-0.016*
	(8.861)	0.000	(0.032)	0.000	(0.033)	(0.001)	(0.008)
Observations	106,025	106,025	106,025	106,025	83,918	83,918	34,328
R-squared	0.937	0.551	0.893	0.469	0.895	0.5	0.975
Y-mean	3,365	0.010	39.33	0.005	9.028	0.015	0.170
Std. Dev. Of Y	128.9	0.008	0.431	0.006	0.163	0.009	0.132
Group FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Controls at Birth Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Each column is from a separate regression estimated with Natality birth data from years 1969 to 1994. We do not include data from 1968 because the educational attainment of mother and marital status of mother are not recorded in 1968. The outcome variables are average birth weight, very low birth weight rate, average gestational age, preterm delivery rate, smoke rate of mothers, average Apgar score, and low Apgar score rate for cells defined by state, year, marital status, age, race, educational attainment of the mother, and the birth order of the newborn. Estimates are weighted by the number of birth in the cells. Cigarette taxes are the state cigarette tax in the child's birth state in the birth year. Taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include group fixed effect and birth state fixed effect. Group is defined by state, marital status, age, race, educational attainment of the mother, and the birth order of the newborn. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, number of the hospital beds, and welfare vendor payment for medical at birth year. Standard errors clustered on state of birth are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table 12: Cigarette Tax Effect on Health in Childhood

	1(Any Physical Health condition) (1)	# of Physical Health condition (2)	1(Any Mental Health condition) (3)	# of Mental Health condition (4)
In-utero Cigarette Tax (10 ¢)	-0.004**	-0.010*	-0.003	-0.008***
	(0.002)	(0.006)	(0.002)	(0.002)
Observations	4,260	4,260	5,204	5,204
R-squared	0.06	0.077	0.082	0.084
Y-mean	0.568	0.973	0.215	0.308
(Std. Dev. Of Y)	(0.495)	(1.105)	(0.411)	(0.701)
Cigarette Tax in Childhood	Yes	Yes	Yes	Yes
Birth State FE	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes
Individual Controls	Yes	Yes	Yes	Yes
Family Background at Birth Year	Yes	Yes	Yes	Yes
State Controls at Birth Year	Yes	Yes	Yes	Yes
Smoke Bans at Birth Year	Yes	Yes	Yes	Yes

Note: Each column is from a separate regression. The sample consists of children surveyed in Child Development Supplement in 1997, 2001, 2007, 2014 and 2019. These children born between 1989 and 2013. Estimates are weighted using the PSID longitudinal weights. Outcome variables are children's health status during ages 6-12. 1(Any physical health condition) = 1 if children have any problem out of anemia, allergies, asthma, diabetes, ear disease, hear difficulty, eye disease, obesity, or development delay. # of physical health condition is the number if problem the children have out of anemia, allergies, asthma, diabetes, ear disease, hear difficulty, eye disease, obesity, or development delay. 1(Any mental problem) = 1 if children have any problem out of convulsion, autism, speech problem, retardation, emotion disturbance, or hyperactivity. # of mental problem is the number of problem the children have out of convulsion, autism, speech problem, retardation, emotion disturbance, or hyperactivity. Cigarette tax at age 6 is controlled for health effect. Cigarette taxes are the state cigarette tax in the child's birth state. Taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Family background at birth includes mother's educational level, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include smoke bans, the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, number of the hospital beds, and welfare vendor payment for medical at birth year. Standard errors clustered on state of birth are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table 13: Effects of Early-life Cigarette Tax on Smoking Behavior in Later Life

	In Adolescent (Data from CDS)		In Adulthood (Data from main PSID)	
	Smoke	Smoke Days in Last Month	Ever Smoked	# Cigarettes/Day (Smokers only)
	(1)	(2)	(3)	(4)
In-utero Cigarette Tax (10 ¢)	-0.005**	-3.981***	-0.016**	-0.660***
	(0.002)	(1.301)	(0.007)	(0.246)
Cigarette Tax at Age 12	-0.002	-0.134	-	-
	(0.001)	(0.407)		
Cigarette Tax at Age 25	-	-	-0.001	0.004
			(0.001)	(0.039)
Observations	2,994	191	4,564	1,156
R-squared	0.199	0.571	0.085	0.242
Y-Mean	0.079	17.850	0.388	12.010
Std. Dev. Of Y	(0.269)	(11.44)	(0.487)	(7.855)
Cigarette Tax in Childhood or Adulthood	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes
Birth State FE	Yes	Yes	Yes	Yes
Individual Controls	Yes	Yes	Yes	Yes
Family Background at Birth Year	Yes	Yes	Yes	Yes
State Controls at Birth Year	Yes	Yes	Yes	Yes

Note: Each column is from a separate regression. For the first two columns, outcome variables are children's smoke behavior during age 12-18. The sample consists of children surveyed in Child Development Supplement in 1997, 2001, 2007, 2014 and 2019. Estimates are weighted using the PSID longitudinal weights. Cigarette tax in the birth state at age 12 is controlled. For the last two columns, outcome variables are individuals' smoke behabior during age 25-35. The sample consists of individuals born to PSID families between 1968-1994 and became household heads or spouses during age 25-35 in later PSID survey. Estimates are weighted using the average PSID longitudinal weights during age 1-18. State cigarette tax in the resident state at age 25 is controlled. Taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Family background at birth includes mother's educational level, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include smoke bans, the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, number of the hospital beds, and welfare vendor payment for medical at birth year. Standard errors clustered on state of birth are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table 14: Effects of Early-life Cigarette Tax on Health Status in Adulthood for People who Never Smoke

	1(Any Health condition)	# of Health condition	Asthma	Lung Disease	Heart Attack	Heart Disease
	(1)	(2)	(3)	(4)	(5)	(6)
In-utero Cigarette Tax (10 ¢)	-0.010*	-0.013**	-0.013**	0.000	-0.002	0.002
	(0.006)	(0.006)	(0.005)	(0.003)	(0.001)	(0.002)
Cigarette Tax at Age 25 (10 ¢)	0.000	0.001	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Observations	2,980	2,980	2,980	2,980	2,980	2,980
R-squared	0.064	0.062	0.069	0.065	0.044	0.052
Y-Mean	0.200	0.218	0.161	0.039	0.002	0.016
Std. Dev. Of Y	(0.400)	(0.457)	(0.368)	(0.194)	(0.049)	(0.124)
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Birth State FE	Yes	Yes	Yes	Yes	Yes	Yes
Individual Controls	Yes	Yes	Yes	Yes	Yes	Yes
Family Background at Birth Year	Yes	Yes	Yes	Yes	Yes	Yes
State Controls at Birth Year	Yes	Yes	Yes	Yes	Yes	Yes

Note: Each column is from a separate regression. The sample consists of individuals born to PSID families between 1968-1994 and became household heads or spouses during age 25-35 in later PSID survey and never smoked. Estimates are weighted using the average PSID longitudinal weights during age 1-18. Outcome variables are individuals' health status during age 25-35. Cigarette tax at birth month is the state cigarette tax in birth state at birth month. Cigarette tax at age 25 is the state cigarette tax in the resident state at age 25. Both taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Age is the age of the individual at the last year he/she showed up in PSID survey during his/her age 25-35. Family background at birth includes the educational level of mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors clustered on state of birth are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table 15: Cigarette Tax Effect on Academic Performance in Childhood

	Reading Score			Math Score		
	Low Score	Medium Score	High Score	Low Score	Medium Score	High Score
	(1)	(2)	(3)	(4)	(5)	(6)
In-utero Cigarette Tax (10 ¢)	-0.007***	0.008**	-0.001	-0.007**	0	0.007**
	(0.002)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Observations	5,100	5,100	5,100	5,080	5,080	5,080
R-squared	0.224	0.059	0.197	0.205	0.051	0.213
Y-mean	0.245	0.356	0.399	0.230	0.330	0.440
Std. Dev. Of Y	(0.430)	(0.479)	(0.490)	(0.420)	(0.470)	(0.496)
Cigarette Tax in Childhood	Yes	Yes	Yes	Yes	Yes	Yes
Birth State FE	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Individual Controls	Yes	Yes	Yes	Yes	Yes	Yes
Family Background at Birth Year	Yes	Yes	Yes	Yes	Yes	Yes
State Controls at Birth Year	Yes	Yes	Yes	Yes	Yes	Yes

Note: Each column is from a separate regression. The sample consists of children surveyed in Child Development Supplement in 1997, 2001, 2007, 2014 and 2019. Estimates are weighted using the PSID longitudinal weights. Outcome variables are children's Woodcock-Johnson test standard scores. The test is provided to children older than 6 and the scores are comparable for different age. Cigarette taxes are the state cigarette tax in the child's birth state. Taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Family background at birth includes mother's educational level, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include smoke bans, the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, number of the hospital beds, and welfare vendor payment for medical at birth year. Standard errors clustered on state of birth are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table 16: Impact on Educational Level

	Highest Grade	1(College or Above)
	(1)	(2)
In-utero Cigarette Tax (10 ¢)	0.040	0.014*
	(0.037)	(0.007)
Observations	5,320	5,320
R-squared	0.333	0.294
Y-mean	14.01	0.366
Std. Dev. Of Y	(2.122)	(0.482)
Cigarette Tax at Age 25	Yes	Yes
Birth Year FE	Yes	Yes
Birth State FE	Yes	Yes
Individual Controls	Yes	Yes
Family Background at Birth Year	Yes	Yes
State Controls at Birth Year	Yes	Yes

Note: Each column is from a separate regression. The sample consists of individuals born to PSID families between 1968-1994. Estimates are weighted using the average PSID longitudinal weights during age 1-18. Outcome variables are individuals' educational level during age 25-30. Cigarette tax at birth year include the state cigarette tax in birth state at birth month. Cigarette tax at age 25 is the state cigarette tax in the resident state at age 25. Both taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Age is the age of the individual at the last year he/she showed up in PSID survey during his/her age 25-30. Family background at birth includes the educational level of mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors clustered on state of birth are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

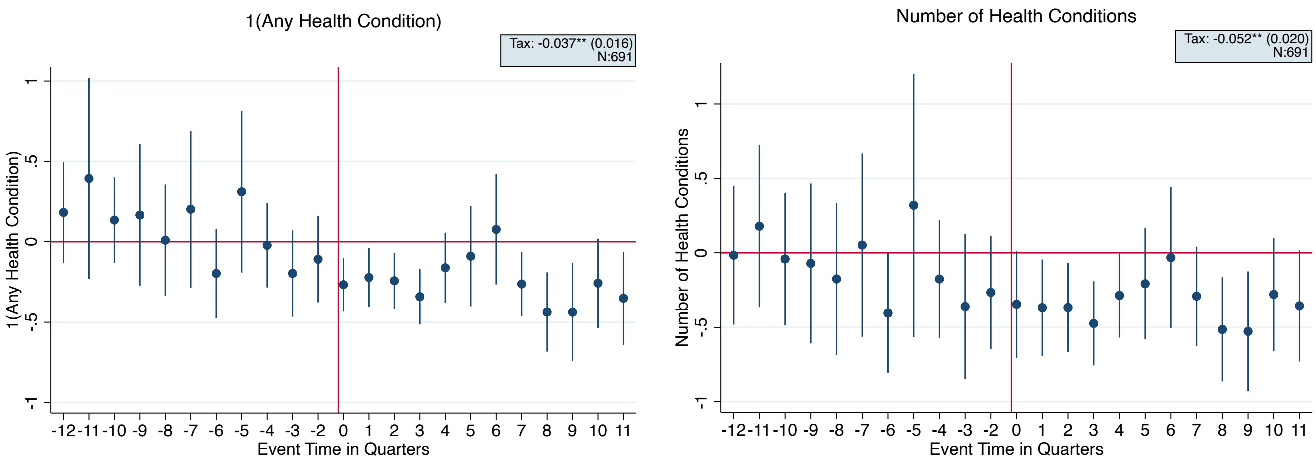
Table 17: Impact on Age of Having the First Kid

	Age of Having the First Kid		
	Whole Sample	Male Sample	Female Sample
	(1)	(2)	(3)
In-utero Cigarette Tax (10 ¢)	0.173*	0.15	0.188
	(0.092)	(0.151)	(0.115)
Observations	3,658	1,584	2,074
R-squared	0.321	0.317	0.34
Y-mean	25.33	26.41	24.45
Std. Dev. Of Y	(5.448)	(5.417)	(5.314)
Cigarette Tax at Age 25	Yes	Yes	Yes
Birth Year FE	Yes	Yes	Yes
Birth State FE	Yes	Yes	Yes
Individual Controls	Yes	Yes	Yes
Family Background at Birth Year	Yes	Yes	Yes
State Controls at Birth Year	Yes	Yes	Yes

Note: Each column is from a separate regression. The sample of the first column consists of individuals born to PSID families between 1968-1994. The sample of the second column and the third column are subgroups of male and female respectively. Estimates are weighted using the average PSID longitudinal weights during age 1-18. Outcome variables is the age of having first kid. Cigarette tax at birth year include the state cigarette tax in birth state at birth month. Cigarette tax at age 25 is the state cigarette tax in the resident state at age 25. Both taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Age is the age of the individual at the last year he/she showed up in PSID survey during his/her age 25-30. Family background at birth includes the educational level of mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors clustered on state of birth are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

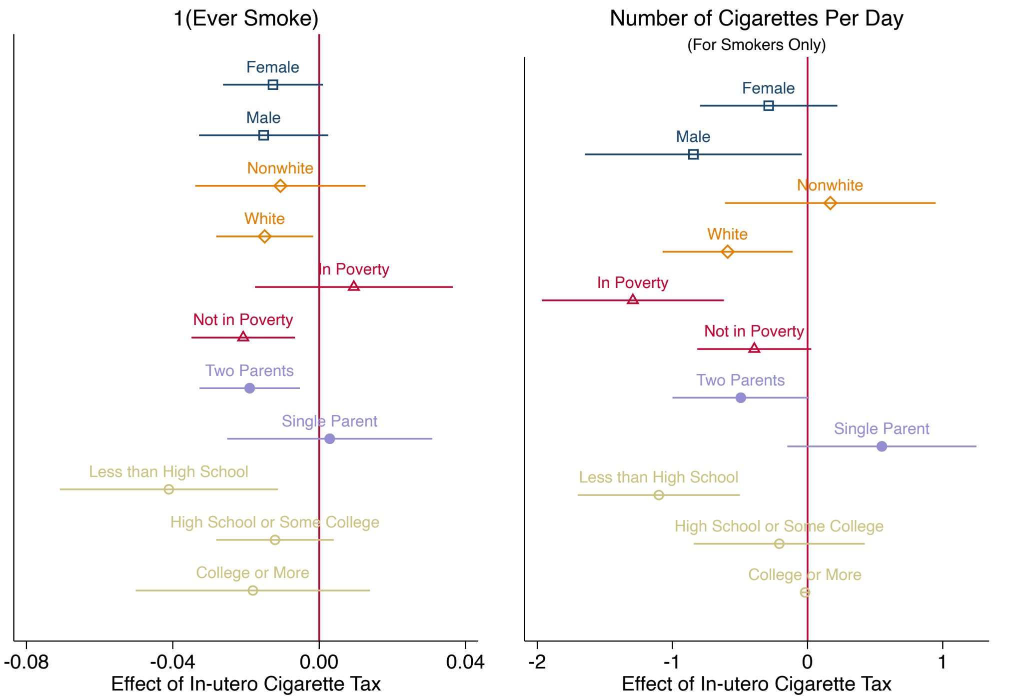
APPENDIX

Figure A1: Robustness of Event Study on Adult Health Condition to Alternative Cutoffs: 75th Percentile



Note: Each figure is from one estimation. Event is defined as any tax hike greater than the 75th percentile of all hikes during 1968-1994. Event time is defined in quarters. Event time equals 0 presents a cohort born in the year-quarter that the tax hike happened. Only states that experience an event are included in the event study sample. I also balance the event study such that events are only included if there are 3 full years in both the pre-period and post-period. The sample contains the "high frequency" tax period of 1968-1973. Estimates are weighted using the average PSID longitudinal weights during age 1-18. Outcome variables are individuals' health status during age 25-35. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Age is the age of the individual at the last year he/she showed up in PSID survey during his/her age 25-35. Family background at birth includes the educational level of mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors are clustered by state of birth. Confidence interval at 95%.

Figure A2: Heterogeneous Effects for Smoke Behaviors



Note: The sample size is too small (<100) for the subgroup of individuals whose mother have college degree or higher level education.
Note: Each coefficient is from a separate regression. The sample consists of individuals born to PSID families between 1968-1994 and became household heads or spouses during age 25-35 in a later PSID survey. Estimates are weighted using the average PSID longitudinal weights during age 1-18. For the educational level of mother subgroups, we define the educational level as less than high school if the highest grade is less than 12, as high school or some college is the highest grade between 12 and 15, and as college or above if the highest grade is more than or equal to 16. For the economic status subgroups, we define in poverty family as families with income less than or equal to 1.5 times Census need standard. Outcome variables are smoke behaviors during age 25-35. Cigarette tax at birth month is the state cigarette tax in the birth state at birth month. Cigarette tax at age 25 is the state cigarette tax in the resident state at age 25. Both taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Age is the age of the individual at the last year he/she showed up in PSID survey during his/her age 25-35. Family background at birth includes the educational level of the mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors are clustered by state of birth. Confidence interval at 90%.

Table A1: Estimation of Effect of State Cigarette Taxes on State-Level Demographic, Economic Policies, and Economic Conditions

	Cigarette Tax at time *t*	
State Covariates at time *t*+1		
Male	0.003	(0.025)
White	-0.018	(0.030)
Married	0.007	(0.050)
Less than HS	0.007	(0.030)
High School or Some College	-0.001	(0.034)
College or Higher Education	-0.006	(0.015)
Age	0.176	(1.843)
State Max. CDCTC	0.187	(0.308)
State Max. EITC	-0.039	(0.039)
State Max. AFDC/TANF Benefit	0.009	(0.076)
State Hospital Beds	1.204	(4.713)
State Welfare Vendor Payment for Medical	-0.308	(0.813)
State Min. Wage	0.264	(0.828)
State Income MTR	-0.46	(1.244)
State per capita GDP	0.292	(3.288)
State Fixed Effect	Yes	
Year Fixed Effect	Yes	
N	1230	

Note: Each row is a separate model with the full set of covariates using samples aggregated to the state-year level. We use data from 1968-1994. Outcome variables are state-level demographics, economic policies, or economic conditions in year *t+1*. Cigarette taxes and controls are from the year *t*. State FE and State FE are controlled in the model. Standard errors clustered on state are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table A2: Effects of Early-life Cigarette Tax on Health Status in Adulthood: Different Age

	1(Any Health condition) (1)	# of Health condition (2)
Panel A, Outcome Variable = Health Status during Age 25-30		
In-utero Cigarette Tax (10 ¢)	-0.014**	-0.019**
	(0.006)	(0.007)
Cig. Tax at Age 25 (10 ¢)	-0.002	-0.001
	(0.001)	(0.001)
N	5,025	5,025
R-squared	0.049	0.05
Y-mean	0.216	0.243
Std. Dev. Of Y	(0.411)	(0.490)
Panel B, Outcome Variable = Health Status during Age 30-35		
In-utero Cigarette Tax (10 ¢)	-0.023***	-0.026***
	(0.007)	(0.008)
Cig. Tax at Age 30 (10 ¢)	-0.001	-0.001
	(0.001)	(0.001)
N	4,227	4,227
R-squared	0.05	0.055
Y-mean	0.194	0.224
Std. Dev. Of Y	(0.395)	(0.486)
Panel C, Outcome Variable = Health Status during Age 35-40		
In-utero Cigarette Tax (10 ¢)	-0.025***	-0.034***
	(0.008)	(0.010)
Cig. Tax at Age 35 (10 ¢)	0	0
	(0.001)	(0.001)
N	2,958	2,958
R-squared	0.057	0.056
Y-mean	0.202	0.244
Std. Dev. Of Y	(0.402)	(0.529)
Panel D, Outcome Variable = Health Status during Age 40-45		
In-utero Cigarette Tax (10 ¢)	-0.031*	-0.058**
	(0.017)	(0.029)
Cig. Tax at Age 40 (10 ¢)	-0.021	-0.027*
	(0.015)	(0.015)
N	1,707	1,707
R-squared	0.094	0.09
Y-mean	0.209	0.27
Std. Dev. Of Y	(0.406)	(0.588)
Panel E, Outcome Variable = Health Status during Age 18-35		
In-utero Cigarette Tax (10 ¢)	-0.019***	-0.024***
	(0.006)	(0.007)
Cig. Tax at Age 18 (10 ¢)	-0.003**	-0.004**
	(0.001)	(0.001)
N	5,553	5,553
R-squared	0.054	0.058
Y-mean	0.264	0.312
Std. Dev. Of Y	(0.441)	(0.564)
Panel F, Outcome Variable = Health Status during Age 22-35		
In-utero Cigarette Tax (10 ¢)	-0.020***	-0.024***
	(0.006)	(0.007)
Cig. Tax at Age 22 (10 ¢)	-0.002**	-0.003**
	(0.001)	(0.001)

N	5,515	5,515
R-squared	0.051	0.056
Y-mean	0.259	0.304
Std. Dev. Of Y	(0.438)	(0.555)
Birth Year FE	Yes	Yes
Birth State FE	Yes	Yes
Individual Controls	Yes	Yes
Family Background at Birth Year	Yes	Yes
State Controls at Birth Year	Yes	Yes

Note: Each column of each panel is from a separate regression. The sample consists of individuals born to PSID families between 1968-1994 and became household heads or spouses during specific age range in later PSID survey. Estimates are weighted using the average PSID longitudinal weights during age 1-18. Outcome variables are health status of individuals during specific age range. Cigarette tax at birth month is the state cigarette tax in birth state at birth month. Cigarette tax at age 25 is the state cigarette tax in the residence state at age 25. Both taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Age is the age of the individual at the last year he/she showed up in PSID survey during specific age range. Family background at birth includes the educational level of mother, if age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors clustered on state of birth are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table A3: Robustness Check on Sample Weight

	1(Any Health condition)	# of Health condition
	(1)	(2)
Panel A, Weighted by Weight at Birth Year		
In-utero Cigarette Tax (10 ¢)	-0.017***	-0.021***
	(0.006)	(0.008)
Cigarette Tax at Age 25 (10 ¢)	-0.002*	-0.002
	(0.001)	(0.001)
Observations	5,402	5,402
R-squared	0.049	0.051
Y-Mean	0.240	0.279
Std. Dev. Of Y	(0.427)	(0.530)
Panel B, Weighted by Weight at Age 18		
In-utero Cigarette Tax (10 ¢)	-0.016**	-0.021***
	(0.006)	(0.008)
Cigarette Tax at Age 25 (10 ¢)	-0.002*	-0.002
	(0.001)	(0.001)
Observations	5,402	5,402
R-squared	0.048	0.051
Y-Mean	0.240	0.279
Std. Dev. Of Y	(0.427)	(0.530)
Birth Year FE	Yes	Yes
Birth State FE	Yes	Yes
Individual Controls	Yes	Yes
Family Background at Birth Year	Yes	Yes
State Controls at Birth Year	Yes	Yes

Note: Each column of each panel is from a separate regression. The sample consists of individuals born to PSID families between 1968-1994 and became household heads or spouses during age 25-35 in later PSID survey. Outcome variables are health status during age 25-35. Cigarette taxes are the state cigarette tax in the birth state. Taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Age is the age of the individual at the last year he/she showed up in PSID survey during his/her age 25-35. Family background at birth includes the educational level of mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors clustered on state of birth are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table A4: Robustness Check: Control State-specific Time Trend

	1(Any Health condition)	# of Health condition	Asthma	Lung Disease	Heart Attack	Heart Disease
	(1)	(2)	(3)	(4)	(5)	(6)
In-utero Cigarette Tax (10 ¢)	-0.020***	-0.022**	-0.022***	0.003	-0.001	-0.002
	(0.007)	(0.009)	(0.008)	(0.004)	(0.001)	(0.002)
Cigarette Tax at Age 25 (10 cents)	-0.001	-0.001	-0.001	0	0	-0.000*
	(0.001)	(0.001)	(0.001)	(0.001)	0.000	0.000
Observations	5,402	5,402	5,402	5,402	5,402	5,402
R-squared	0.063	0.063	0.064	0.058	0.045	0.049
Y-Mean	0.240	0.279	0.185	0.070	0.005	0.019
Std. Dev. Of Y	(0.427)	(0.530)	(0.388)	(0.254)	(0.071)	(0.137)
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Birth State FE	Yes	Yes	Yes	Yes	Yes	Yes
Individual Controls	Yes	Yes	Yes	Yes	Yes	Yes
Family Background at Birth Year	Yes	Yes	Yes	Yes	Yes	Yes
State Controls at Birth Year	Yes	Yes	Yes	Yes	Yes	Yes
State-Specific Time Trend	Yes	Yes	Yes	Yes	Yes	Yes

Note: Each column in each panel is from a separate regression. The sample consists of individuals born to PSID families between 1968-1994 and became household heads or spouses during age 25-35 in later PSID survey. Estimates are weighted using the average PSID longitudinal weights during age 1-18. Outcome variables are individuals' health status during age 25-35. Cigarette tax at birth month is the state cigarette tax in the birth state at birth month. Cigarette tax at age 25 is the state cigarette tax in the resident state at age 25. Both taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Age is the age of the individual at the last year he/she showed up in PSID survey during his/her age 25-35. Family background at birth includes the educational level of mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors clustered on state of birth are in parentheses. State-specific time trend is controlled. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table A5. Comparing OLS regression and Logistic Regression: Effects of Early-life Cigarette Tax on Specific Health Condition in Adulthood

	1(Any Health condition)	# of Health condition	Asthma	Lung Disease	Heart Attack	Heart Disease
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: OLS Regression						
In-utero Cigarette Tax (10 ¢)	-0.018***	-0.021***	-0.017***	-0.004	-0.001	0.001
	(0.006)	(0.008)	(0.006)	(0.003)	(0.001)	(0.001)
Odds Ratio						
	0.947	0.952	0.927	0.947	0.801	1.052
	(0.019)	(0.021)	(0.026)	(0.040)	(0.199)	(0.052)
Panel B, Logistic Regression						
In-utero Cigarette Tax (10 ¢)	-0.105***	-0.107***	-0.122***	-0.080	-	-0.146
	(0.040)	(0.040)	(0.045)	(0.072)	-	(0.134)
Odds Ratio						
	0.900	0.900	0.885	0.923	-	0.864
	(0.036)	(0.036)	(0.039)	(0.066)	-	(0.115)
Birth Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Birth State FE	Yes	Yes	Yes	Yes	Yes	Yes
Individual Controls	Yes	Yes	Yes	Yes	Yes	Yes
Family Background at Birth Year	Yes	Yes	Yes	Yes	Yes	Yes
State Controls at Birth Year	Yes	Yes	Yes	Yes	Yes	Yes

Note: The convergence is not achieved for heart attack for logistic regression. Results in panel B-column 1,3,4,6 is from logit regression and results in panel B-column 2 is from an ordered logit regression.

Note: Odds is the probability that the individual has any of the four smoke related diseases rather than the individual does not have any of the four smoke related diseases. For column 2, odds is the probability that the outcome variable is less than or equal to *j* rather than greater than *j*. Odds ratio is the odds at the 10 cent improved cigarette tax over the odds at the current cigarette tax.

Note: The sample consists of individuals born to PSID families between 1968-1994 and became household heads or spouses during age 25-35 in later PSID survey. Estimates are weighted using the average PSID longitudinal weights during age 1-18. Outcome variables are individuals' health status during age 25-35. Cigarette tax at birth month is the state cigarette tax in the birth state at birth month. Cigarette tax at age 25 is the state cigarette tax in the resident state at age 25. Both taxes are cpi-adjusted and reported in 2020 dollars. The unit is 10 cents. Baseline fixed effects include birth year fixed effect and birth state fixed effect. Individual demographic controls include gender, race, and age square. Age is the age of the individual at the last year he/she showed up in PSID survey during his/her age 25-35. Family background at birth includes the educational level of mother, if the age of mother is greater than 35, gender of head, marital status of head, number of kids in the family, and family income-Census needs standard ratio at birth year. State controls include the minimum legal age for purchasing tobacco products, beer tax, spirit tax, wine tax, EITC benefit, CDCTC benefit, AFDC/TANF benefits, the minimum wage, the maximum income marginal tax rate, per capita GDP, the number of hospital beds, and welfare vendor payment for medical at birth year. Standard errors clustered on state of birth are in parentheses. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Table A6: Comparison of Effect Size on Health Outcomes

	Adult Health				Health Underage 18			
	Our Analysis			Hoehn-Velasco et al. (2021)	Our Analysis	Simon (2016)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Data Source	PSID			Natality Files	PSID-CDS	NHIS		
Birth Cohorts	1968-1994			1965-2000	1989-2013	1988-2009		
Average Cig. Tax	0.50			0.84	0.99	1.24		
Outcome (Y)	Probability of ever have any of the following health conditions: asthma, lung disease, heart disease, heart attack.	Probability of ever have asthma	Probability of ever have lung disease	Probability of being overweight or obese during pregnancy	Probability of ever have any physical health conditions	Probability of having asthma	Probability of two or more doctor visits per year	Sick days from school
Surveyed Age	25-35	25-35	25-35	During pregnancy	6-12	2-17	2-17	5-17
Coefficient corresponding to a 10 cents tax increase	-1.8 pp	-1.7 pp	-0.4 pp	-0.4 pp	-0.4 pp	-0.8 pp	-0.2 pp	-0.03
Mean of Y	24%	18.5%	7%	48.2%	56.8%	5.8%	61.9%	3.4%
Effect compared to the mean	8%	9%	6%	1%	1%	14%	0.4%	1%

Note: This table compares sample characteristics and effect sizes in Hoehn-Velasco et al. (2021) and Simon (2016). All effect sizes estimated by Hoehn-Velasco et al. (2021) and Simon (2016) are scaled to be comparable to our estimated effects, i.e., they reflect 10 cent tax increases in terms of real 2020 USD.