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Cigarette Taxation and Pregnancy:

Policy-Based Estimates of the Price Elasticity of Smoking during Pregnancy

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Abstract:

Cigarette taxation has long been a policy tool used to incentivize healthier behavior. Pregnant women are a group of particular interest in this context due to their unique position to pass health capital down to the next generation. This paper reviews the literature on the tax and price responsiveness of pregnant women to smoking during pregnancy. I first discuss the use of cigarette taxes as a natural experiment and the econometric specifications typically used in the literature. I continue to review overall trends in the tax responsiveness of smoking during pregnancy as well as results by subgroups. Next, I discuss evidence on how facing a tax during pregnancy might uniquely effect women's decision to smoke. I conclude with a discussion of how taxes have been extended into second-stage effects on birth outcomes and future avenues of research. I generally find evidence of pregnant women responding to tax increases, although the elasticities have decreased in magnitude in more recent years. This is consistent with the story suggesting that the least addicted smokers quit in the 1990s, leaving less elastic smokers in the 2000s. Furthermore, women seem to be more responsive to taxes during pregnancy than before pregnancy. Overall, cigarette taxes can be used to evaluate health outcomes, which is a fertile area for future research.

Jel Codes: H2, H3, I1, J1

In the wake of increasing expenditures on health care, policymakers continue to look for cost-effective ways to improve health. One strategy is to incentivize healthier behavior, with smoking pregnant women being of particular interest for such incentives. Smoking during pregnancy damages both maternal and child health. Public health professionals have identified smoking during pregnancy as the greatest risk factor for low birth weight that can be modified through maternal behavior (Shiono, 1995). Additionally, pregnant women are in a unique position to pass health capital down to the next generation: a fetus exposed to stress in utero can become maladapted to the post-birth environment, becoming more likely to experience poor health in adulthood (Barker, 1990). At a time when economists and policymakers seek low-cost ways to improve health, increasing the price of maternal smoking through cigarette excise taxes is a promising approach. This survey reviews the literature on the price responsiveness of pregnant mothers to smoking and reflects upon ways to use cigarette taxes in health research.

A body of literature has used price and tax changes to estimate smoking price elasticities (Chaloupka and Warner, 2000). Ideally, economists would run a controlled experiment assigning higher cigarette prices to a treatment group relative to some control group and would then compare smoking and health outcomes across the two groups. Without a controlled experiment, researchers have primarily relied on state-level changes in excise taxes over time. Pregnant mothers in states that initiated the tax increase are the treated group and are compared with observationally similar mothers in states where the tax did not increase. If mothers are responsive to taxes, this policy is seen a viable approach for improving maternal and child health.

Cigarette tax effects have been shown to be different across demographic groups and over time. I investigate these differences in elasticities and discuss the implications they have in

the study of pregnant mothers' health behavior and the health of their children. The first section reviews cigarette tax variation and how it has been used to study smoking behavior. The second section overviews the major findings in the literature. The third section discusses extensions of the cigarette tax identification strategy to maternal and child health outcomes. I conclude with a brief overview and suggested areas for future research.

I. Cigarette Taxes as a Pseudo-Experiment

State-level cigarette excise taxes are the most common source of variation used by economists who study smoking. Several factors make state excise taxes popular. Cigarette taxes have resulted in a growth in state revenue from 1980 to 2010 of roughly 333%. On average, states raised their excise taxes over this period of time by 80 cents. The average price of a pack of cigarettes in turn has increased from $1.45 to $6.50 (Orzechowski and Walker, 2010). Studies investigating tobacco industry responses to taxation have found pass-through rates of more than 100% due to the oligopilistic nature of the tobacco industry. Thus, it is reasonable to interpret a change in tax as a direct change in price (Gruber, 2001; Chaloupka and Warner, 2000); with roughly 80% of the within-state variation in prices being explained by within-state variation in taxes (Gruber and Koszegi, 2001).

The most common data used to estimate smoking price elasticities for pregnant women is the Vital Statistic natality birth certificate data. The natality data are the census of all mothers who gave birth during a calendar year in the United States. For a given year, the dataset contains the majority of the information recorded on the birth certificate, including information on the state and month of birth, mother's education, mother's race, and child's birth weight. Additionally, most states report whether there was any smoking during pregnancy and the

number of cigarettes smoked[1]. Since 2003, a revision to the standard birth certificate has been adopted by some states so that the birth certificate reports smoking during pregnancy by trimester. However, this information has not been widely used in the literature.

Under-reporting is potentially a major source of measurement error, with up to 23% of mothers not admitting smoking (Dietz et al. 2011). While economists typically do not worry about measurement error in an outcome variable, when the outcome variable is dichotomous, it can downward bias results (Aigner, 1973). Therefore, failure to accurately report smoking could mask the effects of the tax on smoking, making this a concern when using birth certificate data.

A common way of estimating smoking for pregnant women uses a two-way fixed-effect model. Exact models vary across studies but typically follow the same general form:

$$1)\ S_{i,s,t} = \beta_1 \tau_{s,t} + \beta_2 X_{i,s,t} + \mu_t + \gamma_s + \varepsilon_{i,s,t}.$$

Here, $S_{i,s,t}$ is an indicator variable for any smoking during pregnancy by mother i in state s during year and month t (time). $\tau_{s,t}$ is the level of the cigarette excise tax in state s during time t. β_1 is the coefficient of interest: the percentage point change in the probability of smoking during pregnancy per change in price. Time and state fixed effects are captured by μ_t and γ_s, respectively, while $X_{i,s,t}$ is a vector of maternal demographic controls.

When looking at the responsiveness of pregnant mothers, studies focus on the decision to engage in any smoking during pregnancy (i.e., smoking participation) instead of the number of cigarettes smoked. Studies use participation because pregnant women are unlikely to remember

[1] One limitation of the Vital Statistics data is that not all states reported smoking during all years of the data. Notably, California, Indiana, Nebraska, New York, Oklahoma, and South Dakota did not report smoking for some years since 1989. Using these states in a two-way fixed-effect model leads to an unbalanced cross section, which can bias estimation results (Kennedy, 2003). One way of addressing this concern is to run the models after balancing the states on reports of smoking to make sure the results are not sensitive to this change.

the exact number of cigarettes they smoked, and the mothers who do not quit smoking are likely to be those who smoke more cigarettes, which confounds the changes at the intensive margin. Further, mothers who do not quit smoking as taxes increase may smoke cigarettes more intensely, making the net exposure to cigarette smoke ambiguous (Adda and Cornaglia, 2006). When estimating the intensive margin, a typical model will match Equation 1 above; however, the dependent variable will be the average number of cigarettes smoked per day during pregnancy.

The smoking participation price elasticity of demand can be calculated from β_1. Consider the equation for the price elasticity participation of smoking (Evans and Ringel, 1999):

$$2)\ e_d = \frac{\beta_1}{\frac{\partial \mathrm{p}}{\partial\, \tau}} \frac{\bar{p}}{\bar{s}}$$

Here, e_d is the price elasticity of participation. If we assume full pass through, then $\frac{\partial \mathrm{p}}{\partial \mathrm{T}} = 1$, and the price participation of elasticity can be calculated by multiplying β_1 by the ratio of mean prices to the smoking rate[2]. Some studies directly instrument for prices using the change in the tax, others use different datasets for calculating the mean price, and still others just present estimates of β_1. In the literature review section, I standardize the literature by calculating participation elasticities whenever possible.

The two-way fixed-effect model is an extension of difference in differences that allows for multiple tax changes per state and hikes of different magnitudes. Equation 1 will lead to unbiased estimates of e_d only if the same identifying assumptions behind difference in differences are not violated. There must be no differential trends between the treatment and

[2] It is common in the literature to assume full pass through (Evans and ringel, 1999; Lien and Evans, 2005)

control states. If any state-level policies change smoking at the same time the cigarette tax is increased, then β_1 could also be overestimated. One strategy is to include state linear trends in a model, which absorbs constant changes over time in smoking within a state. Some studies have used graphical analysis to make the trends between treatment and control states explicit. Lien and Evans (2005) used propensity score matching to select control states whose pre-trends in smoking matched those of a state that initiated a cigarette tax hike. They then graphed the differences between the two to show that there was no pre-trend in smoking relative to a tax hike. Simon (2014) performed an event study in which each large hike in a state is considered a separate event. These studies are encouraging in that neither show a pre-trend, thus adding credibility to the use of difference in differences in the cigarette tax context.

Levy and Meara (2006) took an alternate method to estimate participation elasticities, exploiting price changes from the Master Settlement Agreement. The Master Settlement Agreement was the lawsuit settlement against the tobacco companies from 46 states for tobacco-related health costs. One of the provisions of the settlement was that the tobacco companies would pay states to compensate for tobacco-related Medicaid expenditures. To finance the agreement, tobacco companies increased nationwide cigarette prices by roughly 19.5%. Interestingly, Levy and Meara found much lower elasticities than in the earlier literature.

While widely used in studies of smoking, there are criticisms of the state cigarette excise tax approach to estimating smoking price elasticities. If health trends are improving more for states that implement tax increases, then there will be a spurious relationship between smoking and a tax increase. State linear trends should absorb some of this variation but may not fully account for omitted variables. In addition, Levy and Meara's findings suggest that smoking may no longer be as responsive to cigarette price increases. This would be the case if since 1999,

marginal smokers have already quit[3]. Those who continue to smoke are those most addicted and least likely to respond to price changes. This does not threaten the internal validity of the estimated β_1 but does suggest problems with external validity: using elasticities estimated from earlier periods will overestimate the response to price changes.

II. Findings in the Literature

A. Participation Elasticities Estimated over Time

Table 1 summarizes the estimates of participation elasticities by study. Notes specific to each study on how the elasticities were derived are in the appendix.

[Table 1 Here: See end of text]

Across studies and over time, mothers have decreased smoking in response to an increase in cigarette prices. While the elasticities are consistently negative, there are large differences in magnitudes. Some of the largest elasticities were found by the first papers to apply the two-way fixed-effects strategy: Evans and Ringel (1999) and Ringel and Evans (2001). In both papers, Evans and Ringel implemented the two-way state year fixed-effects model using the Vital Statistics data. Cigarette taxes were then used as an instrumental variable to estimate the impact of smoking on birth weight. Their preferred estimate gave an elasticity of -0.36 to -0.40, implying that a 10% increase in prices would decrease maternal smoking by about 4%. These moderately sized estimates reflect that at least some smoking mothers respond to a tax increase.

[3] Callison and Kaestner (2013) argued that the price elasticities of smoking for the entire adult population have fallen over time due to the remaining marginal smokers being more heavily addicted.

One criticism of the estimates found by Evans and Ringel is that there were only small increases in taxes during this time. Lien and Evans (2005) addressed this issue by looking at larger cigarette tax hikes. The authors examined tax hikes of 15 cents or more in Arizona, Illinois, Massachusetts, and Michigan as separate state experiments. They estimated a price elasticity of demands of about -0.49 on average and found that decreases in smoking were sharp, occurring shortly after the tax was implemented. Pooling the four experiments together and using 2SLS, a 29 cent tax hike in 2001 reduced low birth weight births (i.e., infants weighing less than 2500 grams) by 0.45%.

These studies imply moderate changes in smoking from a price increase. However, later studies have estimated much smaller effects. Levy and Meara found a tax elasticity of only -0.13 for a price increase from the Master Settlement Agreement. Studies focusing on the post-2000 period, such as DeCicca and Smith (2012) and Markowitz et al. (2012)[4], similarly showed elasticities of -0.23 to -0.14, roughly two to three times smaller than earlier estimates. In looking at the long-term effects of in-utero smoke exposure on child health together with tax increases over 20 years from 1989 to 2009, Simon (2014) found a relatively modest elasticity of -0.15.

Looking at the trend in the percent of women who smoke during pregnancy helps shed light on changes in elasticities over time. Evans and Ringel's 1999 study showed that 17.1% of mothers reported smoking during pregnancy, whereas this number fell to only 12% of mothers between 1999 and 2003. In Figure 1, I explicitly show the stark decline in pregnant women who report smoking over time. The trend in declining elasticities is consistent with the women most

[4] An important caveat in Markowitz et al.'s work is that in one of the versions of the published paper (Markowitz et al. 2013), they show that including linear trends causes the standard errors on their models to get much larger and lose significance. Given the large amount of under reporting in maternal smoking during this time, they take their results as being suggestive.

sensitive to taxation already having quit by the 2000s. While the remaining smokers face larger prices on average, they are the heavier smokers and are therefore less affected by price increases.

[Figure 1 here: see end of text]

B. The Intensive Margin

Most papers estimating price elasticities have focused on participation rather than the intensive margin of number of cigarettes smoked. However, it is worth mentioning some of the work in this area. The earliest studies looking at the intensive margin found small effects on unconditional cigarettes per day (elasticities of -0.14 to -0.08) but no decrease in cigarettes per day conditional on smoking (Evans and Ringel, 1999). Later studies found stronger, but still relatively small, results on the intensive margin. For example Meara and Levy, 2006 found negative and significant effects on conditional smoking intensity of the Master Settlement Agreement, On later period tax increases, the results are also mixed: Markowitz et al. (2001, 2013) found no intensive margin effects when they included state linear trends but did find reasonably large effects for teens when state linear trends were not included in the model. While evidence of the intensive margin remains scarce, the higher intensive margin effects in the later period are also consistent with heavier smokers being too addicted to quit smoking but cutting back on number of cigarettes consumed.

C. Theory and Effects across Subgroups.

The effects of cigarette taxes differ widely across different demographic groups for pregnant women. Elasticities by study and subgroup are shown in Table 2. One way to interpret these differences is to consider how the costs associated with smoking are different for different groups. The full price of smoking during pregnancy is the total of the monetary price of the pack,

the health costs to the mother, and the health costs imposed on the fetus (Bradford, 2003). Any increase in price through taxes, information, or changes in health will decrease smoking during pregnancy. Theory additionally predicts that tax elasticities will be higher among those groups that are less likely to be addicted, more budget constrained, or otherwise face pressure to quit and that they should be more responsive to taxes. Applying simple theory to how these characteristics vary over subgroups can help explain the differences in elasticities across subgroups.

[Table 2 Here: See end of text]

Higher income is associated with a lower tax elasticity of demand because the change in expenditures on a given good from a tax increase will be a lower percentage of total income. Unfortunately, the Vital Statistics birth data does not include family income; however, maternal education offers a proxy for income, and I expect mothers with less than high school education to have a higher tax elasticity than mothers with higher education. A higher percentage of black and Hispanics are lower income, suggesting that they will also be more elastic. An empirical test of this theoretical prediction shows divided results. Most recent studies have found larger effects for dropouts (DeCicca and Smith, 2012; Levy and Meara, 2006). Ringel and Evans, on the other hand, again found the reverse; however, their study was in the earlier period with a different composition of smokers, and they consistently found different effects by subgroups than the rest of the literature. As seen in Table 2, across the studies that examine subgroups by race, we typically see stronger effects on Caucasian mothers. While African American mothers typically have lower incomes, a larger number of Caucasians smoke.

A woman's age is another major predictor of smoking. Becker and Murphy's (1998) theory of rational addiction formalized addictive goods as having the property of adjacent complementarities: the more you consume of the good, the higher the future marginal utility from consuming that good. Since older women are mechanistically likely to have smoked more, reinforcement means that older women will be more addicted and thus less responsive to a tax.

Levy and Meara (2005) and Markowitz et al. (2011) found substantially higher effects for teens. Their estimated elasticities ranged from -0.30 to -0.74. This compares to estimated elasticities of older mothers ranging between -0.11 to -0.52, with mothers over the age of 30 being the least responsive. Other studies have found more mixed evidence of elasticities decreasing with age. Ringel and Evans (2001) found effects to be strongest for older mothers. Gruber and Zinman (2000) found that the price elasticity of teens was similar to the entire population of results. While Lien and Evans did not show results by age group, they did talk about stratifying the sample in a footnote: for teens, the elasticities are sometimes larger and sometimes smaller than those of all mothers in the sample depending on the state they are examining[5]. In sum, the only study that consistently found effects that pregnant teens are less price sensitive than adults is Ringel and Evans (2001). The studies that did find some evidence that adults are more responsive were focused in the earlier period (before 2000), suggesting that the change in elasticities could again be due to the change in the composition of smokers. Additional work on differences in elasticities by subgroup could attempt to resolve this difference in the literature.

[5] -0.70 for Arizona and -0.44 for Massachusetts. This contrasts with elasticities for the entire population of mothers of -0.34 for Arizona and -1.83 for Massachusetts. The tax effects for both teens and all women in Illinois were insignificant but were about twice as large in magnitude for teens. The elasticity for teens in Michigan were positive but insignificant.

A final area of interest is differences in smoking by marital status. However, very few studies have shown results by this subgroup. One exception is Ringel and Evans (2001), who found substantially higher effects for married relative to single mothers (an elasticity of -1.17 versus -0.39). The reason for this difference in elasticity is unclear and has not been updated by the literature. It would be interesting to see if this difference still held with more recent variation in taxes.

D. Cigarette Taxation and Pregnancy: Dynamics and Interactions

Do pregnant women respond differently to taxes than non-pregnant women? Pregnancy itself is a life event that can drastically change a woman's health habits. During pregnancy, many women are faced with both social and medical pressure to quit smoking. Recent work showed that three months prior to pregnancy, 23% of women smoked, while during pregnancy, roughly 11% quit (Tong et al., 2009). What is less clear is whether there is something unique about the interaction between pregnancy and a price increase that affects smoking behavior. This dynamic has policy implications: if women are most responsive to taxes during pregnancy, then this suggests that non-financial incentives directed specifically at pregnant women could be particularly effective at reducing adult smoking.

One way to investigate this interaction is to directly compare the elasticities of pregnant mothers to non-pregnant women of childbearing age. For example, Ringel and Evan's (2001) compared an elasticity of about -0.7 for pregnant women versus an elasticity of at most -0.4 for the population of women. On the other hand, Evans and Ringel's (2000) elasticity of for pregnant mothers of -0.49 is only slightly higher than the typical price elasticity of demand for the population of women. Bradford 2003 found identical price elasticities for pregnant and non-pregnant women. He also showed that an interaction between the cigarette tax and pregnancy

was not significant. However, his models did not include year fixed effects, so it is difficult to know the degree to which national trends might be confounding these results.

In addition to directly comparing the elasticities of non-pregnant women to pregnant women, a small literature has used data on mothers over time (either retrospective or longitudinal) to investigate differences in pregnant women's responsiveness to taxes before, during, and after pregnancy. This is arguably a more comparative sample since every woman in the sample eventually experienced pregnancy, and the difference came from whether the tax increase occurred before, during, or after pregnancy. These studies found that women were most likely to respond to taxes during pregnancy than before pregnancy (Colman, Grossman, and Joyce, 2003; Adams et al, 2012), with effects being strongest early during pregnancy, the time most women are likely to quit anyway (Colman, Grossman, and Joyce, 2003). This suggests that there is some sort of interaction between being pregnant and experiencing a cigarette tax hike.

Two other areas related to the dynamics of smoking during pregnancy are the forward-looking behavior of pregnant women and their relapse behavior (i.e., whether women who quit during pregnancy resume smoking afterward). Reinforcement, as defined in Becker and Murphy's (1988) theory of rational addiction, states that past and current consumption are complements. If mothers are forward looking, an increase in future prices will reduce current consumption. Indeed, some evidence suggests that pregnant mothers decrease consumption after a tax hike is announced but before it is implemented (Gruber and Koszegi, 2001). In terms of relapse behavior, Adams et al. (2012) found that while mothers were relatively price insensitive before pregnancy, increasing taxes by $1 resulted in a 4.3% increase in quitting in the third

trimester, and additionally, mothers who quit due to a $1 tax hike were roughly 5% more likely not to resume smoking after the pregnancy.[6]

III. Taxation and Health: Extensions

The bulk of the evidence discussed in Section II shows that pregnant mothers are responsive to taxes, although the elasticities have decreased in recent years. Given that women have historically responded to price increases, a natural extension is to look at how smoking impacts maternal health and birth outcomes using cigarette taxes as exogenous variation in smoke exposure. Smoking during pregnancy is under reported in most datasets, and it is likely that this attenuates estimates of taxes on smoking. Using an Instrument for a dichotomous variable with an attenuated first stage will result in second-stage estimates that are overly large. This has specifically been shown to be the case for smoking during pregnancy (Brachet, 2007). In sum, using IV estimates to directly scale the effect of smoking on child health is difficult without data that very accurately measures smoking during pregnancy[7].

The medical literature offers a number of reasons for why we would see effects of in utero smoke exposure on child health. The most mapped out biological mechanism is that smoking during pregnancy decreases birth weight (USDHHS, 2001). A birth-weight effect comes from the intake of carbon monoxide from smoking that restricts the flow of blood. This, in

[6] Unfortunately, many of the women who smoke during pregnancy resume smoking after the pregnancy is over (Bradford 2003).

[7] There are some important caveats to using cigarette taxes as an instrumental variable. Cigarette taxes are likely to decrease the mother's second-hand smoke exposure, a mechanism by which child health could improve other than smoking during pregnancy. Women who quit smoking during pregnancy also have more income to spend on other goods and possibly more resources to invest in their children. This income effect could also partly explain an improvement in health outcomes. This makes it difficult to fully ascribe the health effects of a tax to smoking during pregnancy. However, the biological mechanisms mean that the health effects of the pregnant mother are likely to be much smaller than the direct effects of smoking during pregnancy (USDHHS, 2010).

turn, reduces the amount of oxygen and nutrition that reaches the fetus, resulting in decreased birth weight. Effects are strongest in the third trimester because this is the time that the fetus is adding weight from nutrition (USDHHS, 2001). Supporting the medical literature, economists have found causal evidence that cigarette smoke harms a child's health at birth, with a $1 increase in taxes ranging from a 1.35% to 5% reduction in low–birth weight births (Evans and Ringel, 1999; Lien and Evans, 2005). More recently, Markowitz et al. (2013) found smaller effects on low–birth weight status and gestational age, but these were limited to teenagers.

The damage to a child's health from smoking during pregnancy does not end at birth. Cognitive problems can occur when nicotine binds to neural receptors, leading to brain damage (Shea and Steiner, 2008). Nicotine acts as a sedative, slowing the development of the embryo, in turn impairing the development of the child's nervous system (USDHHS, 2010). Many other harmful chemicals in cigarettes are believed to cause cellular damage, birth defects, and other health complications that are not fully understood. Simon 2013 supplemented the medical literature with casual evidence that exposure to a cigarette tax in utero had causal impacts on later life outcomes. A $1 cigarette tax while in utero decreased sick days from school for children ages 5–17 by about one-third of a day. Similarly, there were causal effects on asthma attacks, emergency room visits, and doctor visits. This study also provided evidence that cigarette taxes can directly be used as a policy tool to not only improve health at birth but also longer-term child outcomes.

Simon's (2013) study is just one example of how the cigarette tax identification strategy can be used to look at child health outcomes other than birth weight. Smoking during pregnancy has also been linked to complications for mothers' health, such as increased chances of ectopic pregnancy (USDHHS, 2001), but little has been done to link cigarette taxes with maternal health

outcomes. As mentioned, Simon (2013) showed effects on child health and sick days from school. However, additional work could more directly connect in utero smoke exposure to human capital development, such as long-term education and test scores.

IV. Conclusion and Future Work

States have responded to increasing health costs by enacting policies that encourage healthier behavior. Cigarette taxes continue to be a favorite policy tool for both reducing smoking and raising revenue. The bulk of the evidence in the literature shows that pregnant women are responsive to cigarette taxes, although the elasticity has fallen in more recent years. Women who become pregnant are also most responsive, suggesting that perhaps non-tax policies designed to reduce smoking should specifically target women during the start of pregnancy. The subgroups most affected by cigarette taxes have varied greatly across studies and over time, although younger and low-educated mothers seem to be more responsive. Further, evidence suggests that beneficial child health effects can also be gained through taxes. These include birth outcomes and measures of childhood well-being, such as sick days from school, doctor visits, and asthma.

Future research could attempt to better understand the declines in tax elasticities in recent years. It would be interesting to directly test the hypothesis that the remaining smokers from the 1990s are more addicted and have thus been less responsive to tax increases over the last 10 years. This could possibly be done through surveys on smoking and looking at trends in the average amount smoked per day conditional on smoking. A difficulty in understanding the declining elasticities is that maternal smoking is under reported, so seeking out better data on smoking during pregnancy could help. The National Health Nutrition Examination Survey (NHANES) has data on cotinine levels, which directly proxies for exposure to nicotine. This

could be used to estimate more accurate first-stage results on taxes and maternal smoking. Beyond having a better understanding of the current elasticity levels, examining new health outcomes is a natural extension. Medical and economic research shows that the damage caused to a child from in utero smoke exposure is widespread and long lasting. The literature has just started to look at the consequences, and future work could focus on economic outcomes, such as education, employment, and earnings.

References

Adams, E. Kathleen, Sara Markowitz, Viji Kannan, Patricia M. Dietz, Van T. Tong, and Ann M. Malarcher. "Reducing Prenatal Smoking: The Role of State Policies." *American Journal of Preventive Medicine* 43, no. 1 (July 2012): 34–40.

Adda, Jérôme, and Francesca Cornaglia. "Taxes, Cigarette Consumption, and Smoking Intensity." *American Economic Review* 96, no. 4 (September 2006): 1013–28.

Aigner, Dennis J. "Regression with a Binary Independent Variable Subject to Errors of Observation." *Journal of Econometrics* 1, no. 1 (March 1973): 49–59.

Barker, D J. "The Fetal and Infant Origins of Adult Disease." *BMJ : British Medical Journal* 301, no. 6761 (November 17, 1990): 1111.

Becker, Gary S., and Kevin M. Murphy. "A Theory of Rational Addiction." *Journal of Political Economy* 96, no. 4 (August 1, 1988): 675–700.

Brachet, Tanguy. "Maternal Smoking, Misclassification, and Infant Health." *Misclassification, and Infant Health (November 25, 2005)*, 2007. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1009781.

Bradford, W. David. "Pregnancy and the Demand for Cigarettes." *American Economic Review* 93, no. 5 (2003): 1752–63.

Callison, Kevin, and Robert Kaestner. "Do Higher Tobacco Taxes Reduce Adult Smoking? New Evidence of the Effect of Recent Cigarette Tax Increases on Adult Smoking." *Economic Inquiry* 52, no. 1 (January 1, 2014): 155–72.

Centers for Disease Control and Prevention (US), National Center for Chronic Disease Prevention and Health Promotion (US), and Office on Smoking and Health (US). *How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease: A Report of the Surgeon General*. Publications and Reports of the Surgeon General. Atlanta (GA): Centers for Disease Control and Prevention (US), 2010. http://www.ncbi.nlm.nih.gov/books/NBK53017/.

Chaloupka, Frank Joseph, and Kenneth E. Warner. *The Economics of Smoking*. Handbook of Health Economics. Elsevier, 2000.

Colman, Greg, Michael Grossman, and Ted Joyce. "The Effect of Cigarette Excise Taxes on Smoking before, During and after Pregnancy." *Journal of Health Economics* 22, no. 6 (November 2003): 1053–72.

Dietz, Patricia M., David Homa, Lucinda J. England, Kim Burley, Van T. Tong, Shanta R. Dube, and John T. Bernert. "Estimates of Nondisclosure of Cigarette Smoking Among Pregnant and Nonpregnant Women of Reproductive Age in the United States." *American Journal of Epidemiology* 173, no. 3 (February 1, 2011): 355–59.

Evans, William N., and Jeanne S. Ringel. “Can Higher Cigarette Taxes Improve Birth Outcomes?” *Journal of Public Economics* 72, no. 1 (April 1, 1999): 135–54.

Gruber, Jonathan. “Tobacco at the Crossroads: The Past and Future of Smoking Regulation in the United States.” *Journal of Economic Perspectives* 15, no. 2 (2001): 193–212.

Gruber, Jonathan, and Botond Köszegi. “Is Addiction ‘Rational’? Theory and Evidence.” *The Quarterly Journal of Economics* 116, no. 4 (November 1, 2001): 1261–1303.

Gruber, Jonathan, and Jonathan Zinman. *Youth Smoking in the U.S.: Evidence and Implications*. Working Paper. National Bureau of Economic Research, July 2000. http://www.nber.org/papers/w7780.

Kennedy, Peter. *A Guide to Econometrics*. MIT press, 2003.

Levy, Douglas E., and Ellen Meara. “The Effect of the 1998 Master Settlement Agreement on Prenatal Smoking.” *Journal of Health Economics* 25, no. 2 (March 2006): 276–94.

Lien, Diana S., and William N. Evans. “Estimating the Impact of Large Cigarette Tax Hikes The Case of Maternal Smoking and Infant Birth Weight.” *Journal of Human Resources* 40, no. 2 (2005): 373–92.

Markowitz, Sara, E. Kathleen Adams, Patricia M. Dietz, Viji Kannan, and Van Tong. *Smoking Policies and Birth Outcomes: Estimates From a New Era*. Working Paper. National Bureau of Economic Research, June 2011. http://www.nber.org/papers/w17160.

Markowitz, Sara, E. Kathleen Adams, Patricia M. Dietz, Viji Kannan, and Van T. Tong. “Tobacco Control Policies, Birth Outcomes, and Maternal Human Capital.” *Journal of Human Capital* 7, no. 2 (June 2013): 130–60.

Orzechowski and Walker, “The Tax Burden on Tobacco,” *The Tax Burden on Tobacco: Historical Compilation*, Dec 2010, 46.

Ringel, Jeanne S., and William N. Evans. “Cigarette Taxes and Smoking during Pregnancy.” *American Journal of Public Health* 91, no. 11 (November 1, 2001): 1851–56.

Shea, Alison K., and Meir Steiner. “Cigarette Smoking During Pregnancy.” *Nicotine & Tobacco Research* 10, no. 2 (February 1, 2008): 267–78.

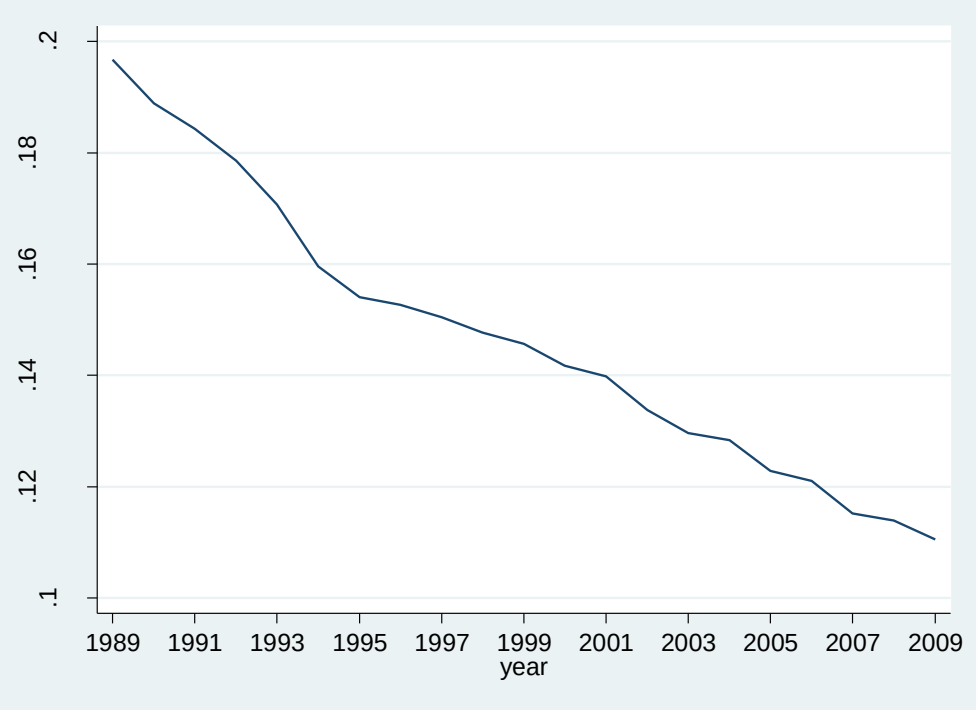
Shiono, Patricia H., and Richard E. Behrman. “Low Birth Weight: Analysis and Recommendations.” *The Future of Children* 5, no. 1 (1995): 4.

Simon, David Eliot. *Does Early Life Exposure to Cigarette Smoke Permanently Harm Childhood Health? Evidence from Cigarette Tax Hikes*. Working paper. University of Connecticut,

Department of Economics, August 2013. http://econpapers.repec.org/paper/uctuconnp/2013-21.htm.

Tong, Van T., Jaime R. Jones, Patricia M. Dietz, Denise D'Angelo, Jennifer M. Bombard, and others. *Trends in Smoking before, During, and after Pregnancy: Pregnancy Risk Assessment Monitoring System (PRAMS), United States, 31 Sites, 2000-2005*. Department of Health and Human Services, Centers for Disease Control and Prevention, 2009. http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5804a1.htm?newwindow=true.

Figure 1: Trends in Smoking during Pregnancy, 1989–2009



The above figure shows the percentage of mothers who reported smoking each year from 1989 to 2010. Data come from the public use Vital Statistics Natality files: 1989–2010.

Table 1: Smoking Participation Elasticities for Pregnant Women by Study

Study	Cohort Years	Dataset	Average Price per Pack (including tax)	Sample Notes	% Smoker	Participation Elasticity
Simon (2014)	1989-2009	Vital Stats	3.15	All	14	-0.15
Markowitz et al. (2012)	2000-2005	PRAMS	3.97	Ages 35 and up	10	-0.12
Decicca and Smith (2012)	1999-2003	Vital Stats	3.52	All Mothers	12	-0.14
Levy and Meara (2006)	1996-2000	Vital Stats	2.50	All	12.7	-0.13
Lien and Evans (2005)	1990-1997	Vital Stats	2.00	mothers in AZ, IL, MA, and MI	17.6	-0.49
Bradford (2003)	1988, 1991	National Maternal and Infant Health Survey	1.64	All	11.3	-0.34
Ringel and Evans (2001)	1989-1995	Vital stats	1.88	All	16.5	-0.70
Evans and Ringel (1999)	1989-1992	Vital Stats	1.74	All	17.1	-0.52

Table 1 lists major studies that have estimated participation price elasticities for pregnant mothers using exogenous changes in price. Markowitz et al. (2012) reported marginal effects from probit models that I converted into elasticities using data on prices from Orzechowski and Walker, 2010. Lien and Evans (2005) ran models on four states and presented the average elasticity across those states.

Table 2: Smoking Participation Elasticities by Subgroups

Study	Cohort Years	Demographic Group	% Smoker	Participation Elasticity
		A: Subgroups by Age		
Markowitz et al. (2012)	2000-2005	Age<20	18	-0.79
		Age 20-24	19	-0.23
		Age 25-34	10	-0.56
		Ages 35 and up	10	-0.12
Gruber and Zinman (2000)	1991-1997	13-18	16	-0.24
		17-18	18	-0.38
		13-16	13	-0.35
Levy and Meara (2006)	1996-2000	15-19	18	-0.30
		20-34	13	-0.06
		35-44	10	-0.30
Ringel and Evans (2001)	1989-1995			
		<=19	18	-0.50
		20-24	20	-0.55
		25-29	16	-0.58
		30-34	14	-1.18
		35-39	13	-1.13
		>=40	11	-1.02
		Panel B: Mother's Education		
Decicca and Smith (2012)	1999-2003	All	12	-0.14
		Mom Dropout	21	-0.24
Ringel and Evans (2001)	1989-1995	Ed<HS	27	-0.30
		Ed>=College	4	-3.39
Levy and Meara (2006)	1996-2000	ED<HS	22	-0.14
		HS	17	-0.10
		Some College	10	-0.08
		College +	2	-0.21
		Panel C: Mother's Race / Marital Status / Other		
Ringel and Evans (2001)	1989-1995	Black	14	-0.55
		White	19	-0.79
		married	13	-1.12
		Unmarried	25	-0.37
Levy and Meara (2006)	1996-2000	White	16	-0.09
		Black	10	-0.09
		Hispanic	4	-0.27

This table shows price participation elasticities estimated by different studies by subgroups. Markowitz et al. (2012) reported marginal effects from probit models that I converted into elasticities using data on prices from Orzechowski and Walker, 2010. Levy and Meara (2006) did not report mean smoking rates by subgroups. I directly estimated this from the public use Vital Statistics data for years 1989–2009.