Available online at www.sciencedirect.com
SCIENCE DIRECT®
Journal of Health Economics 22 (2003) 1053–1072
JOURNAL OF HEALTH ECONOMICS
www.elsevier.com/locate/econbase

The effect of cigarette excise taxes on smoking before, during and after pregnancy

Greg Colman [a], Michael Grossman [c,d], Ted Joyce [b,c,d,*]

[a] *Pace University, New York, NY, USA*
[b] *Baruch College, City University of New York, New York, NY, USA*
[c] *Graduate Center, City University of New York, New York, NY, USA*
[d] *The National Bureau of Economic Research, 365 Fifth Avenue, 5th Floor, New York, NY 10016, USA*

Received 1 April 2003; received in revised form 1 May 2003; accepted 6 June 2003

Abstract

Recent analyses suggest that cigarette excise taxes lower prenatal smoking. It is unclear, however, whether the association between taxes and prenatal smoking represents a decline among women of reproductive age or a particular response by pregnant women. We address this question directly with an analysis of quit and relapse behavior during and after pregnancy. We find that the price elasticity of prenatal quitting and postpartum relapse is close to one in absolute value. We conclude that direct financial incentives to stop smoking during and after pregnancy should be considered.
© 2003 Elsevier B.V. All rights reserved.

JEL classification: I18; H23

Keywords: Smoking; Taxes; Pregnancy; Quit rates

1. Introduction

Prenatal smoking is the most important modifiable risk factor for poor pregnancy outcomes in the United States (US Department of Health and Human Services, 1990). Approximately 20% of all low birthweight births are attributable to smoking, and the risk of sudden infant death syndrome (SIDS) is three times greater for women who smoke (Institute of Medicine, 1985; DiFranza and Lew, 1995). Nor is the impact of maternal smoking limited to the perinatal period. The American Academy of Pediatrics considers environmental tobacco smoke (ETS) a major risk factor for lower respiratory illness, middle ear effusion and asthma in children (American Academy of Pediatrics, 1997).

* Corresponding author. Tel.: +212-817-7960; fax: +212-817-1597.
E-mail address: ted_joyce@baruch.cuny.edu (T. Joyce).

0167-6296/$ – see front matter © 2003 Elsevier B.V. All rights reserved.
doi:10.1016/j.jhealeco.2003.06.003

Maternal smoking has also become an important element of the debate over the optimal level of cigarette excise taxes. Unlike the public health community, economists tend to include only the external costs of smoking—costs imposed on others—in the calculation of optimal tax levels (Manning et al., 1991; Viscusi, 1995). Economists assume that parents account for or internalize the possible damage of cigarettes to the fetus or infant when deciding to smoke.[1] The assumption has strong implications. Evans et al. (1999), for instance, find that if considered external, the costs of maternal smoking adds between 42 and 72 cents per pack to the costs of smoking in 1994 dollars. Since state and federal excise taxes averaged 75 cents in 2000 (Orzechowski and Walker, 2001), the consequences of maternal smoking alone, if treated as external, would justify the present level of taxation.

Recent work by economists suggests that increases in the excise tax for cigarettes may be an effective means of lowering the prevalence of smoking among pregnant women. In two papers (Evans and Ringel, 1999; Ringel and Evans, 2001), authors use national natality files and report participation elasticities of -0.5 and -0.7, which exceed the consensus estimate of aggregate elasticities of -0.3 to -0.5 (Chaloupka and Warner, 2000). Another study that also uses national natality files reports a participation elasticity of -0.35 (Gruber and Köszegi, 2001) The obvious advantage of national natality data is the size of the sample and its national coverage.

However, these studies are limited to an analysis of smoking at a single, but unspecified, point during pregnancy. Consequently, it is unclear whether the prevalence of smoking during pregnancy associated with state excise taxes reflects the response to taxes by women of reproductive age, or a particular response by pregnant women (Ebrahim et al., 2000). The distinction has important implications for policy. If taxes have no effect on quit rates during pregnancy, but do lower the prevalence of smoking among women of reproductive age, then efforts to reduce smoking during pregnancy might best be directed at smoking initiation among adolescent girls. Pregnancy, on the other hand, may provide important motivation for women to quit permanently. As a result, policies directed specifically at pregnant women may be more welfare enhancing than excise taxes directed at all smokers.

In this paper, we analyze the effect of cigarette excise taxes on smoking before, during and after pregnancy. With information on the prevalence of smoking at multiple points in time, we extend the literature on maternal smoking and taxes with an analysis of prenatal quit and postpartum relapse rates. We present a simple model that links quit rates to changes in smoking participation before and during pregnancy. The model provides guidance as to the presence of potential selection effects in conditional analyses based on samples of pregnant smokers. Moreover, our focus on quit probabilities provides comparisons of the effectiveness of taxes as a smoking cessation intervention to clinical trials of prenatal smoking cessation programs based on education and counseling. If taxes are associated with increased quit rates during pregnancy, then taxes may provide an important complement to other smoking cessation interventions as well as a source of funding.

Data are from the Pregnancy Risk Assessment Monitoring System (PRAMS): a random, stratified monthly survey of recent mothers overseen by the Centers for Disease Control and Prevention (CDC). We combine data from 10 states over 7 years (1993–1999) and construct a sample of 115,000 women. Although the number of states is limited, the detailed

[1] The obvious exception would be the medical and remedial costs of maternal smoking borne by taxpayers.

information on smoking and a richer set of covariates makes PRAMS a significant source with which to analyze the effect of cigarette taxes on maternal smoking.

2. Background

The US Surgeon General's 675-page report, *Women and Smoking*, details the distinctive hazards faced by women who smoke. "Although women and men who smoke share excess risks for diseases such as cancer, heart disease, and emphysema, women also experience unique smoking-related disease risks related to pregnancy, oral contraceptive use, menstrual function and cervical cancer" (US Department of Health and Human Resources, 2001, p. 5). Despite the additional risks faced by women, there is only a modest literature on differences in the price sensitivity of cigarettes by gender. Farrelly and Bray (1998) use available panels from the National Health Interview Survey of individuals 18 years and older between 1976 and 1993 and obtain an overall elasticity of −0.26 for men and −0.19 for women. Participation elasticities are less: −0.18 and −0.09 for men and women, respectively. Lewit and Coate (1982) find participation elasticities between −0.13 and −0.39 for women 20–35 years of age, neither of which is statistically significant. The comparable elasticities for men range from −0.29 to −1.28. Chaloupka and Pacula (1998) report smoking participation elasticities of −0.59 for women and −0.93 for men. All three studies use cross-state variation in prices to estimate elasticities. Thus they assume that the unmeasured factors that influence smoking in West Virginia are the same as in Maine. This leaves the studies vulnerable to significant omitted variable bias. Nevertheless, a consistent finding is that women are less sensitive to taxes than are men.

Studies of the effect of cigarettes taxes on prenatal smoking are quite recent. Evans and Ringel (1999) are the first to exploit the smoking indicator that was added to national natality files in 1989. With over 10 million births they estimate participation elasticities and conditional demand elasticities for women who gave birth between 1989 and 1992. They include a full set of state-and-month fixed effects, and thus rely on within-state-and-month variation to identify effects of taxation. They find that a 10% increase in cigarette excise taxes lowers smoking participation by 5%, but has no effect on the number of cigarettes smoked. Their estimates are unaffected by adjustments for border crossing or clean indoor air laws. In a more recent version with this design, Ringel and Evans (2001) add three more years of natality data in order to explore the heterogeneity of responsiveness to taxes by pregnant women. In this analysis they report a participation elasticity of −0.7, which the authors note is several times greater than the participation elasticity for the general population. Moreover, the absolute value of the elasticity increases with socio-economic status. Women who are married, older, and more educated have elasticities that generally exceed 1. As before, taxes have no effect on the number of cigarettes smoked during pregnancy.

Evans and Ringel's elasticities have important policy implications. If pregnant women are more sensitive to changes in prices than non-pregnant women, then other financial incentives in addition to taxes could achieve significant declines. For instance, health insurance premiums could be raised for women who continue to smoke during pregnancy or bonuses awarded for women who quit.

However, other evidence suggests that Evans and Ringel's estimates are optimistic. Real cigarette prices have risen 60% since 1997. Given an elasticity of −0.7, we could expect a 42% drop in maternal smoking. In fact, the proportion of women who smoke during pregnancy has fallen from 13.2% in 1997 to 12.2% in 2000, a 7.6% decline. Clearly, other factors besides price affect prenatal smoking. Gruber and Köszegi (2001) also use natality data and obtain an overall elasticity of −0.35, which implies an even lower participation elasticity. Beside the extra year of data, Gruber and Köszegi aggregate births into monthly cells, which may explain differences with Ringel and Evans (2001).

The other surprising result obtained by Ringel and Evans (2001) is the positive relationship between the absolute value of the elasticities and socio-economic status. For instance, the elasticity of participation is −3.39 for college-educated pregnant women and −0.49 for women with a high school degree. Part of the discrepancy is attributable to the low prevalence of smoking among college-educated women and its effect on the elasticity computation. However, even the marginal effects of taxes on smoking (in absolute value) are greater for the highly educated. This finding is counter to the result that low-income smokers are more sensitive to the price of cigarettes than higher income smokers (Farrelly and Bray, 1998; Evans et al., 1999).

The study by Gruber and Köszegi (2001) merits note because the authors find that pregnant women are forward looking in their smoking behavior. Excise taxes that have been enacted, but not yet, in effect reduce smoking among pregnant women. The elasticity of cigarette consumption with respect to prices is −0.15.

Another recent study uses longitudinal data from the National Maternal and Infant Health Survey to examine the relationship between cigarette prices and maternal smoking (Bradford, 2002). Women who gave birth in 1988 are surveyed again in 1991. Since some women have had an additional child or have become pregnant at the time of the 1991 interview, the author is able to analyze the effect of pregnancy on smoking and the interaction of pregnancy and prices. He finds that the price elasticity of smoking is almost identical for both pregnant and recently pregnant women at about −0.30. The most significant limitation to this analysis is the lack of controls for national trends. Real cigarette prices rose between 1987 and 1991, while smoking prevalence declined. In an earlier draft, the author acknowledged that dummy variables for time wipe out the effect of price. With approximately 6000 women at four points in time in the sample, there may be insufficient within-state variation in prices to identify price effects.

In summary, the literature on the effect of cigarette taxes on smoking by women of reproductive age is remarkably sparse. There is consistent evidence that pregnant and non-pregnant women are sensitive to cigarette prices and taxes. Nevertheless, several important questions remain. First, do pregnant and non-pregnant women respond differently to taxes? The relatively large elasticities obtained by Evans and Ringel imply an interaction between pregnancy and taxes in a model of smoking participation. Ebrahim et al. (2000) question such interactions. They show that the ratio of smoking prevalence between pregnant and non-pregnant women is stable between 1987 and 1996, which they interpret as a decline in ever-smoking among women of reproductive age. We can address this question more directly by analyzing the association between taxes and quit rates during pregnancy. If the elasticity of smoking participation before and during pregnancy is the same, then taxes will have no effect on quit rates.

We can also follow up on Gruber and Köszegi (2001) and offer some insight as to forward-looking behavior among women who are about to become pregnant. PRAMS has information on whether the pregnancy is intended or unintended. We also know whether women who were ever smokers have stopped smoking 3 months before pregnancy. Many women consider the risk to the fetus as the most important reason to quit. In addition, smoking lowers the probability of conception. Thus, we expect that women who are trying to become pregnant are more likely to stop smoking in anticipation of these costs than women whose pregnancies are unintended.

Finally, we can test whether taxes are associated with post-partum relapse rates. Approximately 40% of women quit smoking upon the realization that they are pregnant (Fingerhut et al., 1990). Such behavior underscores the importance of fetal damage as a "cost" of smoking. The fact that approximately 70% of women who quit smoking during pregnancy relapse within 1 year of delivery suggests that these costs are viewed as largely temporary, or at least greater than the costs of second-hand smoke on the newborn. Consequently, taxes as a proportion of the total costs of smoking are probably greater in the post-partum than the prenatal period and may have a greater impact on smoking. The analysis of taxes and post-partum relapse rates represents a novel contribution of this analysis.

3. Analytical framework

3.1. Relation between smoking before and during pregnancy

The quit probability can be viewed as a conditional participation equation, with implications for the elasticity of smoking participation before and during pregnancy. To illustrate, let Π be the probability that a woman continued to smoke in the pregnancy period, given that she smoked before pregnancy, and note that Π is equal to $1 - Q$, where Q is the quit rate. A small number (105 out of 115,000) of our sample smoked during but not before pregnancy, and a small number (649) smoked after but not before or during pregnancy, but we ignore them in what follows. As an identity,

$$\Pi = \frac{S_{\mathrm{d}}}{S_{\mathrm{b}}}, \tag{1}$$

where S_{d} is the probability of smoking during pregnancy or the smoking participation rate during this period at the aggregate level and S_{b} is the smoking participation rate in the period prior to pregnancy.[2] We assume that a woman smokes if her reservation price—the most

[2] Let N_{b} be the number of smokers before pregnancy and let N_{d} be the number of smokers during pregnancy. Assume nobody starts smoking or resumes smoking after getting pregnant. Then $N_{\mathrm{d}} = N_{\mathrm{b}} - Q$, where Q is the number of women who quit. Let N be the total number of women. Then

$$\frac{N_{\mathrm{d}}}{N} = \frac{N_{\mathrm{b}}}{N} - \frac{Q}{N_{\mathrm{b}}}\frac{N_{\mathrm{b}}}{N}$$

Rewrite this as $S_{\mathrm{d}} = S_{\mathrm{b}}(1 - Q)$ or $S_{\mathrm{d}} = S_{\mathrm{b}}\Pi$.

she will pay for a cigarette—is greater than the "full price" of smoking, the latter being defined as follows:

$$F_{\mathrm{p}}(\mathrm{p}=\mathrm{b},\mathrm{d}) = T_{\mathrm{p}} + M_{\mathrm{p}}, \tag{2}$$

where M_{p} is the monetary value of the utility or health cost of smoking in period "p," and "p" could be "before," "during," or "after" pregnancy.

As explained more fully below, we assume that the relevant tax for both smoking before pregnancy and during pregnancy is the one prevailing 3 months prior to pregnancy so that the money price is the same in each period. Since the continuation probability (Π), is the ratio of two participation probabilities [see Eq. (1)], the elasticity of Π with respect to the common money price prevailing in both periods equals the difference between the elasticity of smoking participation during pregnancy with respect to the price minus the elasticity of smoking participation prior to pregnancy with respect to the price:

$$\rho = \eta_{\mathrm{d}} - \eta_{\mathrm{b}} \tag{3}$$

According to Eq. (3), the elasticity of the probability of continuing to smoke during pregnancy with respect to money price (ρ) is negative if the elasticity of smoking participation during pregnancy with respect to money price (η_{d}) is larger in absolute value than the elasticity of smoking participation with respect to money price before becoming pregnant (η_{b}).[3] The reverse holds if η_{b} is larger than η_{d}. A zero elasticity for the probability of smoking continuation implies that taxes have no differential effect on pregnant women. This would support the contention that the decline in smoking participation during pregnancy reflects the general decline among women of reproductive age (Ebrahim et al., 2000).

Let ε_{p} be the elasticity of smoking participation with respect to the full price and let K_{p} be the share of the money price in the full price. Then

$$\rho = K_{\mathrm{d}}\varepsilon_{\mathrm{d}} - K_{\mathrm{b}}\varepsilon_{\mathrm{b}}. \tag{3}$$

Clearly K_{d} is smaller than K_{b} since the health cost of smoking is greater in the period during pregnancy than in the period before it. Hence, if the full price elasticity is the same in each period, one obtains the somewhat counterintuitive result that an increase in the money price of cigarettes raises the probability of continuing to smoke during the pregnancy period or lowers the probability of quitting. The full price elasticity is unlikely, however, to be constant because this implies that the probability of smoking is specified as a log-linear function. This specification does not take into account the distribution of

[3] The money price elasticity of smoking participation in period i is defined to be negative:

$$\eta_i = \frac{\partial \ln S_i}{\partial \ln T}.$$

Note that the elasticity of Q with respect to T (φ) is given by

$$\varphi = -\rho\frac{\Pi}{1-\Pi} = (\eta_{\mathrm{b}} - \eta_{\mathrm{d}})\left(\frac{\Pi}{1-\Pi}\right).$$

reservation prices and does not constrain the participation probability to fall between zero and one.

3.2. Potential selection effects

A final consideration is that reservation prices before and during pregnancy are not observed and must be replaced by their determinants. One of these determinants is the unobserved propensity or taste for smoking. Denote this propensity by V_Q and define it such that an increase in V_Q causes an increase in the quit probability. Note that this disturbance term surely is negatively correlated with the disturbance term in the equation for smoking participation before pregnancy (V_{S*}), where S^* is a latent variable governing the propensity to smoke before pregnancy, and an increase in V_{S*} causes S^* to rise. In a sample of women who smoked prior to pregnancy, a woman from a high price state is likely to have a high value of V_{S*}. Hence T_b and V_{S*} are positively correlated in the quit sample (and T_b and V_Q are negatively correlated) even if they are uncorrelated in the population at large.

The positive association between T_b and V_{S*} will bias downward the effect of taxes on quit rates. However, we can obtain insight as to the importance of such selection effects by comparing estimates of the price elasticity of quitting during pregnancy estimated directly to the same elasticity obtained from the participation equations. Specifically, we will estimate smoking participation equations before and during pregnancy as a function of T_b. Provided taxes are exogenous, we can back out an unbiased estimate of the quit elasticity (see footnote 3). We can compare this estimate to the one obtained directly by regressing the probability of quitting during pregnancy on T_b. If the estimate from the direct estimation is substantially less than the estimate obtained from the unconditional participation equations, then we would have evidence of selection effects.[4]

To summarize, we have outlined a framework in which the conditional probability of quitting during pregnancy may be positively related to cigarette taxes. If true, then we should find that the elasticity of smoking participation during pregnancy exceeds in absolute value the elasticity of smoking participation before pregnancy. This would be consistent with recent work based on natality data in which the elasticity of smoking participation during pregnancy appears substantially greater than the elasticity of participation among women of reproductive age (Evans and Ringel, 1999; Ringel and Evans, 2001). Two caveats exist. First, changes in the non-monetary price of smoking associated with childbearing can yield negative quit elasticities (Eq. (3)). Second, a larger proportion of women who smoke just prior to pregnancy in high-tax states are likely to have a stronger preference for smoking than their counterparts in low-tax states. As a result, the elasticity of quitting with respect to the monetary price may be biased downwards in a sample of pregnant smokers.

[4] One way to account for the bias just outlined is to fit a bivariate probit model with sample selection (Wynand and van Praag, 1981; Greene, 2000). We experimented with such models but identification proved difficult. We used taxes at age 14 to predict smoking participation just prior to pregnancy. However, taxes at 14 had limited explanatory power. One reason is that we did not know the mother's state of residence at birth or, more importantly, at age 14. This form of measurement error would tend to bias out estimates downwards.

4. Empirical implementation

4.1. Data

The Pregnancy Risk Assessment Monitoring System (PRAMS) is a random, stratified monthly survey of recent mothers selected from birth certificates. PRAMS was initiated by the Centers for Disease Control in 1987 as a response to the slowdown in the rate of decline in infant mortality and the absence of any decline in the rate of low birthweight births. PRAMS surveys are carried out by participating states following explicit guidelines developed by the CDC. Each month the PRAMS staff in each state selects between 100 and 250 recent mothers from birth certificates by stratified systematic sampling with a random start. Stratification variables, such as birthweight and race or ethnicity, vary among states. All states over-sample women at increased risk for adverse pregnancy outcomes. Sampled mothers are then sent a self-administered questionnaire 2–6 months after delivery; non-respondents are followed up by telephone. Response rates average between 70 and 80% after follow up. (See http://www.cdc.gov/nccdphp/drh/methodology.htm for more details.)

Twenty-five states participated in PRAMS in 2000, up from five states in 1988. We use surveys from 10 states that participated for at least 5 of the 6 years between 1993 and 1999: Alabama, Alaska, Florida, Georgia (1993–1997), Maine, New York State (excluding New York City), Oklahoma, South Carolina, Washington, and West Virginia. There are 115,000 observations, a total that, when weighted, represents approximately 4,605,470 births, or 17% of deliveries in the US over the same period.

The questionnaire in PRAMS asks women if they ever smoked at least 100 cigarettes in their entire life. Those that answer yes are asked to record the number of cigarettes or packs of 20 cigarettes they smoked per day, on average, in the 3 months before they were pregnant. They may also respond by indicating that they smoked less than one cigarette per day, that they did not smoke at all, or that they do not know. The same set of questions are asked about the period 3 months before delivery and at the time of the survey, which occurs between 2 and 6 months after delivery.

We are primarily interested in the change in smoking behavior.[5] We create four dichotomous indicators of change. The first is one if the woman ever smoked but did not smoke 3 months before pregnancy (Quit–ever–before). The second is one if the woman smoked 3 months before pregnancy but not 3 months before delivery (Quit–before–during). The third indicator is one if the woman stopped during pregnancy, but resumed between 2 and 6 months postpartum (Resume). And the final indicator is one if the woman smoked before but not postpartum (Quit–before–after). We refer to these women as “long-term” quitters. The importance of long-term quits is that women who stop smoking during pregnancy, but resume postpartum, are still at double the risk for SIDS (Schoendorf and Kiley, 1992).

We do not analyze smoking intensity with PRAMS, but we do control for pre-pregnancy cigarette consumption in the Quit–before–during, Resume, and Quit–before–after equations. Consumption before pregnancy is a measure of the stock of smoking capital (Becker et al., 1994). The clinical literature indicates that the lightest smokers prior to pregnancy are the most likely to quit during and least likely to resume (Li et al., 1993; Quinn et al.,

[5] We analyze smoking participation 3 months before delivery in order to compare PRAMS to published works.

1991; Fingerhut et al., 1990). We create a trichotomous indicator of pre-pregnancy consumption: less than 10 cigarettes per day, between 10 and 20 cigarettes per day and more than 20 per day. We eliminated women who did not know how much they smoked before pregnancy ($n = 4325$), during pregnancy ($n = 2808$) and after delivery ($n = 2381$).

PRAMS also contains covariates in addition to those on birth certificates. These include health insurance status at delivery, family income, and pregnancy intention. We use pregnancy intention to test for forward-looking behavior. Women are asked at the time that they first realized that they were pregnant whether they wanted to become pregnant then, or at some other time (mistimed) or not at all (unwanted). We characterize pregnancies that are mistimed or unwanted as unintended. Smoking imposes two potential costs on women who want to have children. First, smoking inhibits conception. Second, and more well known, is the risk of adverse birth outcomes (US Department of Health and Human Services, 2001). Thus, women who are trying to become pregnant may be more likely to quit in the 3 months before pregnancy due to these anticipated costs, than women whose pregnancies are unintended.

4.2. Reported smoking

A limitation of self-reported smoking is the potential for underreporting. Clinical studies of prenatal smoking that use biological markers to estimate exposure find that as little as 10% and as much as 30% of prenatal smoking is not reported by the women. Birth certificates capture less smoking than hospital medical charts (Piper et al., 1993; Buescher et al., 1993) and the prevalence of smoking as reported in PRAMS exceeds that reported on birth certificates. The latter is likely an underestimate of the true difference between birth certificates and PRAMS since birth certificates ask about smoking at any time during pregnancy and PRAMS specifically asks about smoking in the 3 months before delivery. If smoking were equally well reported on PRAMS and birth certificates, the percentage of women reporting smoking anytime during pregnancy should exceed the percentage reporting smoking during the last trimester, since the latter group is a subset of the former. For example, in the National Household Survey on Drug Abuse, 20% of women reported smoking at any time during pregnancy, but only 16% reported smoking during the last trimester.

Fig. 1 compares smoking during pregnancy from three sources: the Behavioral Risk Factor Surveillance System (BRFSS), PRAMS and birth certificates.[6] Women in the BRFSS are asked about smoking and later asked whether they are pregnant at this time. If we accept that there are few false positives, then PRAMS is superior to birth certificates and the BRFSS as a screen for smoking. Smoking in the last 3 months of pregnancy is between 1 and 2 percentage points higher than what is recorded for smoking during pregnancy on birth certificates. Also noteworthy is that the prevalence of smoking based on birth certificates is similar in 9 of the 10 PRAMS states to all available states.[7]

[6] The BRFSS is a monthly telephone survey of adult health practices and behaviors by the Centers for Disease Control and Prevention and State health departments. Initiated in the early 1980s, the BRFSS interviews approximately 125 adults per month in each state (Remington et al., 1988). Fifty states now participate. We use data from 1987 to 2000. There are 33 states in 1987, a number which rises to 50 by 1993. We limit the sample to women 18–44 years of age.

[7] New York, one of the 10 PRAMS states, did not report smoking on the birth certificate.

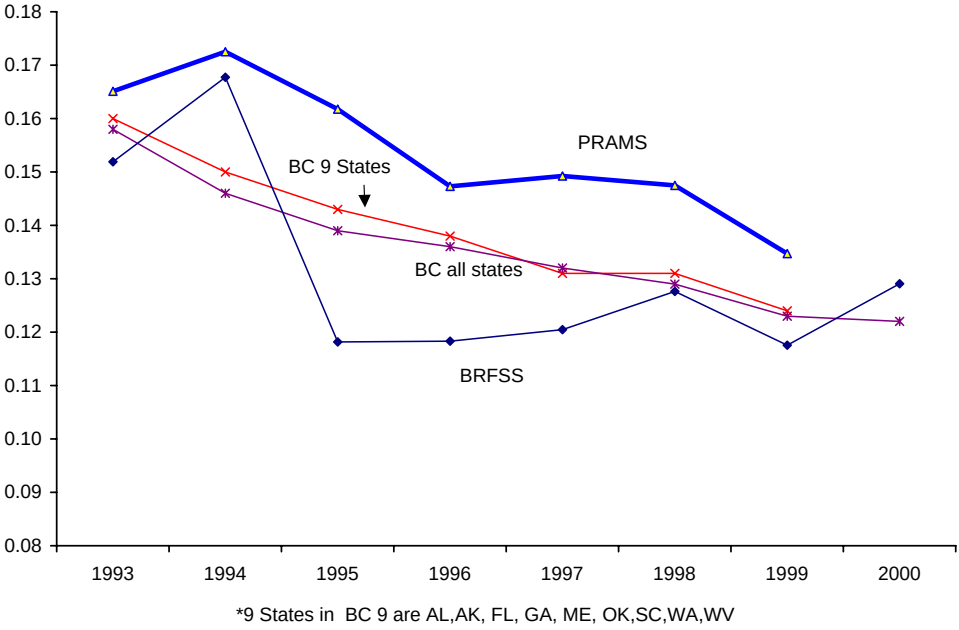

Fig. 1. Proportion that smoke during pregnancy, BRFSS, PRAMS and birth certificates (BC).

4.3. Econometric model

We use probits to estimate smoking participation and quit models. The basic specification is as follows:

$$\text{Prob}(S_{ijt} = 1) = \Phi\left(\sum_k \sigma_k X_{kijt} + \phi T + \tau_j + \tau_t + e_{ijt}\right),$$

where S_{ijt} is one if woman i, in state j, and year t smokes. Let X_{kijt} be maternal characteristics, T is the level of state and federal taxes in 1982–1984 dollars, t_j and t_t are state and year fixed effects respectively, and e_{ijt} is the residual. All analyses are weighted with the survey weights and we use robust procedures for the standard errors that cluster on state and year.

5. Results

5.1. Smoking participation

We first use PRAMS to analyze the effect of state cigarette excise taxes on smoking participation before, during and after pregnancy. Results are shown in Table 1. We use the tax 3 months before pregnancy for smoking before and smoking during pregnancy and the tax at the postpartum interview. Estimates should be interpreted as the marginal

Table 1
Smoking participation before, during, and after pregnancy in PRAMS, 1993–1999

	PRAMS		
	Smoked 3 months before conception (1)	Smoked 3 months before delivery (2)	Smoked at interview date (3)
Real tax 3 months before conception	−0.00063 (1.28)	−0.00108* (3.08)	
Real tax at interview date			−0.00111* (2.32)
Observations	96895	98153	95886
Elasticity	−0.30	−0.91	−0.36
Mean of the dependent variable	0.26	0.15	0.22

The participation models were estimated as probits. Values are marginal effects with robust *z*-statistics in parentheses. All models include indicator variables for family income (5), health insurance (4), maternal education (5), age (2), race (2), marital status (1), parity (1), pregnancy intention (1) as well as state and year fixed effects. All models but column 6 also include indicator variables (5) for income. The 10 PRAMS states are AL, AK, FL, GA (1993–1997), ME, NY, OK, SC, WA, and WV. All models are weighted by survey weights, and standard errors have been adjusted for clustering by state and year. The sample based on birth certificates does not include NY.

* Significant at 5%.

change in probability of each outcome given a one cent change in the real tax. We also present price elasticities for each outcome under the assumption that a one cent increase in taxes causes a commensurate increase in price, for the reasons given in Evans et al., 1999.

Taxes are negatively related to smoking before, during and after pregnancy. Two of the three estimates are statistically significant. ($P < 0.05$). Implied price elasticities range from −0.30 to −0.91.[8] The largest elasticity pertains to taxes 3 months before pregnancy on smoking participation 3 months before delivery. In results not shown, we also regressed smoking 3 months before delivery on taxes 3 months before delivery and found no effect. This is not surprising given that the vast majority of women quit early in pregnancy (Fingerhut et al., 1990). Women who smoke in the last trimester are likely to have the strongest preference for smoking and are thus the least sensitive to changes in monetary prices.

5.2. Quit and relapse behavior

As we argued above, pregnancy causes a large decrease in the reservation price of smoking due to the risks it poses for the fetus. Thus, even if taxes and prices remained unchanged, we expect between 30 and 40% of women who smoke prior to pregnancy to quit during pregnancy (Fingerhut et al., 1990). The question we address in this section is whether states with high taxes have higher quit rates and lower relapse rates than states with lower taxes.

Table 2 shows the means for the covariates that we use in the quit regressions stratified by year and tax-increasing states. A salient feature is that the intensity of smoking prior to pregnancy in the two groups of states is similar in 1993. Approximately 20% of pregnant

[8] We assume that a one cent increase in taxes increase price by the same amount. See Evans et al. (1999).

Table 2
Mean characteristics of women who smoked 3 months before pregnancy by year (1993 and 1999) and tax-increasing versus non-tax-increasing state

	Tax-increasing states: AK, ME, NY, WA		Non-tax-increasing states: AL, FL, GA, OK, SC, WV	
Variable	1993 ($N = 1576$)	1999 ($N = 1557$)	1993 ($N = 3047$)	1999 ($N = 2418$)
Quit during pregnancy	0.344	0.473	0.388	0.458
Family income (×1000 1982–1984 US$)				
<10	0.374	0.381	0.460	0.334
11–20	0.240	0.225	0.171	0.295
20–30	0.287	0.331	0.131	0.082
31–40	0.008	0.006	0.039	0.051
41–50	0.000	0.000	0.001	0.002
>50	0.000	0.000	0.002	0.002
Unknown	0.090	0.057	0.196	0.233
Mother's education				
0–8 years	0.042	0.028	0.044	0.029
9–11 years	0.162	0.193	0.269	0.248
12 years	0.465	0.420	0.415	0.392
13–15 years	0.219	0.214	0.183	0.231
≥16 years	0.074	0.090	0.079	0.089
Unknown	0.038	0.055	0.010	0.012
Mother's age				
<20	0.117	0.178	0.156	0.192
20–29	0.669	0.511	0.577	0.585
≥30	0.213	0.312	0.267	0.223
Insurance coverage				
Medicaid	0.502	0.438	0.569	0.539
Other public	0.046	0.016	0.021	0.020
Private	0.372	0.467	0.316	0.380
Uninsured	0.077	0.076	0.081	0.054
Insurance unknown	0.003	0.004	0.013	0.008
First birth (*yes* = 1)	0.435	0.456	0.430	0.436
Maternal race				
White	0.887	0.874	0.873	0.869
Black	0.071	0.061	0.111	0.094
Other	0.042	0.064	0.016	0.037
Married (*yes* = 1)	0.493	0.500	0.622	0.569
Pregnancy unintended (*yes* = 1)	0.501	0.512	0.501	0.516
Pre-pregnancy smoking				
<11	0.207	0.282	0.195	0.250
11–20	0.632	0.626	0.635	0.621
>20	0.161	0.092	0.170	0.129
Real tax (1982–1984 US$)	40.375	55.452	29.135	28.532

smokers in tax-increasing and non-tax-increasing states smoked less than 11 cigarettes (light smokers) and 16% smoked more than a pack per day (heavy smokers) in 1993. [9] By 1999 there are more light smokers and fewer heavy smokers in the tax-increasing states relative to the non-tax-increasing states. There is also a noticeable shift in the age distribution of pre-pregnancy smokers. The proportion of teens among pre-pregnant smokers increases from 12 to 18% between 1993 and 1999 in the tax-increasing states and from 16 to 19% in the non-tax-increasing states. The shift in age may explain in part the relative increase in light smoking. We turn, therefore, to the multivariate estimates in order to adjust for the changing characteristics of pre-pregnant smokers in the quit models.

We display results from the probit regressions of our four quit probabilities in Table 3. We associate taxes at the beginning of each quit period with quitting behavior. Thus, we use taxes at age 14 in the equation of ever smokers who no longer smoke 3 months prior to conception (Quit–ever–before); similarly, we use taxes 3 months before conception in the quit equations during pregnancy (Quit–before–during) and long-term quits (Quit–before–after) and taxes at the postpartum interview in the relapse models. Taxes at age 14 are strongly and positively correlated with quitting prior to pregnancy. The elasticity is 0.66 (column 1). Taxes before pregnancy significantly increase the likelihood that a woman will quit before delivery (column 2). The implied price elasticity is 1.04. Taxes are also associated with a lower probability that a woman will resume smoking between 2 and 6 months postpartum (column 3). The last estimate associates taxes with what we call "long-term" quits: women who smoked before pregnancy but not after. Long-term quits include women who smoked during pregnancy and stopped postpartum, although this represents only 10% of "long-term" quitters.

The responsiveness of prenatal smokers to taxes is large enough to account for a substantial portion of the rise in quit rates in recent years. From 1993 to 1999 among PRAMS states, the quit rate during pregnancy rose from 37.3 to 46.4% and the weighted average tax rose from US$ 0.33 to 0.40. The coefficient on tax in column 2 implies that quit rates would have risen by approximately 2.5 percentage points due to taxes alone, or over a quarter of the actual change.[10] We obtain a similar result based on the change in prices. For instance, prices rose from US$ 1.33 to 1.41 (6.1%) in real 1982–1984 dollars from 1993 to 1999 in our PRAMS states. Given a price elasticity of 1.04, we would expect the quit rate to rise to 39.6%, which again is approximately a quarter of the observed change in quits.[11]

As we argued above, the quit elasticity obtained from the sample of pre-conception smokers may be biased downwards since women in high-tax states who smoke may have a greater taste for smoking. To obtain insight as to the possible selection effects, we use estimates from the participation equations in Table 1 to back out the implied quit elasticity.[12]

[9] Federal tax increases bracket our study period. The federal excise tax increased from 20 to 24 cents in January 1993 and from 24 to 32 cents in January 2000.

[10] $2.5 = 0.0035(\text{US\$ } 0.40 - \text{US\$ } 0.33)$.

[11] The price changes might appear modest. However, we use the price three months before pregnancy. Thus, many of the pregnancies in our 1999 sample were unaffected by the large price increases that followed the tobacco settlement in November of 1998. In fact, if we use the price three months before delivery, the change in 1982–1984 dollars between 1993 and 1999 in our 10 PRAMS states is from US$ 1.23 to 1.71 or 39%.

[12] Using the formula in footnote 8 and estimates from Table 1, the implied quit elasticity equals $[-0.30 - (-0.91)](0.58/0.42) = 0.84$.

Table 3
Changes in quit probabilities before, during and after pregnancy, 10 PRAMS states, 1993–1999

	Quit–ever–before (1)	Quit–before–during (2)	Resume (3)	Quit–before–after (4)
Taxes at various points in time				
Real tax at age 14	0.0016 (2.42)**			
Real tax 3 months pre-conception		0.0035 (3.13)**		0.0026 (2.96)**
Real tax at interview date			−0.0038** (2.78)	
Selected covariates				
Unintended pregnancy	−0.065 (4.92)**	0.006 (0.34)	−0.009 (0.44)	0.005 (0.39)
First birth	−0.071 (7.13)**	0.144 (9.12)**	−0.106 (6.45)**	0.101 (8.47)**
10–20 cigarettes per day pre-pregnancy		−0.347 (21.65)**	0.099 (4.13)**	−0.201 (10.60)**
21 + cigarettes per day pre-pregnancy		−0.384 (22.39)**	−0.003 (0.09)	−0.165 (17.84)**
Elasticity	0.66	1.04	−1.00	1.46
Mean of dependant variable	0.30	0.42	0.51	0.23
Observations	38099	27514	10927	27550

All models were estimated as probits. Figures are $\mathrm{d}(\text{Prob Quit} = 1)/\mathrm{d}\,\text{tax}_i$. *t*-ratios are in parentheses. Models include indicator variables for family income (5), health insurance (4), education (5), age (2), race (2), marital status (1), plus state and year fixed effects. Resume models also include the time in days between delivery and the post-partum interview. All models are weighted by survey weights and standard errors have been adjusted for clustering by state and year.

From this exercise we obtain a quit elasticity of 0.84, which is less than the estimated elasticity, but reasonably close.

We also display the marginal effects of selected covariates in Table 3. As noted above, women who intend to become pregnant are much more likely to quit smoking prior to pregnancy than women whose pregnancies are unintended. We interpret this finding as support for the importance of future "prices" on current behavior. Another possible interpretation is that women who plan their pregnancies are simply more competent in general than women who do not plan. But if this were true, we should find that women who intended their pregnancies also quit at a higher rate once they become pregnant and resume smoking after pregnancy less often than women who did not intend their pregnancies. Yet, as shown in columns 2 through 4 of Table 3, the difference in the post-pregnancy behavior between the two groups is practically and statistically zero. Nonetheless, the similarity of the two groups after pregnancy does not imply that they are similar before pregnancy, and we lack the instruments to conduct a formal test of heterogeneity.

Another notable finding is the robust impact of first births on quit behavior. Although women delivering their first child are 7 percentage points less likely to quit prior to pregnancy, once pregnant their smoking behavior changes much more than that of women of higher-order births. Specifically, women having a first birth are 14 percentage points more likely to quit during pregnancy, 10 percentage points less likely to resume after delivery, and 10 percentage points more likely to quit long-term relative to women who deliver a higher-order birth. As a percentage of the mean of each quit behavior, these effects are very large. One speculation is that women use previous birthing experience to adjust the expected costs of smoking. Even for women who smoke, the probability of a low birthweight birth is only about 0.12, or double of those that do not. Thus, the high probability of a good birth outcome despite smoking may lead women to discount the risk of prenatal smoking. One way to test this would be to include a measure of previous adverse birth outcomes.

Table 4
Cigarette taxes 3 months before delivery and probability of quitting smoking during pregnancy: sensitivity to specification and sample of PRAMS states

	Marginal effect	*t*-ratio	Price elasticity
1. Full sample (from Table 3)	0.0035	3.13	1.04
2. Only state and year fixed effects	0.0028	2.64	0.84
3. Full sample less Alaska	0.0042	2.94	1.26
4. Full sample less Maine	0.0037	3.04	1.10
5. Full sample less New York	0.0032	3.05	0.90
6. Full sample less Washington	0.0039	2.30	1.14
7. Only Alaska and non-tax-changing states	0.0020	2.92	0.55
8. Only Maine and non-tax-changing states	0.0023	0.94	0.63
9. Only New York and non-tax-changing states	0.0110	4.48	3.44
10. Only Washington and non-tax-changing states	0.0041	2.74	1.17
11. Only AK, ME, NY, and WA	0.0019	1.70	0.67

All models were estimated as probits. Marginal effects are the $\mathrm{d}(\mathrm{Quit} = 1)/\mathrm{d}\,\mathrm{tax}_i$. Except for row 2, all models include indicator variables for parity (1), pregnancy intentions (1), and pre-pregnancy smoking (2), family income (5), health insurance (4), education (5), age (2), race (2), marital status (1), plus state and year fixed effects. All models are weighted by survey weights, and standard errors have been adjusted for clustering by state and year.

Table 5
Cigarette taxes and probability of quitting smoking during pregnancy: by parity, maternal school and pre-pregnancy smoking, 10 PRAMS states 1993–1999

	Parity		Maternal schooling		Pre-pregnancy smoking	
	First birth	Second- and higher-order birth	High school education or less	More than high school	Less than 10 cigarettes per day	10 or more cigarettes per day
	1	2	3	4	5	6
Real tax 3 months before conception	0.0043 (3.29)**	0.0028 (2.24)*	0.0038 (3.28)**	0.0021 (0.94)	0.0028 (2.24)	0.0032 (2.49)**
Elasticity	1.03	1.02	1.29	0.49	0.50	1.22
Mean of dependent variable	0.53	0.35	0.38	0.54	0.72	0.34
Observations	12465	15049	19813	7198	6385	21129

All models were estimated as probits. Figures are $\mathrm{d}Q/\mathrm{d}X_i$. *t*-ratios are in parentheses. Models include indicator variables for family income (5), health insurance (4), education (5), age (2), race (2), marital status (1), parity (1), pregnancy intentions (1), pregnancy smoking (2), and state and year fixed effects. All models are weighted by survey weights, and standard errors have been adjusted for clustering by state and year.

We lacked such data in PRAMS. However, in a study of consecutive births in Georgia, researchers found that women who smoked during their first pregnancy were less likely to smoke in the second, if the first infant had died. Interestingly, an underweight first birth had no effect on smoking during the second pregnancy (Dietz et al., 1997).

The other noteworthy result pertains to prior smoking behavior among those who quit. As shown in Table 4, light smokers, those who smoke less than half a pack a day, are much more likely to quit than heavier smokers. In our sample, for instance, 71% of light smokers, 36% of moderate smokers and 22% of heavy smokers quit during pregnancy.

5.3. Sensitivity analysis

One concern is that our results are sensitive to the inclusion or exclusion of a particular state, since we have only four states in which tax changes were enacted (Alaska, Maine, New York, and Washington). In Table 4 we present additional estimates of the marginal effect of taxes on the probability of quitting during pregnancy. We focus on quits from before to during pregnancy given the health consequences of quitting and the robustness of our initial findings. Each row is from a separate regression in which we have altered the specification or the sample. Row 1 repeats the estimate from Table 3 for convenience. The specification in row 2 includes no covariates other than state and year fixed effects. In rows 3 through 6 we drop one of the tax-increasing states and in rows 7 through 10 we include only one of the tax-increasing states. Except for when we include New York (row 9), marginal effects range from .0020 to .0042 and are statistically significant in seven of the eight cases. In the last row we include only the tax-increasing states. In this specification we rely on the variation in the timing of the tax increases to provide the relevant "comparison" state. The marginal effect falls by almost half when we include only the four tax-increasing states. Nevertheless, changes in taxes still explain almost a quarter of the increase in quits over the study period.[13]

The next set of analyses explores the heterogeneity of taxes on quit probabilities by parity, maternal schooling and pre-pregnancy smoking. We consider only binary stratification because of sample size limitations. Estimates are shown in Table 5. Although none of the differences in marginal effects within each category is statistically significant, we find that the marginal effects of taxes on quit probabilities are greater among women with first births, less education and more pre-conception smoking.

6. Conclusion

In this paper we examine whether increasing cigarette taxes is an effective way to reduce smoking among pregnant women. One justification for raising taxes would be that they influence pregnant women more, and thus change behavior most where the externalities are

[13] The weighted average of real state taxes rose by 15.5 cents between 1993 and 1999 in Alaska, Maine, New York, and Washington. The percent of women who quit smoking during pregnancy increased by 13.0 percentage points, from 34.3 in 1993 to 47.3 in 1999. Thus, .0019(15.5 = 0.029), which is 22% of the change. We obtain a similar result if we use the quit elasticity of 0.67 and a real price change of 14%.

greatest. We find strong support for the use of taxes in our quit equations. We estimate that a 10% increase in cigarette taxes would increase the probability of a woman quitting by 10%, a result that holds up in separate regressions stratified by education, parity, and pre-pregnancy smoking and with various combinations of states. Since higher costs of smoking appear to be quite effective in inducing women to quit smoking during pregnancy, direct financial incentives to stop smoking during and after pregnancy should be considered.

One concern is that quit and relapse elasticities based on a sample of pregnant women who smoke are biased since smokers in high-tax states would have a stronger preference for cigarettes than women in low-tax states. Using the relationship between quit and participation elasticities, we show that the elasticity of quitting during pregnancy estimated directly is close to the quit elasticity that we obtain with the difference in participation elasticities before and during pregnancy. We interpret this result as some evidence that the conditional estimates based on a sample of smokers are not obviously contaminated by pre-pregnancy attrition in high-tax states.

Maine, Washington, and New York have increased cigarette excise taxes by a simple average of 30.5 cents in constant dollars since 1999. On the basis of our estimates, quit rates should increase 5.8 percentage points in these states.[14] If realized, these changes compare favorably to the change in quit rates achieved by prenatal smoking cessation programs. A meta-analysis of prenatal smoking interventions found that quit probabilities were approximately 6.6 percentage points greater for those in treatment relative to control groups (Dolan-Mullen et al., 1994). The recent tax increases in New York and Washington are large and probably unrepresentative of future tax increases in most other states. Nevertheless, they underscore the potential of increasing the monetary costs of smoking during pregnancy to affect quit rates.

Taxes appear to be nearly as effective in reducing relapse rates as in encouraging quitting. We find that a 10% rise in taxes reduces the likelihood of resuming smoking by 10%. However, despite the increased taxes of recent years, half of all quitters resume smoking within 6 months of delivery and 75% resume within a year, suggesting that their reservation prices tend to return to pre-pregnancy levels. One interpretation is that new mothers do not perceive postpartum smoking to be as harmful as prenatal smoking despite recent research on the relationship between smoking and SIDS, asthma and lower respiratory infections. This suggests that doctors and public agencies need to better advertise the dangers of postpartum smoking.

Acknowledgements

This research was supported by a grant from the National Institute for Child Health and Human Development (NICHD) to Baruch College, the City University of New York (1 R01 HD40218-01). Greg Colman also acknowledges dissertation support from The Commonwealth Fund (Grant No. 20000463). We thank Robert Kaestner, Kevin M. Murphy, and participants from the NBER Summer Institute for comments and the PRAMS Working Group and the Centers for Disease Control and Prevention (CDC) and in particular, Mary Rogers, Christopher Johnson, and Nedra Whitehead for access to and technical support

[14] Use the marginal effect for the tax-increasing states, 0.0019 from Table 4, and multiply by 30.5.

regarding the PRAMS survey. The views expressed in the manuscript are the authors' and not those of NICHD, the Commonwealth Fund, the PRAMS Working Group, the CDC, or Baruch College.

References

American Academy of Pediatrics, Committee on Environmental Health, 1997. Environmental tobacco smoke: a hazard to children. Pediatrics 99, 639–642.

Becker, G.S., Grossman, M., Murphy, K.M., 1994. An Emperical Analysis of Cigarette Addiction. American Economic Review 84, 396–418.

Bradford, W.D., 2002. Pregnancy and the Demand for Cigarettes. Manuscript, University of South Carolina.

Buescher, P.A., Taylor, K.P., Davis, M.H., Bowling, J.M., 1993. The quality of the new birth certificate data: a validation study in North Carolina. Am. J. Public Health 83, 1163–1165.

Chaloupka, F.J., Pacula, R.L., 1998. An Examination of Gender and Race Differences in Youth Smoking Responsiveness to Price and Tobacco Control Policies. National Bureau of Economic Research Working Paper no. 6541.

Chaloupka, F.J., Warner, K.E., 2000. The economics of smoking. In: Newhouse, J.P., Culyer, A. (Eds.), The Handbook of Health Economics. Elsevier Science, Amsterdam, pp. 1539–1627.

Dietz, P.M., Adama, M.M., Rochat, R.W., Mathis, M.P., 1997. Prenatal smoking in two consecutive pregnancies: Georgia 1989–1992. Maternal Child Health J. 1 (1), 43–51.

DiFranza, J.R., Lew, R.A., 1995. The effect of maternal cigarette smoking on pregnancy: complications and sudden infant death syndrome. J. Fam. Pract. 40, 385–394.

Dolan-Mullen, P., Ramirez, G., Groff, J.Y., 1994. A meta-analysis of randomized trials of prenatal smoking cessation interventions. Am. J. Obstet. Gynecol. 171 (5), 1328–1334.

Ebrahim, S.H., Floyd, R.L., Merritt, R.K., Decoufle, P., Holtzman, D., 2000. Trends in pregnancy-related smoking rates in the United States, 1987–1996. JAMA 283, 361–366.

Evans, W.N., Ringel, J.S., Stech, D., 1999. Tobacco taxes and public policy to discourage smoking. In: Poterba, J.M. (Ed.), Tax Policy and the Economy, vol. 13. MIT Press, Cambridge, MA, pp. 1–55.

Evans, W.N., Ringel, J.S., 1999. Can higher cigarette taxes improve birth outcomes? J. Public Econ. 72, 135–154.

Farrelly, M.C., Bray, J.W., 1998. Response to increases in cigarette prices by race/ethnicity, income, and age groups—United States, 1976–1993. Morb. Mortal. Wkly Rep. 47 (29), 605–609.

Fingerhut, L.A., Kleinman, J.C., Kendrick, J.S., 1990. Smoking before, during, and after pregnancy. Am. J. Public Health 80, 541–544.

Greene, W.H., 2000. Econometric Analysis, fourth ed. Prentice Hall, Upper Saddle River, NJ.

Gruber, J., Köszegi, B., 2001. Is addiction 'rational'? theory and evidence. Q. J. Econ. 116 (4), 1261–1305.

Institute of Medicine, 1985. Preventing Low Birthweight. Washington, DC: National Academy Press.

Lewit, E.M., Coate, D., 1982. The potential for using excise taxes to reduce smoking. J. Health Econ. 1, 121–145.

Li, C.Q., Windsor, R.A., Perkins, L., Goldenberg, R.L., Lowe, J.B., 1993. The impact on infant birth weight and gestational age of cotinine-validated smoking reduction during pregnancy. JAMA 269, 1519–1524.

Manning, W.G. et al. 1991. The Costs of Poor Health Habits. Cambridge, MA: Harvard University Press.

Orzechowski and Walker, 2001. The Tax Burden on Tobacco. Orzechowski and Walker.

Piper, J.M., Mitchel Jr., E.F., Snowden, M., Hall, C., Adams, M., Taylor, P., 1993. Validation of 1989 Tennessee birth certificates using maternal and newborn hospital records. Am. J. Epidemiol. 137, 158–168.

Quinn, V.P., Mullen, P.D., Ershoff, D.H., 1991. Women who stop smoking spontaneously prior to prenatal care and predictors of relapse before delivery. Addict. Behav. 16, 29–40.

Remington, P.L., Smith, M.Y., Williamson, D.F., Anda, R.F., Gentry, E.M., Hogelin, G.C., 1988. Design, characteristics, and usefulness of state-based behavioral risk factor surveillance: 1981–1987. Public Health Rep. 103, 366–375.

Ringel, J., Evans, W.N., 2001. Cigarette taxes and smoking during pregnancy. Am. J. Public Health 91, 1851–1856.

Schoendorf, K.C., Kiley, J.L., 1992. Relationship of sudden infant death syndrome to maternal smoking during and after pregnancy. Pediatrics 90, 905–908.

US Department of Health and Human Services, 1990. The Health Benefits of Smoking Cessation: A Report of the Surgeon General. US Department of Health and Human Services, Public Health Service, Rockville, MD.

US Department of Health and Human Services, 2001. Women and Smoking: A Report of the Surgeon General. Office of the Surgeon General, US Department of Health and Human Services, Public Health Service, Rockville, MD.

Viscusi, W.K., 1995. Cigarette taxation and the social consequences of smoking. Tax Policy Econ. 9, 51–101.

Wynand, P., van Praag, B., 1981. The demand for deductibles in private health insurance: a probit model with sample selection. J. Economet. 17, 229–252.