Cigarette Taxes and Smoking During Pregnancy

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Objectives. This study sought to estimate how changes in state cigarette excise taxes affect the smoking behavior of pregnant women.

Methods. Detailed information about mothers and their pregnancy was used to examine the impact of taxes on the propensity of pregnant women to smoke. The 1989 to 1995 Natality Detail Files were used in conducting analyses to assess the impact of taxes on smoking among different subpopulations.

Results. Higher cigarette excise taxes reduced smoking rates among pregnant women. A tax hike of $0.55 per pack would reduce maternal smoking by about 22%. Overall, a 10% increase in price would reduce smoking rates by 7%. Estimates for subpopulations suggested that nearly all would be very responsive to tax changes, including the subpopulations with the highest smoking rates.

Conclusions. Smoking rates among pregnant women are responsive to tax hikes. (*Am J Public Health.* 2001;91:1851–1856)

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,[5–14] and youth access restrictions.[15–19] 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 Warner[20] 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 general[21] 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 has been identified as the "single largest modifiable risk factor for low birthweight."[22(p11)] Because the medical costs of treating low-birthweight infants are much higher than the costs for normal-weight births,[23] maternal smoking is associated with higher medical costs of treating newborns.[22,24–27] Maternal smoking during pregnancy is also an important and preventable cause of sudden infant death syndrome,[28–32] a risk factor for ectopic pregnancy and spontaneous abortion, and a predictor of neonatal mortality.[21]

To date, only 1 published study of which we are aware has examined the impact of higher taxes on maternal smoking during pregnancy. Using data from the 1989 to 1992 Natality Detail Files, Evans and Ringel[33] 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 along 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/sociodemographic 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 $\text{Prob}(S_{ist}=1)=\Phi(X_{ist}\gamma_1+T_{st}\gamma_2+u_s+v_t)$, where i, s, and t index individuals, states, and time, respectively, and $\Phi(\bullet)$ is the evaluation of the standard normal cumulative density function. The

vector X contains demographic characteristics of the mother, u_s represents state effects, and v_t 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 tax (federal 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 $\partial \text{Prob}(S_{ist}=1)/\partial T_{ist}=\beta_2\phi(\bullet)$, where $\phi(\bullet)$ 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.[38]

Policymakers 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,[38–41] we estimated elasticities according to the procedure of Evans et al.[39]

Data

Our primary data set was the Natality Detail File,[42] 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.[43,44] However, aggregation of national cigarette consumption surveys generates only 60% of cigarette sales,[35] 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.[45] 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,*[46] 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 (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

if the mother drank directly before entering the hospital. Given the purpose of this study, we were willing to sacrifice some potential explanatory variables to obtain the large samples from the Natality Detail Files.

We omitted from our sample all women without valid data on smoking participation during pregnancy. The vast majority of observations omitted involved women who gave birth in 1 of the 7 states that did not report maternal smoking data at some point during the sample period. These states and the years during which smoking data were not reported were as follows: California, Indiana, South Dakota, and New York (excluding New York City), all study years; New York City, 1989 to 1994; Oklahoma, 1989 to 1990; and Louisiana and Nebraska, 1989.

Furthermore, because we organized the data by month of conception, observations at the beginning and end of our sample period involved selected samples. For example, the only women conceiving in mid-1995 who were included in the 1995 Natality Detail File were women with premature births. Likewise, women who conceived in the second quarter of 1988 but had a premature delivery in late 1988 were not included in the 1989 natality file. To address this problem, we deleted the first and last 5 months of our sample period, giving us 80 months of data in total. The final data contained approximately 20 million of a possible 26 million births taking 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 for the tax coefficient from the probit model and its *t* statistic, and the implied price elasticity of demand. In the final column, we report the estimated percentage point change in mean smoking rate generated from a 55-cent tax hike, the value of a federal tax hike proposed in 1999 by President Clinton.[47]

We used information from more than 20 million birth records, and in this sample 16.5% of mothers reported smoking during their pregnancy. The marginal effect of −0.00066, precisely estimated with a *t* statistic of −26.7, indicates that for every 1-cent increase in taxes, the maternal smoking rate would fall by 0.066 percentage points. Put another way, the proposed 55-cent tax hike should reduce smoking by 3.6 percentage points, a 22% drop in the mean smoking rate.

We calculated the implied participation price elasticity of −0.7 by multiplying the marginal effect by the real average price per pack (175 cents in 1997 dollars) during this period and dividing by sample smoking participation rate (0.165). This number suggests that a 10% increase in price would reduce the smoking rate for this group by 7%. Most estimates of the aggregate elasticity of demand for cigarettes are in the −0.3 to −0.5 range, with the participation price elasticity being about half the demand elasticity.[20,39,48,49] Thus, the participation price elasticity of demand for this sample is 3 to 4 times the estimate for the general adult population.

To explore the heterogeneity in the impact of tax increases on maternal smoking across different demographic groups, we estimated models for 4 racial/ethnic groups, 6 age groups, 5 education groups, married and unmarried women, and births of different parity. We also constructed estimates for 4 subpopulations with particularly high smoking rates: young unmarried women (24 years or younger), unmarried women at low education levels (less than high school), White women at low education levels, and White unmarried women. These results are reported in the remaining rows of Table 1. For each subgroup, we used group smoking rates to calculate marginal effects and the implied participation price elasticities of demand.

For all subpopulations but one (women who did not report their level of education), tax hikes had a statistically significant negative impact on maternal smoking rates. Among women of various racial/ethnic groups, the group with the highest smoking rate (White women) was also the one most sensitive to tax changes. Likewise, the marginal effects of a tax change were larger for mothers with higher parity births, a group with higher smoking rates. In contrast, younger women (less than 30 years of age), unmarried women, and women at lower education levels (high school or less) had higher-than-average smoking rates for their subgroups but lower-than-average responsiveness to tax changes. An important point to note is that for all subgroups except those not reporting education, the price elasticity of demand was in excess of the values typically reported for the general population.

DISCUSSION

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.[45] 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

TABLE 1—Probit Estimates of the Impact of Taxes on Smoking Participation: 1989–1995 Natality Detail File Data

	No. of Observations (×1000)	Smoked, %	Low Birthweight, %	Marginal Effect of Probit Coefficient on Real Tax Variable (*t* statistic)	Implied Price Elasticity	Change in Smoking Percentage With $0.55 Tax Hike
Full sample	20 025	16.5	7.3	−0.00066 (−26.7)	−0.70	−3.6
Race/ethnicity						
Black, non-Hispanic	3 498	13.6	13.4	−0.00043 (−8.2)	−0.55	−2.4
White, non-Hispanic	13 428	19.3	5.9	−0.00087 (−26.2)	−0.79	−4.8
Hispanic	2 198	5.5	6.5	−0.00020 (−4.3)	−0.64	−1.1
Other	901	12.0	6.7	−0.00037 (−4.5)	−0.54	−2.0
Age, y						
≤19	2 674	18.4	9.7	−0.00053 (−7.2)	−0.50	−2.9
20–24	5 270	20.0	7.4	−0.00063 (−11.7)	−0.55	−3.5
25–29	5 798	15.8	6.4	−0.00052 (−11.3)	−0.58	−2.9
30–34	4 370	13.8	6.6	−0.00093 (−19.2)	−1.18	−5.1
35–39	1 648	12.8	7.8	−0.00082 (−11.4)	−1.13	−4.5
≥40	266	11.1	9.0	−0.00065 (−3.9)	−1.02	−3.6
Marital status						
Married	14 141	12.9	5.8	−0.00082 (−30.1)	−1.12	−4.5
Unmarried	5 883	25.2	10.9	−0.00053 (−10.4)	−0.37	−2.9
Education						
Less than high school	4 219	27.1	9.8	−0.00047 (−7.0)	−0.30	−2.6
High school	7 334	19.8	7.6	−0.00056 (−13.1)	−0.49	−3.1
Some college	4 207	11.7	6.3	−0.00057 (−13.3)	−0.86	−3.1
College	3 835	3.6	5.1	−0.00070 (−26.2)	−3.39	−3.8
Education not reported	429	17.5	8.0	−0.00014 (0.6)	−0.14	−0.7
Parity						
1st	8 201	13.6	7.6	−0.00067 (−18.5)	−0.86	−3.7
2nd	6 498	16.4	6.3	−0.00067 (−15.2)	−0.71	−3.7
3rd	3 238	19.8	7.2	−0.00075 (−11.4)	−0.66	−4.1
4th or higher	2 087	22.9	9.6	−0.00075 (−9.0)	−0.57	−4.1
Subgroup with high smoking rate						
Unmarried, ≤24 y	4 010	21.7	10.1	−0.00057 (−9.4)	−0.46	−3.1
Unmarried, less than high school	4 742	26.5	11.1	−0.00048 (−8.3)	−0.32	−2.7
White, less than high school	6 885	29.4	6.9	−0.00063 (−11.9)	−0.37	−3.4
White, unmarried	2 487	39.5	8.5	−0.00050 (−5.7)	−0.22	−2.8

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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