Cigarette Taxes and Smoking During Pregnancy

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In recent years, researchers from numerous disciplines have examined the impact of various policies designed to discourage smoking, including counteradvertising,1–4 workplace smoking policies,5–8 and youth access restrictions.9–11 Much of the research, however, has centered on the impact of higher prices or excise taxes on cigarette demand. In a recent report, Chaloupka and Warner12 reviewed 55 studies that examined the impact of prices or taxes on cigarette consumption. Nearly all of these studies demonstrated declines in aggregate cigarette consumption or proportions of smokers when prices or taxes were increased. However, there has been limited evidence on the impact of higher taxes on smoking in an important group: pregnant women.

The impact of antismoking policies on this group is of particular interest, given the well-known link between maternal smoking and the health of infants. A report of the surgeon general13 concluded that maternal smoking during pregnancy reduces birthweight by an average of 200 g, doubles the chance of an infant’s having a low birthweight, and is responsible for 17% to 26% of low-weight births (less than 2500 g). Cigarette smoking is associated with higher medical costs of treating newborns.22,24–27 Maternal smoking is also an important and preventable cause of sudden infant death syndrome.28–32 A large number of studies have examined the impact of higher taxes on maternal smoking during pregnancy. Using data from the 1989 to 1992 Natality Detail Files, Evans and Ringer33 found that higher taxes reduce smoking rates, but not average daily consumption, among women who continue to smoke. They estimated a smoking participation price elasticity of about –0.50, indicating that for every 10% increase in cigarette prices, the maternal smoking rate falls by 5%. In addition, they found that the tax-induced reduction in smoking led to improved birth outcomes. Among those women who quit smoking in response to a tax increase, average birthweights rose by approximately 400 g.

These estimates provide an indication of the mean response to a tax hike. In contrast, exploring heterogeneity in responses to the tax would provide valuable information about the distribution of the benefits of this public policy. Low-birthweight rates vary systematically across demographic groups, with children of young mothers, mothers at low education levels, African American mothers, and unmarried mothers having higher rates. Many of these same groups exhibit high rates of smoking during pregnancy. Increasing cigarette taxes would be a particularly effective method of improving birth outcomes if the groups that face the highest risk of adverse outcomes are also the groups most likely to quit smoking in response to the tax change. In this article, we examine heterogeneity in cigarette demand elasticities across socioeconomic and demographic lines.

A large number of studies have examined the impact of higher cigarette prices on demand, but fewer studies have examined, within the same data set, how demand responses vary across population subgroups. Most efforts have examined the differences in demand responses between teenagers/young adults and adults,34–37 between men and women,38 and among various income/socio-demographic groups.36,38,39 One reason for limited research on demand heterogeneity is the small samples used in many studies. The extreme size of the data set we used allowed us to investigate in detail heterogeneity across groups in responsiveness to cigarette tax hikes.

METHODS

Study Design

The primary variables of interest in our models were measures of smoking during pregnancy (S) and cigarette taxes faced by a woman during her pregnancy (T). We exploited the fact that our sample contained observations varying across individuals, states, and time by using a “within-group” estimator in which we examined changes in smoking participation rates within a state before and after cigarette tax changes. The primary outcome was an indicator variable assigned a value of 1 if a mother smoked during pregnancy and assigned a value of 0 otherwise. We modeled the dichotomous outcome with a probit specification.

The within-group probit model can be characterized by the equation Prob(Sit=1)=Φ(Xi0γ1+Ti0γ2+ui+vit), where i, s, and t index individuals, states, and time, respectively, and Φ(·) is the evaluation of the standard normal cumulative density function. The...
vector $X$ contains demographic characteristics of the mother, $u_i$ represents state effects, and $v_i$ represents time effects. The state effects are estimated by inserting a set of dummy variables for the state in which the birth took place. The time effects are estimated via a set of monthly dummy variables, one for each unique year/month in the panel.

The state dummy variables control for state-specific characteristics that do not vary in the sample, such as social norms, and might affect both an individual’s smoking decision and a state’s cigarette tax policy. The month effects capture factors that are common to all states but vary over time, such as federal tax changes and secular declines in maternal smoking. The use of state and month effects creates a model in which states with tax changes represent treatments and states with no tax changes act as comparison groups. The covariate of interest is the real federal tax plus state, measured in cents per pack, in the month a child was conceived.

To translate the probit parameters into economically meaningful terms, we calculated the “marginal effect” of a tax change, that is, the change in the probability of smoking given a 1-cent increase in the tax rate. Mathematically, the marginal effect is defined as $\partial \Pr(Y_i = 1)/\partial T_{st} = \beta \varphi(\cdot)$, where $\varphi(\cdot)$ is the evaluation of the standard normal probability density function. We evaluated the probability density function at the value for a person with a probability of smoking equal to the sample mean of $S$.  

Policy makers can change taxes, but consumers respond to changing prices. Economists typically assess responsiveness to price changes via “price elasticities” that measure the percentage change in use given a percentage change in price. Because retail prices are a function of the taxes levied on cigarettes, we translated marginal effects into implied price elasticities. Assuming that retail prices increase by a penny for each 1-cent increase in state excise taxes, we estimated elasticities according to the procedure of Evans et al.  

### Data

Our primary data set was the Natality Detail File, which is an annual census of births in the United States. Natality data are taken directly from birth records and contain information on birth outcomes, demographic characteristics, and maternal smoking, along with health information about the mother. We used natality data for 1989 (the first year smoking data were available) through 1995.

The Natality Detail Files record self-reports of whether mothers smoked during their pregnancy and average number of cigarettes smoked per day. As in any survey that involves self-reported smoking data, there was the possibility that smokers understated their cigarette consumption. By chemically testing for cotinine, a byproduct of nicotine, researchers have found that adults tend to accurately report smoking participation. However, aggregation of national cigarette consumption surveys generates only 60% of cigarette sales, indicating that individuals tend to underreport consumption.

Women may underreport their cigarette consumption for a variety of reasons, but we suspect that the negative public sentiment toward smoking during pregnancy is the most likely reason that some pregnant women underreport their cigarette use. Because adults appear to more accurately report smoking participation, we focus on the discrete smoking participation indicator as the outcome of interest.

For most women, the decision of whether to continue to smoke is made early in the pregnancy. Studies have shown that approximately 39% of women who smoked before pregnancy quit smoking while they are pregnant, with nearly 70% of this group doing so as soon as they find out they are pregnant. Therefore, the tax rate that is most relevant is the one measured near the beginning of the pregnancy. We used the tax that the woman faced during the month she conceived. We estimated month of conception from information on month of birth and clinical estimates of gestation. Using data from *The Tax Burden on Tobacco*, we computed monthly observations on state excise taxes. The monthly, all-product consumer price index was used to translate nominal taxes into real 1997 values.

Subsequently, referring back to the probit model equation, the unit of observation in our sample represents a woman, $i$, who conceived a child in month $t$ and gave birth in state $s$. The decision to use state of occurrence rather than state of residence was not critical, in that 98% of all women live and give birth in the same state. We should stress, however, that we observed whether a mother smoked during pregnancy but not the time path of smoking. We were not able to determine whether a mother quit smoking before she became pregnant or as soon as she became pregnant; both types of quitting behavior are recorded as “not smoking” in our model.

We should also note that our data cannot identify whether a mother began smoking again after the pregnancy. Given the problems associated with smoking during pregnancy, we believe that this is an interesting outcome.

To control for the fact that women with certain characteristics may be more or less likely to live in states with higher excise tax rates, we exploited the rich demographic data in the Natality Detail Files and added an extensive list of other cofactors to our multivariate models. We constructed 5 education groups (no reported schooling, less than high school, high school, some college, college), 6 age groups ($<$20, 20–24, 25–29, 30–34, 35–39, $>$39 years), 4 racial/ethnic groups (White non-Hispanic, Black non-Hispanic, Hispanic, other), 4 parity levels (first, second, third, fourth or higher), 3 plurality levels (singleton, twin, triplet or more), 4 Kessner index levels (prenatal care not reported, inadequate, intermediate, adequate), and 2 sex-of-child and marital status (married, unmarried) groups, along with 80 month-of-conception groups and 49 state groups. Our basic model comprised 150 covariates, including the tax variable.

Ideally, we would like to have included other covariates in the model, such as income or maternal drinking. The Natality Detail Files, however, do not provide information on income, and the quality of the maternal drinking data is poor. For example, in the 1991 Natality Detail File, approximately 1% of women reported having consumed alcohol during their pregnancy—a figure much smaller than the 12.4% documented in the 1991 Behavioral Risk Factor Surveillance System survey. We suspect that because there is physical evidence involved with smoking (e.g., nicotine stains on teeth and fingers and the smell of smoke), women are less likely to be deceptive about smoking than about alcohol consumption, which would be detectable only
RESULTS

20 million of a possible 26 million births took place over this time period.

RESULTS

Results are summarized in Table 1. The first row includes estimates for the entire sample, and subsequent rows include estimates for different subpopulations. In each row of the table, we report number of observations, maternal smoking rate, percentage of births that were low weight, the marginal effect of a tax change among women who smoked before pregnancy. The marginal effect of a tax change among women who smoked before pregnancy was in excess of the values typically reported for the general adult population. The results presented in this article provide further evidence that higher cigarette taxes reduce maternal smoking rates by a statistically significant and quantitatively important amount. Our results indicate that for every 10% increase in price, smoking participation rates among pregnant women fall by 7%. To put these results in another context, we estimate that a 55-cent increase in excise taxes will reduce maternal smoking rates by 3.6 percentage points, or about 22%.

We also examined heterogeneity in demand responses across important subgroups (e.g., racial/ethnic, age, and marital status groups) and specific subpopulations with particularly high smoking rates (e.g., unmarried women at low education levels and single White women). In all subgroups but one, we found a statistically significant and quantitatively large negative relationship between cigarette excise taxes and maternal smoking during pregnancy. In nearly all cases, pregnant women were found to be more responsive to higher cigarette taxes than the general adult population.

We are left to speculate about 2 results: Why are pregnant women more responsive to tax hikes than others? and How can we explain the heterogeneity in the results across subgroups? The large tax response among pregnant women is probably due to the fact that a large group of pregnant women are motivated to quit. Fingerhut et al. found that among women who smoked before pregnancy, 39% quit once they became pregnant. Given the willingness of a large group to quit, a higher purchase price seems to be an adequate inducement to make this group more responsive than adults in general. The heterogeneity in the elasticities across subgroups can best be explained by noting that the
Natality Detail File Data

<table>
<thead>
<tr>
<th>No. of Observations (×1000)</th>
<th>Smoked, %</th>
<th>Low Birthweight, %</th>
<th>Marginal Effect of Probit Change in Smoking</th>
<th>Implied Price Elasticity</th>
<th>Change in Smoking Percentage With $0.55 Tax Hike</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full sample</td>
<td>20 025</td>
<td>16.5</td>
<td>7.3</td>
<td>-0.00066 (-26.7)</td>
<td>-0.70</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black, non-Hispanic</td>
<td>3498</td>
<td>13.6</td>
<td>13.4</td>
<td>-0.00043 (-8.2)</td>
<td>-0.55</td>
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<tr>
<td>White, non-Hispanic</td>
<td>13 428</td>
<td>19.3</td>
<td>5.9</td>
<td>-0.00087 (-26.2)</td>
<td>-0.79</td>
</tr>
<tr>
<td>Hispanic</td>
<td>2198</td>
<td>5.5</td>
<td>6.5</td>
<td>-0.00020 (-4.3)</td>
<td>-0.64</td>
</tr>
<tr>
<td>Other</td>
<td>901</td>
<td>12.0</td>
<td>6.7</td>
<td>-0.00037 (-4.5)</td>
<td>-0.54</td>
</tr>
<tr>
<td>Age, y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤19</td>
<td>2 674</td>
<td>18.4</td>
<td>9.7</td>
<td>-0.00053 (-7.2)</td>
<td>-0.50</td>
</tr>
<tr>
<td>20–24</td>
<td>5 270</td>
<td>20.0</td>
<td>7.4</td>
<td>-0.00063 (-11.7)</td>
<td>-0.55</td>
</tr>
<tr>
<td>25–29</td>
<td>5 798</td>
<td>15.8</td>
<td>6.4</td>
<td>-0.00052 (-11.3)</td>
<td>-0.58</td>
</tr>
<tr>
<td>30–34</td>
<td>4 370</td>
<td>13.8</td>
<td>6.6</td>
<td>-0.00093 (-19.2)</td>
<td>-1.18</td>
</tr>
<tr>
<td>35–39</td>
<td>1 648</td>
<td>12.8</td>
<td>7.8</td>
<td>-0.00082 (-11.4)</td>
<td>-1.13</td>
</tr>
<tr>
<td>≥40</td>
<td>266</td>
<td>11.1</td>
<td>9.0</td>
<td>-0.00065 (-3.9)</td>
<td>-1.02</td>
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<td>Marital status</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>14 141</td>
<td>12.9</td>
<td>5.8</td>
<td>-0.00082 (-30.1)</td>
<td>-1.12</td>
</tr>
<tr>
<td>Unmarried</td>
<td>5 883</td>
<td>25.2</td>
<td>10.9</td>
<td>-0.00053 (-10.4)</td>
<td>-0.37</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than high school</td>
<td>4 219</td>
<td>27.1</td>
<td>9.8</td>
<td>-0.00047 (-7.0)</td>
<td>-0.30</td>
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<tr>
<td>High school</td>
<td>7 334</td>
<td>19.8</td>
<td>7.6</td>
<td>-0.00056 (-13.1)</td>
<td>-0.49</td>
</tr>
<tr>
<td>Some college</td>
<td>4 207</td>
<td>11.7</td>
<td>6.3</td>
<td>-0.00057 (-13.3)</td>
<td>-0.86</td>
</tr>
<tr>
<td>College</td>
<td>3 835</td>
<td>3.6</td>
<td>5.1</td>
<td>-0.00070 (-26.2)</td>
<td>-3.39</td>
</tr>
<tr>
<td>Education not reported</td>
<td>429</td>
<td>17.5</td>
<td>8.0</td>
<td>-0.00014 (0.6)</td>
<td>-0.14</td>
</tr>
<tr>
<td>Parity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st</td>
<td>8 201</td>
<td>13.6</td>
<td>7.6</td>
<td>-0.00067 (-18.5)</td>
<td>-0.86</td>
</tr>
<tr>
<td>2nd</td>
<td>6 498</td>
<td>16.4</td>
<td>6.3</td>
<td>-0.00067 (-15.2)</td>
<td>-0.71</td>
</tr>
<tr>
<td>3rd</td>
<td>3 238</td>
<td>19.8</td>
<td>7.2</td>
<td>-0.00075 (-11.4)</td>
<td>-0.66</td>
</tr>
<tr>
<td>4th or higher</td>
<td>2 087</td>
<td>22.9</td>
<td>9.6</td>
<td>-0.00075 (-9.0)</td>
<td>-0.57</td>
</tr>
<tr>
<td>Subgroup with high smoking rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unmarried, ≤24 y</td>
<td>4 010</td>
<td>21.7</td>
<td>10.1</td>
<td>-0.00057 (-9.4)</td>
<td>-0.46</td>
</tr>
<tr>
<td>Unmarried, less than high school</td>
<td></td>
<td>4 742</td>
<td>26.5</td>
<td>11.1</td>
<td>-0.00048 (-8.3)</td>
</tr>
<tr>
<td>White, less than high school</td>
<td></td>
<td>6 885</td>
<td>29.4</td>
<td>6.9</td>
<td>-0.00063 (-11.9)</td>
</tr>
<tr>
<td>White, unmarried</td>
<td>2 487</td>
<td>39.5</td>
<td>8.5</td>
<td>-0.00050 (-5.7)</td>
<td>-0.22</td>
</tr>
</tbody>
</table>

Note. All models include (when appropriate) controls for age, race/ethnicity, education, and marital status of mother; parity of birth; adequacy of prenatal care; and sex of child, along with state and month of conception effects.

groups that are the most likely to quit smoking during pregnancy also have the greatest relative response to tax hikes.

For example, Fingerhut et al.45 showed that older women, married women, and more educated women are most likely to stop smoking during pregnancy. These are the very same groups for which we found the greatest implied price elasticity. Again, it appears that higher taxes have the largest effects in groups that are already more motivated to quit smoking.

In the final 4 rows of Table 1, we report model estimates for 4 subgroups with particularly high smoking rates during pregnancy. Among these groups, smoking rates ranged from 21.7% for unmarried women younger than 25 years to nearly 40% for White unmarried women. For each of the groups, higher taxes reduce smoking participation rates by a statistically significant amount. All groups have elasticities that are at least comparable to estimates for the general population, and in some cases the elasticities approach –0.50.

A few other results are noteworthy. First, there has been considerable debate recently about whether higher cigarette taxes will reduce teen smoking rates.37,50–53 We found a large and statistically precise impact of taxes...
on smoking among teen mothers, although teens are less price sensitive than older mothers. Second, because elasticity of demand was calculated at the mean rate of smoking participation for each group, it was possible to obtain the same marginal effect for 2 groups and calculate very different demand elasticities (e.g., consider the comparison between women who graduated from high school and women who attended some college).

Most demand studies also generate estimates of the impact of taxes or prices on average daily consumption for remaining smokers. This model could be estimated in our sample because the Natality Detail Files also contain self-reports of average daily consumption. Consistent with the results from previous work on maternal smoking,33 we found little evidence that higher taxes reduce daily cigarette consumption for remaining smokers. Using the more than 3.1 million observations involving valid data on daily consumption among women who smoked during their pregnancy, we regressed cigarettes consumed per day on the same set of covariates used in constructing Table 1. The tax coefficient from this regression was 0.00223, with a t statistic of 1.83. Because the average number of cigarettes consumed per day among smokers was 12.5, this translates into a price elasticity of demand of 0.03, which, although positive, is very small.

Even given the large sample size, we cannot reject, at the 95% critical value, the null hypothesis that this elasticity is zero. The positive coefficient for the tax variable in this regression is most likely driven by the large effects of taxes on smoking participation. If smokers with low daily consumption are more likely to quit, a tax hike could appear to increase average daily consumption for remaining smokers.

As mentioned earlier, some potentially important predictors of cigarette consumption, most notably income, are not part of the Natality Detail Files. Missing covariates would bias our estimates only if the excluded variables were correlated with the variable of interest, excise taxes. This does not appear to be the case. To illustrate this point, we ran a probit model for the entire sample and included only 3 sets of variables: state effects, month-of-conception effects, and the tax variable. All other demographic covariates were excluded. The marginal effect on the tax coefficient (t statistic) was –0.00058 (–25.1), and the implied participation price elasticity was –0.62. Both estimates are close to the results reported for the full sample in Table 1. Excluding all demographic covariates from the model changed the implied impact of taxes only marginally, suggesting that these excluded covariates should not have seriously biased our estimates.

CONCLUSIONS

Smoking participation rates vary widely across demographic and socioeconomic groups. For this reason, it seems likely that responsiveness to cigarette price changes would vary along the same lines. In this article, we investigated heterogeneity in the price elasticity of smoking participation. Our results indicate that White women, older women, and highly educated women are most responsive to changes in cigarette taxes. It is encouraging to note, however, that nearly all subgroups of pregnant women have higher smoking participation price elasticities than the general population. This is not a surprising result. Because many pregnant women try to quit smoking, interventions such as cigarette tax hikes may be more effective during pregnancy than at other points in a woman’s life.

There is already a large body of work demonstrating that higher cigarette taxes reduce aggregate smoking and smoking rates. Our study adds to this literature by demonstrating that smoking rates in an important subgroup, pregnant women, are also responsive to tax hikes. A direct implication of these results is that the benefits from higher taxes in regard to improved maternal and child health need to be added to any cost–benefit calculation.

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