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CIGARETTE TAXES AND MATERNAL SMOKING

By

GREGORY J. COLMAN

A dissertation submitted to the Graduate Faculty in Economics in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

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Abstract

CIGARETTE TAXES AND MATERNAL SMOKING

By

Gregory J. Colman

Adviser: Professor Ted Joyce

Cigarette smoking by the mother during pregnancy risks the health of the mother and the infant. This study examines whether cigarette taxes are an appropriate way to reduce maternal smoking. Taxes would be appropriate if pregnant women, whose smoking is more costly to society than smoking by non-pregnant women, are more sensitive to changes in cigarette taxes than non-pregnant women. Using the Pregnancy Risk Assessment Monitoring Survey (PRAMS) from the CDC, we find that pregnant women are, if anything, less sensitive to changes in cigarette taxes than non-pregnant women. We also find that increases in cigarette taxes raise the likelihood than a woman will quit smoking when she becomes pregnant, and reduce the likelihood that she will resume smoking afterward.

Acknowledgements

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Introduction

Our knowledge of the dangers of maternal smoking has come a long way since the first Surgeon General's Report in 1964 tentatively suggested a connection between smoking and low birth weight[1]. The enormous literature on the subject has been summarized in the recent Surgeon General's Report on Women and Smoking[2]: prenatal smoking reduces birth weight by an average of 250 grams, and doubles the risk of low birth weight (defined as birth weight under 2500 grams), which is the strongest predictor of infant mortality. It increases the risk of ectopic pregnancy, the leading cause of maternal mortality, as well as of abruptio placentae, preeclampsia, neonatal mortality, stillbirth, and Sudden Infant Death Syndrome (SIDS), the leading cause of death among infants in the first year of life[3]. Despite these dangers, 12.6% of all pregnant women report smoking at some time during their pregnancy[4], and the prevalence of smoking among teenage mothers is rising[5].

If the mother and her family bore all the costs of her smoking, it might be argued that the government could ignore these costs. But the extra medical costs due to maternal smoking have been estimated to be from $10 to $17 billion in 1994 alone[6].

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[1] U.S. Department of Health, Education, and Welfare (1964), *Smoking and Health*, Report of the Advisory Committee to the Surgeon General of the Public Health Service, PHS Publication No. 1103 (U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control), p. 39.

[2] U.S. Department of Health and Human Services (2001), *Women and Smoking: A Report of the Surgeon General*, Rockville (MD): U.S. Department of Health and Human Services, Public Health Service, Office of the Surgeon General.

[3] Ibid. p. 306.

[4] Ventura, S.J., J.S. Martin, S.C. Curtin, F. Menacker, and B.E. Hamilton (2001), *Births: Final Data For 1999*. National vital statistics reports; 48(14), Hyattsville, Maryland: National Center for Health Statistics.

[5] Mathews, T.J. (2001), 'Smoking During Pregnancy in the 1990s', *National Vital Statistics Reports*, Hyattsville, Maryland: National Center for Health Statistics, 49(7), p.1.

[6] Evans, W. N., J.S. Ringel, and D. Stech (1999). 'Tobacco Taxes and Public Policy to Discourage Smoking'. In J. M. Poterba (ed.) *Tax Policy and the Economy*. Cambridge, MA: MIT Press 13: p. 48.

Recently, some economists have looked at increasing cigarette taxes as a viable way of reducing maternal smoking. One problem is that the government has no way of imposing the tax increases just on pregnant women; it must impose them on everyone. Taxes would be a suitable instrument if the smokers who cause the greatest externalities—pregnant women—respond most to the rise in taxes. But do they? No study has been able to answer this question. Ringel and Evans (2000)[7] estimate the price responsiveness of pregnant women using data from birth certificates. Naturally, birth certificates contain no data on the non-pregnant population. But based on the consensus estimates in the literature on cigarette demand, they conclude that the participation elasticity of pregnant women is three to four times greater than that of the general adult population. In contrast, Gruber and Köszegi (1999), who also use birth certificate data, judge the elasticity of demand among pregnant smokers to be lower than that of the general population. They note, "[The lower elasticity] is consistent with the notion that women who are still smoking at the time they are giving birth may be less sensitive to economic factors such as prices."[8] The divergence of views continues because no study so far has been able to compare directly the price responsiveness of pregnant with non-pregnant women.

A further uncertainty is why cigarette taxes would be expected to reduce maternal smoking. Do they work by reducing the number of people who smoke in general, and therefore the number of pregnant women who smoke? Or do taxes affect the likelihood that a woman will quit smoking when she becomes pregnant, and, if

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[7] Ringel, J.S. and W.N. Evans (2000), 'Cigarette Taxes and Smoking During Pregnancy', Working Paper.

[8] Gruber, J, and B. Koszegi (1999), 'Rational and Irrational Addiction: Theory and Evidence', Working Paper, p.8.

she has quit, the likelihood she will resume smoking after delivery? Previous studies have not examined these questions because they lacked the necessary data. The few available population-based surveys of quitting during pregnancy and resuming afterwards, such as the National Health Interview Survey and the National Household Survey on Drug Abuse, contain data on fewer than 5,000 pregnant women, far too few to isolate the effects of cigarette prices and taxes.

We are able to address these questions by using a new data set, the Pregnancy Risk Assessment Monitoring Survey (PRAMS), produced by the CDC in cooperation with the states. PRAMS is a survey of recent mothers whose names are obtained from a sample of recent birth certificates. It includes information on the smoking of pregnant women at three periods prior to the birth: three months before pregnancy, three months before delivery, and at the time of the survey, which is from two to six months after delivery. It thus allows us directly to compare the price responsiveness of a group of women when they are pregnant and when they are not, which is before and after their pregnancies. The information on smoking in the three periods also tells us which women quit smoking upon becoming pregnant, and which resumed afterward, enabling us to analyze the effect of price on these transitions.

This study is organized as follows. First, we review the previous literature on the correlates of maternal smoking. Second, we outline our theoretical model. Third, we describe our estimation strategy. Four, we present our results. Finally, summarize our conclusions.

Literature Review

Characteristics of women

The few studies that have measured maternal smoking at several periods during previous decades indicate that it has declined since the 1960s. Kleinman and Kopstein (1987)[9] use the 1967 and 1980 National Natality Surveys, which are follow-back surveys of recent mothers chosen randomly from birth certificates. The study is limited to married women since only they were asked about smoking in both surveys. The authors found that among women under 20 years old, about 45% of white women and 30% of black women smoked before pregnancy in 1967 and 1980[10]. But among women over 20, the prevalence declined from 45% to 30% among white women, and from 40% to 26% among black women over the period. Particularly striking is the change over time according to educational categories. The drop in smoking before pregnancy rose monotonically with years of schooling. For example, it declined from 54% to 47% among women with less than a high school degree, but from 38% to 15% among women with a college degree or more. Since few women start to smoke when they become pregnant, the patterns and trends are similar in smoking during pregnancy. Using the data on smoking before and during pregnancy, the authors calculate quit rates. In 1967 from 10% to 12% of all education categories reported quitting when they became pregnant. By 1980, the percentage who quit among women with less than a high school degree had not changed, but among college educated women, the percentage had risen to 27 %. The authors point out that these

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[9] Kleinman, J.C., and A. Kopstein (1987) 'Smoking During Pregnancy, 1967-80', *American Journal of Public Health*, 77 (7): p. 823.
[10] Ibid. p. 824.

numbers probably differ from those of the general population of pregnant women, since married women smoke less than non-married women.

Using the 1988 and 1982 Surveys of Family Growth (NSFG), Chandra (1995) reports similar trends, though the prevalences are higher because the NSFG includes all women of reproductive age[11]. The Surveys asked women whether they smoked during their most recent pregnancy. There may be some recall bias since women in 1982 were asked about their smoking behavior as far back as the 1960s or earlier. Still, the trends are similar to the contemporaneous data reported above. Among women whose last birth was in the 1960s or earlier, 35% smoked. The share dropped to 32% in the 1970s, to 26% for births between 1981 and 1984, and to 23% for births between 1985 and 1988. The drop increased with education. Among women with less than a high school degree, 46% reported smoking during their pregnancies in the 1960s; by 1985-88, this share had dropped to 38 %. Among women with more than a high school degree, however, the share dropped from 27% to 14%. The study also finds that in 1985-1988, prenatal smoking is more common among non-Hispanic white women (27%) than among non-Hispanic black (20%) or Hispanic women (13%), that it is higher among women who did not want the birth (33%) than among women who did (19%), among never-married (32%) than ever-married women (22%), and among women whose family income was 149% or less of the poverty limit (32%) than those whose family income was 300% or more of the poverty limit (17%).

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[11] Chandra A (1995), *Health aspects of pregnancy and childbirth: United States, 1982–1988*. Vital and Health Statistics. Series 23, No. 18. Hyattsville (MD): U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Health Statistics. DHHS Publication No. (PHS), p. 6.

A number of studies have used various supplements on smoking and pregnancy from the National Health Interview Survey, produced by the National Center for Health Statistics. The first is Fingerhut et al. (1990)[12]. The study is based on the 1986 National Health Interview Survey of about 2000 women 18 to 44 years old who were pregnant or had had a child in the five years prior to the survey. Since the sample included few black women and because the smoking behavior of teenagers differs significantly from that of older women, the authors limited their analysis to white women between 20 and 44 years old. They find that smoking before pregnancy is more common among younger and unmarried women, and declines monotonically as education increases. About 40 % of women quit smoking when they learn they are pregnant, with the percentages being about the same across age and marital status. Education, however, is a strong predictor of quitting. About 28 % of women with less than a high school degree quit, whereas over 60 % of college-educated women do[13]. Also, more than twice the percentage of lighter smokers (less than one pack per day) quit than did heavier smokers. Although the odds ratios for relapse rates by characteristic of mother are not significantly different from unity, perhaps because of the small sample size (191), relapse was more common among younger, married, more educated, heavier pre-pregnancy smokers, and women who quit late in pregnancy. Overall, 70 % of the women who quit during pregnancy resumed within one year.

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[12] Fingerhut, L.A., J.C. Kleinman, and J.S. Kendrick (1990), 'Smoking Before, During, and After Pregnancy', *American Journal of Public Health*, 80:541-544.
[13] Ibid. p. 542.

LeClere et al. (1997)[14] analyzes data from the Health Promotion and Disease Prevention supplement to the 1990 National Health Interview Survey. The supplement contains a series of questions on smoking and pregnancy. Of women who had had a birth in the past five years, the supplement asks if she ever smoked, used to smoke, smoked during the year prior to her last pregnancy, and smoked during her most recent pregnancy. The results mainly confirm previous findings. Overall, about 25% of women reported smoking before their most recent pregnancy, and 15% said they smoked during their pregnancy. The likelihood of having smoked before becoming pregnant declines with age, income, and education, is greater among white than among black mothers, among non-Hispanic than Hispanic, and among unmarried than married women. The same patterns prevail when the women were asked about smoking during their most recent pregnancy. Comparing the prevalence of smoking before and during shows that 37% of smokers quit when they become pregnant. Also, as with prevalence, quitting rises with age, education, and income, and is more common among black than among white mothers.

Ko and Schulken (1998)[15] used the Pregnancy and Smoking supplement to the 1991 NHIS to analyze quitting and relapse rates, and report grimmer results than previous studies. Similar to previous studies, about 38% of the sample said they quit during pregnancy. But 17% relapsed during pregnancy, leaving 21% who remained

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[14] LeClere, F.B., and J.B. Wilson (1997), 'Smoking Behavior of Recent Mothers, 18-44 Years of Age, Before and After Pregnancy: United States, 1990', Hyattsville, Md: National Center for Health Statistics, *Advance Data From Vital and Health Statistics*, No. 288.

[15] Ko M., and E.D. Schulken (1998), 'Factors Related to Smoking Cessation and Relapse Among Pregnant Smokers', *American Journal of Health Behavior*, 22(2):83-89.

abstinent throughout pregnancy. After pregnancy, a further 20% relapsed, leaving only 1% who quit during pregnancy and had not relapsed by the time of the survey[16].

Most studies of the smoking patterns of pregnant women use data from controlled experiments of methods to induce pregnant smokers to quit and to prevent relapse after pregnancy. The disadvantage of these is that they may not represent the whole pregnant population of the U.S. The advantage is that they often use biological markers for smoking rather than relying on self-report, and they ask their participants important questions omitted from the national surveys. A few of the important clinical studies are summarized next.

Quinn, Dolan Mullen, and Ershoff (1991)[17] use data from four smoking cessation intervention trials conducted from 1985 to 1987 in California to study the differences between women who quit on their own when they become pregnant ("spontaneous quitters") and those who do not ("intake smokers"). Forty-one percent of the sample were spontaneous quitters, and most of these quit all at once rather than gradually cut down. Compared with intake smokers, quitters were younger, had fewer children, consumed fewer cigarettes before pregnancy, and were much more likely to believe that smoking harms the fetus (59.3% vs. 33.5%). The authors note that some of the intake smokers told them that several of their relatives had smoked throughout their pregnancies and delivered healthy babies. Using multiple logistic analysis, the authors found that, controlling for demographic factors, the strongest predictors of smoking during pregnancy were a high pre-pregnancy smoking rate, the presence of another smoker in the household, and a weak belief in the harmful effects of maternal

[16] Ibid. p. 85.

smoking. Education was not significantly correlated with quitting. The study also compared women who were able to abstain from smoking throughout their pregnancy with those who relapsed before delivery, which was about 20% of the sample. In the bivariate comparison, women who relapsed tended to have more education, experienced nausea less often during pregnancy, had "slipped" once or more prior to relapsing, and were less likely to believe in the harmful effects of maternal smoking.

O'Campo et al. (1992)[18] analyze the maternal smoking of 847 mothers who were participating in the Johns Hopkins University Infant Feeding Study in Baltimore, MD in 1985 and 1986. Prevalence was higher among black women than among white women, declined with education and age, and especially among women who intended to breastfeed their infants (19% vs. 41%). Among both black and white women, 41% quit when they became pregnant or just before, of whom 10% quit while planning to become pregnant. Also, the rate of quitting rose with education and was almost double (62% vs. 38%) among women who intended to breastfeed. The women were also asked why they quit. Seventy-five % said they quit to protect the health of the child, 8% credited advice from family or physician, and 6% mentioned illness or nausea from smoking. Multiple logistic regression mostly confirmed the bivariate results. Quitting was more likely among educated, primiparous, married women, and those intending to breastfeed. Of those that quit, about 40% relapsed by the twelfth week postpartum. Multiple logistic regression

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[17] Quinn, V.P., P.D. Mullen, and D.H. Ershoff (1991), 'Women Who Stop Smoking Spontaneously Prior to Prenatal Care and Predictors of Relapse Before Delivery', *Addictive Behaviors*, 16: 29-40.
[18] O'Campo, P., H. Brown, R.R. Faden, and A.C. Gielen (1992), 'The Impact of Pregnancy on Women's Prenatal and Postpartum Smoking Behavior', *American Journal of Preventive Medicine*, 8:8-13.

indicated that neither age, education, parity, nor ethnicity predicted relapse; only the use of formula rather than breastfeeding significantly predicted relapse.

Severson et al. (1995)[19] surveyed 13,495 mothers in 49 pediatric practices in Oregon. Compared with non-smokers, pre-pregnancy smokers tended to be younger, less educated, and to consume more alcohol. Thirty-five % of the 2901 mothers who reported smoking before pregnancy said they quit during pregnancy and were still abstinent during their first well-baby visit, when the survey was conducted. One hundred eighty-four mothers said they quit but had relapsed. Quitters tended to be lighter smokers, better educated, and especially, less likely to have a partner who smoked. Stepwise logistic regression found that controlling for education and age, quitting was less likely among women who smoked heavily before pregnancy, who were older, and who had a husband who smoked. Considering relapse rates, neither schooling nor age was a significant predictor, but having a husband who smoked and having consumed alcohol in the previous week remained significant.

Carmichael et al. (2000)[20] studies the correlates of postpartum relapse using data from ten states that participated in PRAMS. Using multiple logistic analysis, they find that relapse is more likely among women who are black, have one previous live birth, gained more than 35 pounds during pregnancy, began prenatal care late (third trimester or never), and were under unusual stress during the period, such as from divorce or loss of employment.

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[19] Severson, H.H., J.A. Andrews, E. Lichtenstein, M. Wall, and L. Zoref (1995). 'Predictors of Smoking During and After Pregnancy: A Survey of Mothers of Newborns', *Preventive Medicine* 24:23-28.

[20] Carmichael, S.L, I.B. Ahluwalia, and the PRAMS Working Group (2000), 'Correlates of Postpartum Smoking Relapse', *American Journal of Preventive Medicine*, 19(3):193-196.

Thus the literature suggests that from 20% to 25% of women smoke before pregnancy. Pre-pregnancy smoking is more likely among white, young, uneducated, and unmarried women, and those who intend to use formula rather than to breastfeed, and who have a partner who smokes. From 35% to 40% of pre-pregnancy smokers quit during their pregnancy. Of these, somewhat less than half relapse before delivery. Quitting rises with age and education, and is more common among women who smoked less before pregnancy, who intended to breastfeed, who strongly believed that smoking harms the fetus, and who did not have a partner who smoked. Of women who quit during pregnancy, from 70% to 99% relapse within a year of giving birth. Significant correlates of relapsing varied more from study to study than did those of quitting because of the often small sample sizes and the widely differing populations from which the samples were drawn. A few predictors stand out, however. Relapsing after pregnancy is more common among women whose partner smoked, who used formula rather than breastfeeding and experienced little nausea during pregnancy. The role of education is unclear. Some studies have found that relapse rates rose with education, and some that relapse fell or was uncorrelated with education.

Sensitivity to taxes

There is a large literature on the price sensitivity of smoking, summarized in Chaloupka and Warner (2000)[21]. They find that estimates of the total elasticity of demand range from –0.14 to –1.23, but are concentrated between –0.3 and –0.5, and that estimated elasticities of participation tend to exceed those of average daily

cigarettes smoked among smokers. Most studies also find that among adults, price responsiveness declines with age, education, and income, and is greater among men than among women, and among non-whites than among whites.

There have been fewer studies of the price responsiveness specifically among pregnant women. Among the earliest is Rosenzweig and Schultz (1983)[22], which used cigarette taxes as an instrument in a TSLS estimate of the effect of cigarette consumption on the birth weight of the child. Using a sample of about 10,000 women from the 1967, 1968, and 1969 National Natality Followback Surveys, they find a negative but not statistically significant effect (p-value=0.155) of cigarette taxes on the number of cigarettes smoked per day. A major weakness of this study is its use of variation among states to identify the effect of taxes on smoking. Taxes do vary substantially among states, and generally variation in the independent variable is desirable. But a state may have higher tax rates because its inhabitants disapprove of smoking as well as of other unhealthy behavior. Unless the equation that attempts to explain smoking includes a reasonable proxy for a state's attitude towards unhealthy behavior, the resulting estimate of the effect of taxes will be biased towards a larger negative number, which may explain why Rosenzweig and Schultz find such an unusually large negative effect. In addition, their estimate refers to women in the late 1960s, which is probably not much help in predicting the response of women to taxes in the 2000s.

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[21] Chaloupka, F.J. and K.E. Warner (2000), 'The Economics of Smoking', in Joseph P. Newhouse and Anthony Culyer (eds.), *The Handbook of Health Economics*, Amsterdam: Elsevier Science, pp. 1546-56.

[22] Rosenzweig, M. R. and T. P. Schultz (1983), 'Estimating a Household Production Function: Heterogeneity, the Demand for Health Inputs, and Their Effects on Birth Weight', *Journal of Political Economy*, 91(5): 723-746.

Evans and Ringel (1999)[23] pursue the same question as Rosenzweig and Schultz—the effect of smoking on birth weight—but use a much larger data set, the Natality Detail File from the National Center for Health Statistics, a data set of about 4 million observations per year derived from the information on birth certificates. Instead of using one cross section, Evans and Ringel use data on many states over a number of years, from 1989 to 1992, and include state effects. Using about 10 million observations, Evans and Ringel find an elasticity of participation of about –0.5, when using a probit specification, and –0.2 in a linear probability model. They also find that taxes have no significant effect on cigarettes smoked.

Lien and Evans (2000)[24] compare smoking in states that had recently enacted large increases in cigarette taxes with states that had not, using difference-in-difference analysis. This analysis requires that trends in smoking before the tax increases be similar in treatment and control states, so that any difference in smoking after the tax increases reflect only the tax and not differential trends. Thus they needed states whose trends they could measure for some period–they chose two years–both before and after the tax hikes, and whose tax changes were large. Four states met this requirement: Arizona, Illinois, Michigan, and Massachusetts. Data on the smoking behavior and other characteristics of pregnant women and their infants come from the 1990 to 1997 Natality Detail Files. The authors estimated a participation elasticity of –0.45, with a standard error of 0.04. They then used this estimate to find the impact of lower maternal smoking on the average birth weight of

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[23] Evans, W. N. and J. S. Ringel (1999), 'Can Higher Cigarette Taxes Improve Birth Outcomes?', *Journal of Public Economics*, 72: 135-154.
[24] Lien, D.S. and W.E. Evans (2000), 'The Impact of Large Cigarette Tax Hikes on Maternal Smoking,' working paper.

the infant, concluding that maternal smoking reduced infant birth weight by 531 grams, with a standard error of 106 grams, a result similar to Evans and Ringel (1999), which estimated that smoking reduced birth weight by about 400 grams.

Ringel and Evans (2000)[25] use the largest data set of any study on smoking to examine the price responsiveness of pregnant women by various characteristics. Such estimates are important for evaluating whether cigarette taxes are an appropriate tool for deterring maternal smoking. As the authors note, "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." Pooling 20 million observations from the Natality Detail Files from 1989 to 1995, they estimate a probit model of smoking participation on approximately 150 covariates, including state, year, and month dummies, as well as indicators of maternal education, age, ethnicity, parity, adequacy of prenatal care, sex of child, and marital status.

Their results contradict almost all the accepted patterns in price responsiveness by personal characteristics. Previous studies, including some by one of the authors, have found that whites are the least price sensitive, followed by blacks, and then Hispanics. Ringel and Evans find the reverse order of responsiveness. Further, they find that price responsiveness rises, rather than falls, with both age and education. They do not really offer an explanation, though they note that those who are most likely to quit smoking during pregnancy are also the most price sensitive. They also estimate a model of the number of cigarettes smoked by those who continue to smoke during pregnancy, and find, as in their 1999 study, that price has no effect. One

might wonder if the results are so different from studies of the non-pregnant population because so many covariates are included. But the authors find that dropping all the covariates except taxes does not much change the results: the price elasticity for the whole sample, for instance, is –0.7 with all covariates and –0.62 with only state and time dummies. The authors cannot directly compare pregnant with non-pregnant women, but they note that their estimate of the participation elasticity among pregnant women is three to four times that of the general population, as indicated in the various surveys of the issue, such as Lewis and Coate (1982)[26] and Chaloupka and Warner (2000)[27]. But it is unclear whether one should compare a point estimate from a single study one pregnant women with the census estimate of the general population from other studies. The authors' own previous studies show a range of responsiveness among pregnant women, from –0.2 to –0.45 to the current estimate, and these are all from the same basic data set, the National Natality Files.

The National Natality Files are also used by Gruber and Köszegi[28] in their test of forward looking behavior by cigarette smokers. As explained in more detail below, the Becker and Murphy model implies that expected future prices of addictive goods such as cigarettes should affect the amount a person smokes currently. The problem in testing this model is that there is no data on the prices smokers expect. Gruber and Koszegi get around this by using state tax changes that have been passed by the state legislature but not yet put into effect. Since cigarette prices move roughly in line with cigarette taxes, consumers can be assumed to expect a price increase of about the

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[25] Op. Cit.
[26] Lewit, E. M., and D. Coate (1982), 'The Potential for Using Excise Taxes to Reduce Smoking', *Journal of Health Economics*, 1: 121-45.
[27] Op. Cit. pp. 1546-56.

same size as the future tax increase. Gruber and Köszegi first calculate the average cigarette consumption of pregnant women by state and month from Natality data, and then regress consumption in a given month and state on the current tax in that state and month and on announced taxes in the same state that have not yet been implemented. Both coefficients are significant, with implied elasticities of –0.16 for current price and –0.1 for future price. Including only the current tax, the authors calculate elasticity of –0.24 among those who smoke.

Gruber and Zinman (2000)[29] also use Natality data in their study of youth smoking. Among other causes, they examine whether the decline in cigarettes' price in the early 1990s contributed to the rise in smoking among teenagers during the decade, and for this purpose they estimate elaticities of demand among various segments of the teen population. They find an elasticity of participation among all teens of –0.353 and a conditional elasticity of –0.124.

Bradford (2000)[30] analyzes the price responsiveness of pregnant women in order to estimate the consumer surplus women give up when they become pregnant, and would lose if taxes were raised high enough to deter them from smoking at all. He uses the National Maternal and Infant Health Survey (NMIHS) 1988 and the 1991 follow up to the same survey, with about 6200 observations. With so few observations, he must rely on variation among states, rather than within states over time, to identify the effect of prices on demand, a method, as mentioned about, that is vulnerable to bias from omitted state variables. Using a Heckman selection model, he

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[28] Op.Cit. pp.6-7.

[29] Gruber, J., and J. Zinman (2001), 'Youth Smoking in the United States: Evidence and Implications'. In Jon Gruber (ed.), *Risky Behavior Among Youths: An Economic Analysis*. Chicago: The University of Chicago Press, p. 69-120.

finds a conditional elasticity of –0.26, while his first stage regression implies an elasticity of about –0.5.

Table 1 summarizes the studies reviewed. It shows that the elasticity of participation centers around –0.5, which is roughly in line with the consensus estimate of the price elasticity among all adults of –0.3 to –0.5. The Farrelly & Bray[31] estimate is obviously at the low end, not only for women, but also for men, whose price elasticity of participation they estimate to be only –0.18. Since most studies find that women are less price sensitive than men, the table lends some support to Ringel and Evans's (2001) view than pregnancy increases women's price sensitivity. But a problem with simply comparing elasticity estimates is that smoking carries a larger stigma for pregnant than for non-pregnant women, implying that pregnant women have a larger incentive to underreport their smoking. If this underreporting is uncorrelated with price, which seems likely, it will not bias the slope in a regression of participation on price, but it will bias upwards the estimated elasticity.

Restrictions on smoking and buying

Responding to evidence that second-hand smoke threatens the health of non-smokers, as well as to reduce youth smoking, many states have enacted laws and regulations to limit where people can smoke, who can buy cigarettes, and where

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[30] Bradford, W.D. (2000), 'Pregnancy and the Demand for Cigarettes', working paper.
[31] Farrelly, M.C. and J.W. Bray (1998), 'Response to Increases in Cigarette Prices by Race/Ethnicity, Income, and Age Groups - United States, 1976-1993', *Morbidity and Mortality Weekly Report*, 47(29):605-9.

tobacco companies can advertise[32]. The CDC groups the restrictions into four categories: smoke-free indoor air (for example, in private workplaces or restaurants), minors' access to tobacco products (such as vending machines), advertising of tobacco products, and excise taxes. As of 1998, the last year of our study, 46 states restricted smoking in some degree. The exceptions were Alabama, Kentucky, Mississippi, and North Carolina.

Most studies find that smoke-free indoor air restrictions reduce the prevalence of smoking as well as the number of cigarettes smokers consume. This holds true whether the study uses state-level or person-level data, and whether it focuses on adults or teenagers. As discussed below, however, there is some dispute over whether the restrictions themselves reduce smoking or whether they are simply proxies for state sentiment towards smoking.

Among studies that use state-level data are Chaloupka and Saffer (1992)[33] and Yurekli and Zhang (2000)[34]. Chaloupka and Saffer (1992) test the impact of smoking restrictions while taking into account the possibility that states with low cigarette consumption pass the most restrictive smoke-free air laws. The authors group smoking restrictions into public place and private work place restrictions; all states that restrict smoking in the latter also restrict the former. The authors assume that average cigarette consumption in a state depends on the presence of smoking restrictions as well as price, income, and other demographic variables. The presence

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[32] Fishman, J.A., H. Allison, S.B. Knowles, B.A. Fishburn, T.A. Woolery, W.T. Marx, D.M. Shelton, C.G. Husten, and M.P. Eriksen (1999), 'State Laws on Tobacco Control—United States, 1998', *The Morbidity and Mortality Weekly Report*, 48: 21-67.

[33] Chaloupka, F.J. and H. Saffer (1992), 'Clean Indoor Air Laws and the Demand for Cigarettes', *Contemporary Policy Issues*, 10(2):72-83.

[34] Yurekli, A.A. and P. Zhang (2000), (The Impact of Clean Indoor-Air Laws and Cigarette Smuggling on Demand for Cigarettes: An Empirical Model,' *Health Economics*, 9:159-170.

of smoking restrictions, in turn, is assumed to depend on per capita tobacco production, the strength of fundamentalist religion in the state, and the percentage of the population that votes. Following the usual 2SLS procedure, they regress per capita cigarette consumption on the predicted probability of a state having smoking restrictions as well as on price, per capita income, and other demographic variables. They find that restrictions on smoking in public places significantly reduce cigarette consumption, but that further restrictions on smoking in private worksites have no effect. A Wu-Hausman test indicates that smoking restrictions are endogenous.

Yurekli and Zhang (2000) essentially redo Chaloupka and Saffer (1992) using a longer time series of consumption and price data and more refined measures of smoking restrictions. For example, their index of smoking restrictions incorporates the strictness as well as the presence of various smoking bans. Like Chaloupka and Saffer (1992), they find that restrictions reduce state per capita cigarette sales. They estimate that without such restrictions per capita sales would have been about 4.5% higher in 1995.

Among studies that use person-level data are Wasserman et al. (1991)[35], Chaloupka (1992)[36], Chaloupka and Grossman (1996)[37], Taurus and Chaloupka (1999)[38], and Wakefield et al. (2000)[39]. Wasserman et al. (1991) use data from seven

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[35] Wasserman, J., W.G. Manning, J.P. Newhouse, and J.D. Winkler (1991), 'The Effects Of Excise Taxes and Regulations on Cigarette Smoking', *Journal of Health Economics*, 10: 43-64.
[36] Chaloupka, F.J. (1992), 'Clean indoor air laws, addiction, and cigarette smoking', *Applied Economics* 24(2): 193-205.
[37] Chaloupka, F.J. and M. Grossman (1996), 'Price, Tobacco Control Policies and Youth Smoking', National Bureau of Economic Research working paper no. 5740.
[38] Tauras, J.A. and F.J. Chaloupka (1999), 'Clean indoor air, and cigarette smoking: Evidence from the Longitudinal Data For Young Adults', National Bureau of Economic Research working paper no. 6937.

National Health Interview Surveys from 1970 to 1985 to analyze the effect of smoking restrictions on adult smoking, and data from NHANES II to analyze their effect on teenage smoking. They create an index of the severity of smoking restrictions. States that restrict smoking in private work places are assigned a "1"; those that restrict smoking in restaurants but not in private work places are assigned a "0.75"; those that restrict smoking in four or more public places other than those above are assigned a "0.5"; and those that restrict smoking only in one to three public places are assigned a "0.25." The authors estimate a Poisson-type model (not a true Poisson because fractions of cigarette packs are used) and a two-part model, the first of which analyzes the decision to smoke using a probit specification, and the second is an OLS regression of cigarettes smoked among smokers. Among both adults and teenagers, the coefficients on price and on the restriction index are negative and statistically significant, but the implied price elasticity of demand among adults is only –0.23, lower than most other studies. To understand why their results differ, the authors use their NHIS data to duplicate the specification in Lewis and Coate (1982) and obtain very similar price effects. But when they added their smoking restriction index to Lewis and Coate's (1982) specification the coefficient on price dropped substantially, suggesting that earlier studies' results may be biased from omitting measures of smoking restrictions.

As Chaloupka and Grossman (1996)[40] point out, the effectiveness of clean-air regulations in reducing teenage smoking is paradoxical, since the index largely

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[39] Wakefield, M.E., F.J. Chaloupka, N.J. Kaufman, C.T. Orleans, D.C. Barker and E.E. Ruel (2000), 'Effect of Restrictions on Smoking at Home, at School, and in Public Places on Teenage Smoking: Cross Sectional Study', *BMJ*, 321:333-337.
[40] Op. Cit. p. 7.

reflects restrictions in private workplaces, where teenagers spend little time. They suggest that the restrictions instead reflect anti-smoking sentiment in the state. If so, the restrictions per se may have no effect on teen smoking and still show up as significant in cigarette demand regressions.

Chaloupka (1992) examines the effects of clean air laws in the context of Becker and Murphy's rational addiction model, using the Second National Health and Nutrition Examination survey (NHANES2), a national survey of about 28,000 persons of all ages conducted from 1976 to 1980. Following several Surgeon General reports (1986), he groups restrictions by their severity: "nominal", "basic", "moderate", and "extensive." He regresses current cigarette consumption on dichotomous variables for these categories, demographic characteristics, as well as on lags and leads of both consumption and price, instrumenting consumption with price and tax. All the coefficients have their expected signs. In particular, "nominal" restrictions have negative but not statistically significant effects, while the effects of "basic" and "moderate" restrictions are negative and significant.

Taurus and Chaloupka (1999b)[41] apply a person fixed-effect model to longitudinal data from the Monitoring The Future Project, which surveys from 15,000 to 19,000 high school students and then re-interviews them every other year up to seven times. Rather than use dichotomous indicators of the strength of indoor clean air restrictions, as in Chaloupka (1992), which would be highly collinear with state and year indicators, the authors summarize clean air restrictions with an index similar to that of Wasserman et al. (1991). They find that clean air restrictions significantly

[41] Tauras, J.A. and F.J. Chaloupka (1999b), 'Determinants Of Smoking Cessation: An Analysis Of Young Adult Men and Women', National Bureau of Economic Research Working Paper No. 7262.

reduce both the likelihood of smoking and the number of cigarettes consumed by smokers.

Wakefield et al. (2000) conduct their own survey of about 17,000 high school students to learn about smoking restrictions in the home and in school and their effect on teenage smoking. They group students by their degree of cigarette addiction, from "non-susceptible non-smoker," a student who does not smoke and strongly intends not to smoke in the future, up to "established smoker," a student who has smoked at least 100 cigarettes in his or her life. The authors use a king of ordered logit analysis (they call it "thresholds of change analysis") to find the effect of smoking restrictions on the likelihood that a student will move from one stage to the next. The regressors also include data on state and local smoking prohibitions as well as demographic information. They find that both total and partial home bans as well as enforced school bans reduce the chance a student's addiction will progress, while restrictions on smoking in public places and school bans that are announced but unenforced have no effect.

Many states also restrict the sale of cigarettes to persons under a certain age, ranging from 18 to 21. Most studies find such "youth access restrictions" have little or no effect. In their study of the determinants of youth smoking, Chaloupka and Grossman (1996) find that smoke-free air restrictions reduce youth smoking but that youth access restrictions are either insignificant or are significant with the wrong sign. They suggest that their results could reflect weak enforcement of these laws. The authors also include a variable indicating whether the state uses cigarette tax revenues for anti-smoking campaigns. The coefficient on this variable is negative

and significant, and causes the price coefficient to decline in absolute value, suggesting that the two are correlated as well as that anti-smoking campaigns are effective. In contrast to Wasserman et al. (1991), the authors find that including smoking restrictions has no effect on the price coefficient.

Gruber and Zinman (2001)[42] also test the effect of youth access restrictions but include state and year fixed-effects to control for unobserved state characteristics. Using the Monitoring The Future, Youth Behavioral Risk Survey, and National Natality data sets, they find no consistent effect of clean air or youth access restrictions, except that access restrictions reduce the amount smoked.

Quitting

Both the theoretical and empirical analysis of quitting lag behind that of prevalence. In their model of rational addiction, more fully described below, Becker & Murphy[43] explain their model with figure 3. The straight line shows all the combinations of c(t) and S(t) where $dS/dt = 0$, that is, where $c(t) = \delta S(t)$. By definition, every point on the straight line is a potential steady-state. The curved lines show the relation between c(t) and S(t) for various prices. BM stress that there are two steady-states, for example, a_1 and a_2, where actual consumption equals steady-state consumption. The first is an unstable steady-state because any movement away from it leads further away: if for some reason consumption declines slightly, then consumption drops to zero; if consumption increases slightly, it continues to increase until reaching a_2. This implies we should observe a bi-modal distribution of cigarette

[42] Op. Cit. p. 97

smoking, some people clustered around a_1 and on the verge of either quitting or shooting up to a_2, and others clustered around a_2, a clustering that is found in the real world. The diagram also implies that quitters should be consuming relatively little prior to quitting, which also accords with observed patterns. Another aspect of the BM model also suggests that quitting should be more common among light smokers. Since the marginal utility of smoking rises with the size of the addictive stock, so does the marginal disutility of not smoking. Thus the cost in utility of quitting is higher, the larger is the addictive stock. We should expect, then, that a given increase in price will change consumption more among women with smaller addictive stocks.

We can easily apply the BM model of quitting to pregnant women. Pregnancy can be viewed as an increase in price, which shifts the curved c(S) line downward. Those who had been smoking heavily before pregnancy shift from a_2 to b_2, while those who had been smoking lightly quit altogether. An advantage of the BM over simpler models is that it implies women who quit will do so cold-turkey, an implication confirmed in empirical studies.

There are relatively few empirical studies of smoking initiation or cessation. A seminal one is Douglas (1998)[44], which uses the 1987 National Health Interview Survey. Douglas points out that the typical model of smoking participation, which assumes that participation is a function of price and other variables, cannot tell us whether price reduces smoking because it reduces initiation or because it increases quitting. To understand this question requires data not only on whether a person smokes, but also on how long he has smoked and if he has quit. Few data sets have

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[43] Becker, G. and K. Murphy (1988), 'A Theory of Rational Addiction', *Journal of Political Economy*, 96(4): 675-700.

such information, which may explain the paucity of smoking cessation studies. The NHIS includes information on when a person began to smoke and when he quit, as well as on demographic characteristics and state of residence. Douglas analyzes the data with the split-sample hazard model of Schmidt and Witte (1989), which allows for two types of persons, those who change their state—from non-smoker to smoker, or from smoker to non-smoker—and those that do not. He assumes that persons are rational in the BM sense (i.e. that future costs matter), and will quit when the present discounted value of the benefits of smoking exceeds the present discounted value of its cost. Since the costs of smoking are largely health costs, and since these appear generally later in life, he expects the likelihood of quitting to rise with age. He finds that current price has no effect on starting or quitting, but that state restrictions on smoking and future prices strongly increase the odds a person will quit. One reason that price has no effect on starting, he suggests, is that he had to assume that everyone in the sample still lives in the state where he or she grew up, introducing a possibly significant source of measurement error.

Another weakness of Douglas (1998) is that its data is not truly longitudinal; rather, it is cross-section data with recollected information on past cigarette consumption. Poor recollection could bias the coefficients. Taurus and Chaloupka (1999b)[45] study smoking initiation and cessation with actual longitudinal data from the Monitoring the Future Project. As mentioned above, this survey collects smoking data on a sample of high school seniors and then re-interviews them every other year up to seven time afterwards. The authors estimate a semi-parametric non-

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[44] Douglas, S. M. (1998), 'The Duration of the Smoking Habit', *Economic Inquiry*, 36(1): 49-64.
[45] Op. Cit.

proportional Cox hazard model of the probability of quitting. They find that price significantly increases the likelihood of quitting among both men and women, but only among employed women do smoking restrictions increase quitting.

Foster and Jones (2000)[46] apply a similar econometric model to data from the British Health and Lifestyle Survey (HALS). Similar to the NHIS, the HALS has self-reported data on individual smoking histories as well as current smoking. The authors acknowledge the potential weakness of retrospective data but also point out that it allows them to include persons who began smoking as far back as 1920 and gain precision from the many changes in the taxes on cigarettes since then. Using a split-population duration model similar to Douglas (1998), they find no effect of tax changes on starting but a significant effect on quitting for both men and women.

Kenkel et al. (2001)[47] is the only study of the correlates of cessation specifically among women. They use the Young Women Cohort of the National Longitudinal Study (NLS), which follows a cohort of young women who began smoking in the 1960s and were re-interviewed nineteen times through 1999. Since the NLS asked about smoking in only a few years, the authors construct retrospective smoking histories from one of those years, 1991. They check the accuracy of the retrospective data by comparing smoking prevalence for previous years from the NLS with contemporaneous estimates from the NHIS, and find a close correspondence. Using a discrete-time hazard function, they find that quitting is positively correlated with

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[46] Forster, J and A.M. Jones (1999), 'The Role of Tobacco Taxes in Starting and Quitting Smoking: Duration Analyses of British Data', Working Paper, University of York.
[47] Kenkel, D., D. Lillard, and A. Mathios (2001), 'To Quit or Not to Quit: An Economic Analysis of Women's Smoking Cessation Decisions,' working paper.

price, year, being pregnant, and having a parent who died of a smoking-related illness.

Theoretical Model

Our model is a simple extension of the rational addiction model of Becker and Murphy 1988 (BM). "Rational" is used in a very weak sense; it simply means that the consumer considers the future, even the future of his or her addiction. This concept of rationality seems particularly apt when analyzing the behavior of pregnant women, since if anything will make a person look forward, it is the responsibility of caring for a child.

BM ask, how will an addict plan his or her life to maximize lifetime utility, taking into account the nature of addiction? They make the following assumptions:

(1) Consumers derive utility from "c", an addictive good, and "y", which represents all other goods (U_c, $U_y > 0$).

(2) Utility also depends on "S", the depreciated sum of past consumption. "S" evolves like any other capital good, increasing with consumption and declining due to depreciation.

(3) The more of an addictive good a person has consumed in the past, the greater is the marginal utility of an additional unit of the good in the present ($U_{cs} > 0$). They call this the "reinforcement" aspect of addictive consumption.

(4) A given quantity of an addictive good provides less utility the greater the past consumption ($U_s < 0$). This incorporates the notion of "tolerance."

The full price of consuming the addictive good for such a maximizing consumer consists of two parts, the money price and the increase in tolerance that consumption brings, which reduces future utility from the addictive good. More formally[48], the full price of consumption, $\pi(t)$, is

$$\pi(t) = p_c e^{(\sigma - r)t} + \mu^{-1} \int_t^T u_s(\upsilon) e^{-(\sigma+\delta)(\upsilon - t)} d\upsilon$$

We modify BM's model to incorporate some of the special characteristics of women who are or who want to be pregnant. First, we assume that consumers derive utility not only from "c" and "y" but also from "H=H(c)", the health of their children. We make H depend only on c and not S, because research indicates that so long as the woman abstains during the last trimester of her pregnancy, her infant faces the same odds of ill health as do children of non-smoking mothers (Surgeon General 2000). The full price then becomes

$$\pi(t) = p_c e^{(\sigma - r)t} - u_H H_c - \mu^{-1} \int_t^T u_s(\upsilon) e^{-(\sigma+\delta)(\upsilon - t)} d\upsilon.$$

Since the full price for a pregnant women has the extra term in it, which is positive (both H_c, and u_s are negative), we expect that pregnant women will smoke less than non-pregnant women.

A more complicated question is whether demand for cigarettes among pregnant women is more or less elastic than among non-pregnant women. Because BM

[48] Op. Cit. p. 677.

assume quadratic utility functions, their model, and hence our adaptation of it, implies linear demand functions. They show[49] that the linear or marginal effect of price is

$$\frac{dc}{dp_c} = \frac{\mu}{\alpha_{cc}} \frac{\delta(\sigma+\delta)}{\beta},$$

where β is a positive constant, δ is the depreciation of the addictive stock, σ is the subjective discount factor, and α_{cc} is essentially the second derivative of the maximized utility function with respect to consumption, and is negative. Assuming for simplicity that health is a linear function of cigarette consumption, then for pregnant women, this second derivative is $\alpha_{cc} + U_{HH}H_c^2$. Plugging this term into the above equation for the marginal effect shows that the marginal effect is smaller among pregnant than among non-pregnant women. But since we expect both the marginal effect and participation to decline when women become pregnant, we have no a priori prediction on the change in their ratio, which is used to calculate the elasticity.

We also adapt BM's model for women who want to be pregnant, which includes most of our sample. For these women fertility also enters into utility. We assume that fertility depends not only on smoking but also on age: F = F(a,c) and that utility is concave in F as in everything else. The full price then is:

$$\pi(t) = p_c e^{(\sigma-r)t} - u_F H_c - \mu^{-1} \int_t^T u_s(\upsilon) e^{-(\sigma+\delta)(\upsilon-t)} d\upsilon,$$

which would be larger for women who want to become pregnant than those for whom $U_F = 0$. This price rises with age, because $U_{FF} < 0$ and $F_c F_a > 0$. Thus we expect that

[49] ibid p. 685.

as women age, those that still want to become pregnant will smoke less than other women.

Becker, Grossman, and Murphy (1991)[50] shows that the rational addiction model implies that the marginal effect of price varies according to different persons' subjective discount factors. To those who discount the future heavily, the current price (i.e. the money price) is most important, and they respond little to changes in future costs. Since older and more educated consumers are thought to have smaller discount factors, the model implies that the marginal effect of price should vary inversely with age and education. We can apply this to pregnant women by noting that pregnancy may reduce a women's subjective discount factor since it focuses her attention her future responsibilities, reducing the marginal effect of price. As the appendix shows, whether the elasticity also varies with the subjective discount factor is ambiguous.

Empirical Strategy

Similar to the studies reviewed above, we estimate a linear reduced form demand equation for smoking:

$$C_{ijtp} = X_{ijt}\beta_p + \alpha_p T_{jtp} + s_j + y_t + e_{ijtp},$$

where C is smoking and the subscripts i,j,t,p index individuals, states, and years, and periods, respectively. Individual characteristics of the mother are captured by X_{ijt}, and the excise tax on cigarettes in constant dollars by T_{jtp}; s_j and y_t control for state

and year fixed effects and e_{ijtp} is the residual. There are three periods: before (b), during (d), and after (a) pregnancy. With estimates of α_b, α_d, and α_a we can calculate the elasticity of participation of women who are and who are not pregnant, and possibly determine which group is more price responsive, and hence if cigarette taxes are an appropriate policy for reducing maternal smoking. We will also analyze the amount smoked conditional on positive smoking (smoking intensity).

We use ordinary least squares when the outcome is cigarettes smoked per day and probit estimation when the outcome is smoking participation. We take into account the multi-stage survey design of PRAMS using the survey procedures in STATA 7 (Stata Corportation, 1998) and in SAS 8.1 (SAS Corporation, 2000).

One question is whether to use cigarette taxes or prices. Consumers, after all, actually respond to prices, not taxes. But prices are jointly determined by supply and demand and therefore should be considered endogenous. Some economists believe this is not a problem when using individual level data since any individual consumer's demand has only an insignificant effect on price (Chaloupka and Warner 2000)[51]. Nonetheless, we will test the endogeneity of prices by running a two-stage least squares (2SLS) regression of consumption on prices, using taxes as an instrument for price, and apply a Hausman test of endogeneity.

Evans, Ringel, and Stech (1998)[52], however, point out that there are other reasons besides its exogeneity to use tax rather than price. To begin with, tax changes are the main reason that prices change. As shown further on, taxes are estimated to explain

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[50] Becker, G.S., M. Grossman, and K.M. Murphy (1991), 'Rational Addiction and the Effect of Price on Consumption,' Center for the Study of the Economy and the State Working Paper no. 68.
[51] Op. Cit. p. 1550.
[52] Op. Cit. p. 16.

about 80% of the variation in prices. Second, taxes are known much more precisely than prices, which vary by quality of the cigarette as well as by where it is bought. Third, the government directly controls taxes, not prices. And fourth, as mentioned above, price reflects both supply and demand. For these reasons, we will focus on the effect of taxes rather than prices.

To test if $\alpha_b > \alpha_d$ and $\alpha_a > \alpha_d$, we stack the data referring to the period before and after pregnancy on top of the data referring to the period during pregnancy. Most of the independent variables will be the same for all three periods, but at first we will not impose the constraint that the *effect* of the independent variables are the same in each period. In the following, the coefficient "b" equals one if the period is before pregnancy, and zero otherwise; similarly, the coefficient "a" equals one if the period is after pregnancy, zero otherwise.

$$\begin{bmatrix} C_{ijtb} \\ C_{ijtd} \\ C_{ijta} \end{bmatrix} = \begin{bmatrix} X_{ijtb} \\ X_{ijtd} \\ X_{ijta} \end{bmatrix}\begin{bmatrix} \beta_b \\ \beta_d \\ \beta_a \end{bmatrix} + \begin{bmatrix} T_{jtb} \\ T_{jtd} \\ T_{jta} \end{bmatrix}\begin{bmatrix} \alpha_b \\ \alpha_d \\ \alpha_a \end{bmatrix} + \begin{bmatrix} s_j \\ s_j \\ s_j \end{bmatrix}\begin{bmatrix} \delta_{jb} \\ \delta_{jb} \\ \delta_{ja} \end{bmatrix} + \begin{bmatrix} y_t \\ y_t \\ y_t \end{bmatrix}\begin{bmatrix} \delta_{tb} \\ \delta_{td} \\ \delta_{ta} \end{bmatrix} + \begin{bmatrix} e_{ijtb} \\ e_{ijtd} \\ e_{ijta} \end{bmatrix}$$

$$\begin{bmatrix} C_{ijtb} \\ C_{ijtd} \\ C_{ijta} \end{bmatrix} = \begin{bmatrix} X_{ijtb} \\ X_{ijtd} \\ X_{ijta} \end{bmatrix}\begin{bmatrix} \beta_d + b\Delta_b + a\Delta_a \\ \beta_d + b\Delta_b + a\Delta_a \\ \beta_d + b\Delta_b + a\Delta_a \end{bmatrix} + \begin{bmatrix} T_{jtb} \\ T_{jtd} \\ T_{jta} \end{bmatrix}\begin{bmatrix} \alpha_d + b\Delta_{Tb} + a\Delta_{Ta} \\ \alpha_d + b\Delta_{Tb} + a\Delta_{Ta} \\ \alpha_d + b\Delta_{Tb} + a\Delta_{Ta} \end{bmatrix} + \begin{bmatrix} s_j \\ s_j \\ s_j \end{bmatrix}\begin{bmatrix} \delta_{jb} \\ \delta_{jb} \\ \delta_{ja} \end{bmatrix} + \begin{bmatrix} y_t \\ y_t \\ y_t \end{bmatrix}\begin{bmatrix} \delta_{tb} \\ \delta_{td} \\ \delta_{ta} \end{bmatrix} + \begin{bmatrix} e_{ijtb} \\ e_{ijtd} \\ e_{ijta} \end{bmatrix}$$

The coefficient β_d gives the effect of tax on smoking during pregnancy, while the various Δs will tell us whether the effect of tax during pregnancy differs from its effect before pregnancy and during pregnancy. If the coefficients on the state and year indicator variables do not differ significantly between the three periods, we can improve the precision of the tax coefficients by constraining the coefficients on state

and year to be the same for all three periods. Also, we will correct the standard errors for the correlation among error terms of the same individual.

There are a number of other coefficients we want to compare with each other. We want to see if using the birth certificate measure of smoking, which refers only to the period during pregnancy, produces a different coefficient on tax from the PRAMS measure of smoking. Therefore we run the following:

$$C^{BC}_{ijtd} - C^{PRAMS}_{ijtd} = X_{ijt}\beta_d + \alpha_b T_{jtd} + s_j + y_t + e_{ijtd}$$

Since the PRAMS measure, we believe, is a more accurate indicator of smoking, a coefficient on β_d that is insignificantly different from zero implies that the measurement error in the birth certificate variable is uncorrelated with the tax. If so, we can use birth certificate data, which also measures smoking during pregnancy, rather than PRAMS data in the stacking equation above to compare the effect of tax on smoking before, during, and after pregnancy. This will increase the sample size and hence the precision of the comparison. Finally, we will stack PRAMS data on smoking during pregnancy on top of BRFSS data of non-pregnant women as another test of the difference in the effect of tax between pregnant and non-pregnant women.

We also want to know whether raising cigarette taxes increases the chance that a woman will quit smoking when she becomes pregnant. The following regression might seem to answer this question:

$$Q_{ijt} = X_{ijt}\beta + \alpha T_{jt} + s_j + y_t + e_{ijt}$$

where Q_{ijt} equals one if the women smoked before becoming pregnant and quit upon becoming pregnant, and is zero if she smoked both before and during pregnancy. The error term, e_{ijt}, includes all of the person's characteristics, other than those included in X_{ijt}, that influence whether she will quit, characteristics such as taste for smoking, for example. The estimated coefficients in the above regression would be biased unless $E[e_{ijt}| X_{ijt}, T_{jt}] = 0$, that is, so long as the average taste for smoking among women in the sample is independent of the tax and other regressors. But as cigarette taxes increase, women with low tastes for smoking are likely to quit before they become pregnant. As they drop out of the quit sample, the average taste for smoking among women who still smoke when they become pregnant, which is captured in the error term, is likely to rise. Thus the errors and cigarette taxes will not be independent.

One solution is to run a slightly different regression:

$$S_{ijtb} - S_{ijtd} \equiv D_{ijt} = X_{ijt}\beta + \alpha T_{jt} + s_j + y_t + e_{ijt},$$

where S_{ijtp} equals one if the woman smokes in period "p", zero otherwise. If she smokes before but not during, D_{ijt} will be one; if she smokes in both periods, D_{ijt} will be zero. Thus D_{ijt} is similar to Q_{ijt} but since it includes all the women in the sample, does not create the sample selection problem. The drawback of the above regression is that D_{ijt} will also be zero when the woman smokes in neither period, making the coefficients hard to interpret.

We can also include all the women in the sample with a multinomial logit model. There are four possible outcomes:

1) smoke in each period (1,1,1);

2) 'smoke', 'quit', 'resume' (1,0,1);

3) 'smoke', 'quit', 'do not resume' (1,0,0);

4) 'do not smoke' (0,0,0).

We are particularly interested in the effect of taxes on the likelihood of outcome 3 compared with outcome 2. This would tell us the effect of taxes on the probability of resuming smoking after having quit during pregnancy. To analyze quitting after becoming pregnant, we combine outcomes 2 and 3. The new categories, then, are:

1) smoke before and during (1,1);

2) smoke before but quit during (1,0);

3) 'do not smoke' (0,0,0).

We would then look at the effect of taxes on the likelihood of outcome 2 relative to outcome 3.

Another solution to the sample selection problem is to include in the quit equation some measure of each woman's taste for smoking. If we were restricted to cross-section regressions there would be no way of obtaining such a measure. But we can treat the stacked data set as longitudinal. As long as the taste for smoking remains the same over the course of a woman's pregnancy, we can proxy this taste with the fixed person effects from a regression of number of cigarettes consumed on tax and pregnancy status, the two variables that change from before to during and after pregnancy. Unfortunately we have only three time periods and few changes in the independent variables with which to estimate the fixed effects.

Our last outcome of interest is restarting after pregnancy among women who quit during pregnancy. The multinomial or ordered equations mentioned above will show the effect of taxes on this outcome also. In addition, we will run simple probit

regressions with "restarting" as the dependent variable and taxes and other factors as the independent variables. The literature review shows that there is little agreement on the correlates of this outcome, partly because the sample sizes in previous studies have been small. The large size of our data set should allow us to identify the important correlates more accurately than has been done so far. Unfortunately, we lack data on one of the most important influences on restarting, whether the husband or partner smokes.

All of the models above assume that the consumer pays the cigarette tax that their state government imposes. But because of smuggling, this may not be true. The government of the state of Washington, for example, estimates that its citizens buy one quarter of their cigarettes in some other state. This should bias downward the absolute effect of taxes on consumption since even if the state raised taxes substantially, because of smuggling the prices consumers actually pay, and therefore their consumption, may not have changed much. Lewit and Coate (1982)[53] observe that organized smuggling may not influence the retail price that much because too great a difference between prices of legal and illegal cigarettes would alert law enforcement agencies. But some smuggling for personal consumption certainly takes place. They test for the importance of casual smuggling by estimating demand functions for their whole sample as well as for the sub-sample that lived more than 20 miles from the nearest state border. The price coefficient in the restricted sample is almost twice as large as for the entire sample. More recent studies, however, find little effect from smuggling. Evans and Ringel (1999), in their cigarette demand equation, include the difference between the own-state tax and the lowest tax in a

nearby state, and find no statistically significant effect of smuggling[54]. We will test for the importance of smuggling in our sample following Lewis and Coate's (1982) method.

Data

Data on smoking come from the Pregnancy Risk Assessment Monitoring System (PRAMS), a random, stratified monthly survey of recent mothers selected from birth certificates. PRAMS was created 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 birth weight 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 birth weight 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 two to six months after delivery; non-respondents are followed up by telephone. Response rates average between 70 and 80 % after follow up.
(http://www.cdc.gov/nccdphp/drh/methodology.htm)

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 six years between 1993 and 1998: Alabama, Alaska, Florida, Georgia (1993-1997), Maine, New York

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[53] Op. Cit.p. 126.
[54] Op. Cit. p. 148.

State (excluding New York City) Oklahoma, South Carolina, Washington and West Virginia. There are 101,409 observations, a total that, when weighted, represents approximately 4,012,101 births, or 17 % of deliveries in the U.S. 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 three months before they were pregnant. They may also respond by indicating that they smoked less than one cigarette per day, that they didn't smoke at all, or that they do not know. The same set of questions are asked regarding the period three months before delivery and at the time of the survey, which occurs between 2 and 6 months after delivery. Thus, we have self-reported measures of smoking participation and intensity at three points in time: three months before pregnancy, three months before delivery and at the time of the postpartum survey. We eliminated women that that did not know how much they smoked before pregnancy (n=3767), during pregnancy (n=2469) and after delivery (n=2103).

PRAMS also contains a rich set of covariates, some of which are also on birth certificates, such as the mother's age, education, parity, and marital status, and others that are not included on the birth certificate, such as family income, mother's insurance status, and pregnancy intention. On some topics PRAMS includes both the mother's response to the PRAMS questionnaire and to the birth certificate question. Both PRAMS and birth certificates, for example, ask the mother whether and how

much she smokes, but PRAMS words its questions differently, a difference that appears to elicit more truthful responses, as the following comparison suggests.

Table 2 shows the percentage of recent mothers that smoked before, during and after pregnancy as reported by PRAMS[55] and by birth certificates in 1995[56]. The last column gives the percentage difference. Comparing column 2 to column 4 suggests that underreporting is less a problem in PRAMS than in birth certificate data, but one should note that the comparison is not perfect, because the two sources ask different questions. Birth certificates only ask the mother if she smoked at any time in her pregnancy. Many women who smoked early in their pregnancies but quit by the third trimester would have answered 'yes' to the birth certificate question and 'no' to PRAMS. But this only implies that underreporting on birth certificates is probably greater than the table indicates.

An important question is whether results from studying PRAMS can be generalized to women in other states. To find out we first compare the characteristics of women in PRAMS with those of women in two other population-based surveys, the Behavioral Risk Factor Surveillance Survey (BRFSS) and the 1998 National Health Interview Survey, Pregnancy and Smoking Supplement. Certain differences among the data sets make comparisons imperfect. PRAMS includes all women, regardless of age, who have had a birth and who lived in the state in which they delivered. The BRFSS, in contrast, includes only persons over 18 years old; we have limited our BRFSS sample to women 18 to 45, regardless of whether they have

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[55] Centers for Disease Control and Prevention (1998), *PRAMS 1995 Surveillance Report*, Atlanta, GA: Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion.

given birth. While both PRAMS and the BRFSS are conducted each year, the NHIS Pregnancy and Smoking Supplements are conducted sporadically. We use the most recent, from 1998. The Supplement asks women if they have had a birth within the last five years, which roughly corresponds to our sample frame for PRAMS of 1993 to 1998. Thus the Supplement contains mainly retrospective information and some of the data are not strictly comparable to that in PRAMS and BRFSS. For example, the Supplement asks women their educational level at the time of the survey—1998—not at the time they gave birth.

Nonetheless, as table 3 shows, there is broad agreement among the three surveys on the characteristics of women 18 to 45 and of recent mothers. Column 1 shows estimates based on the ten PRAMS states we use in this study. Column 2 gives estimates from the 48 states the participated in the BRFSS in each year between 1993 and 1998. Column 3 shows estimates from BRFSS only among the same ten states as we use for PRAMS. Column 4 is from the NHIS Smoking and Pregnancy Supplement.

Both PRAMS and BRFSS show that about 30% of women have a high school degree, and about the same percentage have completed college. The NHIS shows a higher percentage of college graduates, but this may reflect the NHIS's more detailed education questions, which are not quite comparable to those in PRAMS and the BRFSS. Comparing column 1 with column 2 shows that white women make up a slightly smaller share of the population surveyed by PRAMS than among all U.S. women. However, if we limit the comparison to women in the ten PRAMS states, the

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[56] Mathews, T.J. (2001), 'Smoking During Pregnancy in the 1990s', *National Vital Statistics Reports*, Hyattsville, Maryland: National Center for Health Statistics, 49(7).

racial distribution among pregnant and reproductive age women is very similar. The age distribution among the PRAMS and U.S. populations is very different; most women in the PRAMS population are between 20 and 29, whereas most reproductive age women are over 30. But as a comparison of columns 1 and 4 shows, this merely reflects the younger ages of women giving birth compared with all reproductive age women.

We also compare the prevalence of smoking using PRAMS, the BRFSS, and birth certificates. Figure 1 shows percentage of non-pregnant women that smoked based on data from the BRFSS and PRAMS. The series obtained from PRAMS reflects smoking participation three months before pregnancy in the 10 sample states. The other two time series display smoking among women 18 to 44 years of age who were not pregnant at the time of the survey as obtained from the BRFSS. One plot shows smoking participation in the same 10 states as in the PRAMS sample; the second show smoking participation in all 33 states that participated in the BRFSS. The three plots are quite similar in level and trend.

Figure 2 displays similar data for smoking during pregnancy. Two series from birth certificates have been added. The series labeled BC_10 is smoking participation during pregnancy as measured by birth certificates in the 10 states included in PRAMS; the series labeled BC_all is same but pertains to all states and vital registration areas that reported smoking to the National Center for Health Statistics. The two series obtained from the BRFSS include smoking among the subset of women that said they were pregnant at the time of the survey.

All five series in Figure 2 display roughly the same trend. Smoking during pregnancy has decline for all series since 1994. The level of smoking, however, differs substantially by source. Overall, the prevalence of smoking in the BRFSS and birth certificates is approximately a 2 to 3 percentage points lower than is reported by PRAMS.

Neither the BRFSS nor birth certificates ask about smoking before and after pregnancy, but we can compare PRAMS data on these questions with the results from previous studies, as summarized in the literature review above. As shown in table 4, according to PRAMS about 26% of women smoked before their most recent pregnancy, not much different from the 25% found by LeClere et al. (1997). Among White women ages 20 to 44, Fingerhut estimated that about 32% smoked before pregnancy, not far from the 30% shown in table 4 among white women surveyed by PRAMS. Similarly, LeClere et al. (1997) estimated that about 15% of women smoked at some time during their pregnancies, close to the 15% to 17% shown in table 4.

Since smoking among pregnant women has been declining and among non-pregnant women has been stable, a natural inference is that an increasing percentage of women quit smoking when they learn they are pregnant. Yet a recent study reaches a different conclusion[57]. That study was based on data from the BRFSS, which has several limitations for studying the behavior of pregnant women. First, the number of pregnant women in the survey is small, between 700 and 900 per year. By contrast, there are over 17,000 women per year in our sample from PRAMS.

Second, as we showed in Figure 2, both the BRFSS and birth certificates appear to underreport smoking during pregnancy as compared to PRAMS. One reason may be that women are reluctant to admit to smoking while pregnant, but more forthcoming postpartum if the baby is healthy. Another reason may be that both the BRFSS and birth certificates ask only if the woman smoked at any time during pregnancy. Women that smoked in the first trimester but quit are less likely to report that they smoked during pregnancy[58]. Finally, Ebrahim et al. analyzed the BRFSS only from 1987 to 1996, the last year of data available to them. They also confined their analyses to the 33 states for which data are available in all years. Using the same data, we regressed a dichotomous indicator of smoking on the survey year, a dichotomous indicator for pregnancy, year-times-pregnancy, and the women's age. Like them, we found no statistically significant difference in smoking trends among pregnant and non-pregnant women (t = -0.75). But when we add to their sample the BRFSS data from 1997 through 2000, the differential trend coefficient becomes significant (t = -3.63). When we analyze the period 1990 to 2000 and the 43 states for which data are consistently available, the differential trend becomes larger in absolute terms and is again significant (t = -3.51).

We can confirm these inferred trends in quitting with direct data on quitting from PRAMS since it asks each women if she smoked before and during, and thus whether she quit smoking when she became pregnant. Table 5 shows the percentage of women who report quitting smoking during their pregnancies in 1993 and 1998 for

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[57] Ebrahim, S.H., R.L. Floyd, R.K. Merritt, P. Decoufle and D. Holtzman (2000), 'Trends in Pregnancy-Related Smoking Rates in the United States, 1987-1996', Journal of the American Medical Association, 283:361-366.

the ten states in our study. Among all women in our sample of states, 38% reported quitting before the sixth month of their pregnancies in 1993. Quitting was highest among women who primiparous, light smokers, privately insured, younger, white, and educated. By 1998 percentage of all women who quit had risen to 46.2%, a statistically significant change. The increase was particularly strong among women who were primiparous, privately insured, between 20 and 29 years old, white, and high school-educated. The largest percentage point change was among the college-educated, but the difference is not statistically significant.

Both the proportion and nature of women who quit matches closely the findings of previous studies, as summarized in the literature review above. So, generally, do our estimates of postpartum resumption of smoking.

Data on taxes and prices come from *The Tax Burden on Tobacco*, produce by Orzechowski and Walker. Nominal values were converted to real using the Consumer Price Index, All Urban Consumers. The two series are highly correlated. Using price and tax data for the 1980s and 1990s, a regression of real cigarette price on real tax and dichotomous variables for state and year gives a coefficient on the real tax of 1.134 with a t-value of 65.84. From this we can calculate a partial R^2 with the following formula:

$$R^2_{x_j} = \frac{t^2_{x_j}}{t^2_{x_j} + df},$$

[58] Kharrazi, M. (1999). 'Evaluation of Four Maternal Smoking Questions', U.S. Department of Health and Human Services, *Public Health Report* 114: 60-69.

where df is the degrees of freedom of the error term. Since the degrees of freedom is 994, this formula gives a partial R^2 of 0.81, implying that taxes explain about 81 % of the variation in prices.

Of the ten states in our study, four changed their cigarette taxes between January 1, 1993 and December 31, 1998, as shown in table 6. An important question is whether the tax increases are exogenous to smoking behavior. That is, do tax increases reduce smoking or does a drop in the number of smokers embolden the government to impose higher taxes?

A recent paper suggests that it may be the latter (Kubik and Moran 2001)[59]. The authors use the election schedules in each state to instrument for tax changes, based on their observation that tax changes are smaller in the year after an election than in other years. They find that the elasticity of demand is twice is large when using election timing as an instrument for taxes than when using actual taxes. They speculate that changes in taxes may reflect changes in anti-smoking sentiment in the state, which also influences cigarette consumption.

The evidence of the endogeneity of tobacco taxes revealed in this paper is impressive, perhaps too impressive. Their regression of the log of cigarette prices on a dichotomous variable indicating an election year shows that the election cycle changes prices by less than one % (i.e., one penny), though it is significant ($t \approx 3$). This would seem to imply a weak instrument. Bound, Jaeger, and Baker (1995)[60] show that weak instruments can produce very biased results if the instruments are

[59] Kubik, J.D. and J.R. Moran (2001), 'An Instrumental Variables Approach for Estimating the Incidence of Endogenous Policies', working paper.

even weakly correlated with the error term in the structural equation. Such a correlation seems possible in this case. Suppose politicians do want to raise taxes because of recent increases in smoking (i.e. taxes are endogenous), but never get around to actually raising them until election time. Then taxes would be then endogenous even though they are correlated with the exogenous election cycle.

Gruber and Zinman (2001) indirectly test the endogeneity of cigarette taxes by including the lagged values of state per capita cigarette consumption in their cigarette demand regressions. If taxes are endogenous, reduced consumption one year should lead to higher taxes the next. They find that the coefficients on the lagged terms are generally insignificant, and that their inclusion has very little effect on their price coefficients[61].

A more direct but cruder way of checking endogeneity is to examine the reasons legislators gave for increasing cigarette taxes. These are briefly summarized in table 6. Based on their public statements, the most common motive is to eliminate budget deficits, followed by reducing smoking. Unless a drop in smoking caused the budget deficit, which is conceivable but unlikely, the first motive implies that taxes are exogenous to cigarette consumption. The second motive—to reduce smoking—is more likely to follow a recent rise rather than a recent decline in smoking. Thus if consumption declines when taxes rise, causation is likely to run from the latter to the former, rather than the other way around. For Maine, however, cigarette taxes may be endogenous since the money is used to fund anti-smoking advertising campaigns. To

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[60] Bound, J., D.A. Jaeger, and R.M. Baker (1995), 'Problems with Instrumental Variable Estimation When the Correlation Between the Instruments and the Endogenous Explanatory Variable is Weak', *Journal of the American Statistical Association.* 90(430):443-450.
[61] Op. Cit. p. 104.

take this into account, we include a dichotomous variable that equals one if the state is spending cigarette tax funds on anti-smoking programs.

As a further check on exogeneity we shall examine the effect on the coefficient on tax of adding successively more covariates, starting from state and year indicator variables, up through education, income, etc. There is a chance the real tax is not exogenous to these over variables because the education, income, and other characteristics of the women in our sample change from 1993 to 1998, as shown in table 23. They become somewhat older, more educated, more likely to be non-white, and to be privately insured.

Each woman in our sample is assigned three cigarette taxes, corresponding to her cigarette consumption during three different periods, before pregnancy, before delivery, and after delivery. Since the PRAMS question asks about smoking during the three months before to pregnancy, we assign her the tax that prevailed at the beginning of that period. The date of her pregnancy is calculated by subtracting her gestational interval from her date of birth. We assume the relevant tax for consumption three months before delivery is that which prevailed when she became pregnant, because most women who quit do so early in their pregnancies. As shown in table 7, about 70% of women who quit do so before their fourth month. For the tax after delivery, we assign the tax that prevailed on day the woman was interviewed.

Results

We first compare the adjusted characteristics of smokers before, during, and after pregnancy, shown in tables 8, 9, and 10 with the unadjusted characteristics presented

in the prior section. The two are very similar: smoking decreases with education and income, is less prevalent among women who are non-white, privately insured, married, primiparous (except for smoking before pregnancy), and whose pregnancy was unintended. In contrast to the unadjusted numbers, however, smoking *rises* with age, once education is controlled for, which directly contradicts our model. Possibly the results reflect the effect of cohort rather than age, an uncertainty we cannot remove since we cannot include age, cohort, and year in a single regression.

The coefficients on tax in the participation regressions provide some support for our theoretical models, though the important coefficients are generally statistically insignificant. The coefficients on tax in the regressions of smoking before and smoking after pregnancy are larger than the corresponding coefficient in the regression of smoking during pregnancy, but only the tax coefficient on smoking after pregnancy is statistically significant. To test whether the differences in the tax coefficients are statistically significant, we stacked the data as described earlier. As shown in table 17, none of the coefficients are statistically different from one another. One way of increasing the power of the test would be to reduce the number of coefficients. This would be possible if, for example, the coefficients on year and state in one period were not significantly different from their values in other periods. Then we could constrain these coefficients to be equal for all three periods. To test for this equality, we used an F-test on the period *times* year and period *times* state interactions; the test strongly rejects the null hypothesis that the coefficients from all periods equal.

The second column in the tables show the effect of tax on participation only among women who lived more than 20 miles from a state with a lower cigarette price. As mentioned earlier, if smuggling is a problem, we would expect this effect to be larger, and this is what we find, although the differences are not statistically significant.

The third column shows a regression of participation on the real cigarette price, using real cigarette taxes as an instrument for price. Generally the price coefficient is larger in absolute value than the coefficients on the real tax. This is the opposite of what we expected. Let S indicate the likelihood of smoking. Then, by the chain rule,

$$\frac{dS}{dP} = \frac{dS}{dt} \Big/ \frac{dP}{dt}.$$

Since, as noted in the data section, we estimate that $\frac{dP}{dt} = 1.2$, we would expect the price coefficient to be smaller than that on the tax. The result of finding the opposite is that the estimated elasticities are always, and sometimes implausibly, larger when calculated using the coefficient on price. A Hausman test indicated that the differences between the coefficients on price in OLS regressions and the corresponding instrumental variable coefficients are statistically significant, suggesting that prices are, in fact, endogenous even when using individual-level data.

It is possible that even taxes, however, may not be completely exogenous. Table 22 shows the coefficient on the real tax as more independent variables are added to a regression analyzing participation before pregnancy. The tax coefficient changes as variables are added, ranging from –0.0008 to –0.0010. None of the changes are statistically significant, but they suggest that some of the change in the tax may

reflect the changes in the population of the states, as shown in table 23 and discussed above.

Tables 11, 12, 13 shows regressions of average daily cigarettes consumed among smokers on the same covariates as above. As in the participation regressions, smoking declines as education and income rise, and is greater among women who are older, white, publicly insured, and unmarried. Women having their first child tend to smoke more than other women before and after pregnancy, but less during pregnancy.

None of the tax coefficients are significant, nor are the differences among the coefficients on smoking before, during, or after pregnancy, as shown in table 17. The lack of a difference is not inconsistent with the Becker-Murphy model. On one side, the model predicts that women with future costs on their minds will respond less to changes in the current price. On the other, women who continue to smoke during pregnancy probably have higher discount factors than women who quit or who do not smoke. This suggests they should respond more to changes in the current price. The net result is indeterminate. Similar to earlier studies, we find that the conditional elasticities are much smaller in absolute value than elasticities of participation shown in tables 8, 9, and 10.

Tables 14, 15, and 16 give OLS regressions of average daily cigarette consumption among all women in the sample, smokers and nonsmokers. Thus they are the sum of the effects of the independent variables on participation and on conditional intensity. All of the coefficients on tax after pregnancy are significant at the 5% level, while all of the coefficients on tax before pregnancy are significant at the 10% level; the coefficient on tax during pregnancy, however, is significant is

significant at the 10% level only among women who live more than 20 miles from a lower price. As in the participation regressions, the tax appears to have its greatest effect before and after pregnancy, although again the differences are not statistically significant.

The elasticities given at the bottom of tables 14, 15, and 16 appear roughly equal for smoking during and before pregnancy, and somewhat larger afterwards. Using the delta method, we estimated the standard errors of the elasticities and of the differences between the them. None of the differences were statistically significant. For example, the estimated standard error of the total elasticity of cigarette consumption during pregnancy is 0.42, and of cigarette consumption after pregnancy is 0.36. Assuming the covariance between the elasticities to be zero, the standard error of the difference is 0.87. The t-value for the difference, then, is 0.26.

Our findings on the correlates of quitting and restarting, shown in tables 18 - 21, generally match those noted in the literature review. Quitting rises with education and income, declines with age, and is more common among married, non-white, privately insured, primiparous women. The first column shows the effect of taxes without any correction for sample selection, a possibility raised in the empirical section. The effect of tax on quitting is positive, but not significant. We next try to ameliorate the sample selection problem. We expect that if there is a problem, it is likely that the tax is positively correlated with the error term, which includes the unmeasured taste for smoking. Thus we would expect that without any correction for sample selection, the measured effect of taxes would understate its true effect, or be smaller in absolute value. We try to account for sample selection by including two

measures of each woman's taste for smoking, the fixed effect from the stacked regressions, and the amount she smoked before becoming pregnant. The results are shown in table 20. The fixed effect variable is highly negative, suggesting that persons with higher tastes for smoking are much less likely to quit, as expected. But surprisingly, adding fixed effects or pre-pregnancy consumption does not change the tax coefficient at all. This implies either that taxes are uncorrelated with the unmeasured taste for smoking, or that the fixed effects are not a good proxy for these tastes. Another method of avoiding the sample selection problem is to include the whole sample in the quit equation. One way of doing this is by using multinomial logistic regression. The results of this regression, shown in table 18, are qualitatively similar to the simple quit regression discussed above. The multinomial logit shows that as the tax increases, the odds of quitting rise compared with the odds of not quitting, though the effect again is not significant.

Finally, our regression of the correlates of resuming smoking after pregnancy, given in table 21, show that restart falls with income and education, rises with the woman's taste for smoking (as measured by the fixed effects), and is less common among women who are white and primiparous. Taxes significantly reduce the likelihood that a woman will relapse after pregnancy, given that she quit during pregnancy, an effect that increases in absolute value when the fixed effects are added. The *difference* between taxes after and during pregnancy, however, has no significant effect.

Conclusions

The results presented above tentatively support our expectation that the coefficients on smoking before and after pregnancy exceed the coefficient on smoking during pregnancy, although none of the differences are statistically significant. Further, the results support our expectation that increases in taxes would increase the likelihood that a woman will quit smoking during pregnancy, and decrease the likelihood that she will resume smoking afterwards.

The estimated *elasticities*, however, are approximately the same for women before and during pregnancy, and somewhat larger after pregnancy, implying, for reasons given in the introduction, that cigarette taxes may not be the ideal instrument to reduce maternal smoking.

Table 1

Estimated Price Elasticity of Demand From Various Studies

Authors	Data	Time Period	Total elasticity	Participation	Conditional
Pregnant Women					
Evans & Ringel (1999b)	Natality Detail	1989-1992	–0.09	–0.52	–0.04
Lien & Evans (2000)	Natality Detail AZ,IL,MI,MA	1990-1997	NA	–0.45	NA
Ringel & Evans (2000)	Natality Detail	1989-1995	NA	–0.70	NA
Gruber & Koszegi	Natality Detail	1989-1996	NA	NA	–0.24
Gruber & Zinman (2001)	Natality Detail Teens	1991-1997	NA	–0.353	–0.124
Bradford (2000)	NMIHS	1988		–0.50	–0.26
All Women					
Farrelly & Bray (1998)	NHIS	1976-1993	–0.19	–0.09	–0.10
Lewit & Coate (1982	NHIS, ages 26-35 yrs	1976	–0.577	–0.388	–0.134
Chaloupka and Pacula (1998)	Monitoring the Future	1992-1994	–0.595		

Table 2

Smoking Participation as Reported in PRAMS and on Birth Certificates in 1995

	PRAMS			*Birth Certificates*	
States in PRAMS 1995	3 months before pregnancy (1)	3 months before delivery (2)	3 months after delivery (3)	Tobacco use during pregnancy (4)	% Difference [(4) – (2)]/ (2)
ALABAMA	28.1	16.2	23.6	13.4	-21%
ALASKA	31.2	18.2	25.3	19.2	5%
FLORIDA	24.3	13.3	19.9	12.9	- 3%
GEORGIA	24.1	13.5	20.6	11.2	-21%
MAINE	35	21.9	29.5	18.2	-20%
MICHIGAN	29.5	19.5	24.9	18.3	-7%
NEW YORK	30.6	19.7	27.6	NA	NA
OKLAHOMA	35.6	22.9	30.9	17.5	-31%
SOUTH CAROLINA	23.3	13.8	19.8	14.8	7%
WASHINGTON	23.9	14.7	19.1	16.2	9%
WEST VIRGINIA	39.5	27.5	35.8	24.6	-12%
Simple Average	29.6	18.2	25.2	16.6	-9%
Weighted Average	27.9	16.2	23.9	15.0	-8%

Source: PRAMS 1995 Surveillance Report

Table 3

Maternal Characteristics in PRAMS, BRFSS (Women 18-45), and the NHIS 1998 Pregnancy & Smoking Supplement, 1993-1998

	1	2	3	4
	PRAMS	BRFSS	BRFSS (PRAMS states)	NHIS
Sample Size	101,409	203,102	41,770	5,309
Maternal Education				
0 to 8 Years	2.3	3.2	3.0	4.4
9 to 11 Years	7.0	6.2	6.4	5.8
12 years	31.9	31.0	30.6	25.3
13 - 15 years	25.9	29.4	31.0	30.7
16 years or more	30.7	30.2	29.1	33.3
Education Unknown	2.2	0.1	0.1	0.5
Maternal Race				
White	76.0	80.3	76.9	78.1
Black	19.7	11.8	16.8	13.5
Other	3.7	7.6	6.0	8.2
Race Unknown	0.5	0.3	0.4	0.3
Maternal Age				
Under 20	13.4	6.2	5.9	16.9
20 to 29	52.7	34.3	34.5	52.2
30 years and over	33.9	59.5	59.7	30.9
Married	67.4	57.3	55.6	73.7

Table 4a

Smoking Participation Before Pregnancy by Characteristics of the Mother in 10 PRAMS States, 1993 & 1998

	1993	1998	1993	1998	1998-93 (95% CI)
Parity	N	N	%	%	
First Birth	6243	6524	26.2	28.3	2.2 (-1.0, 5.3)
Second or Later Birth	7848	7908	26.3	25.3	-1.0 (-3.7, 1.8)
Parity Unknown	247	551	29.3	34.1	4.8 (-9.7, 19.3)
Cigarettes Smoked Before Pregnancy					
No cigarettes	9535	10118	0.0	0.0	0.0 (0.0, 0.0)
10 and fewer	1669	2036	100.0	100.0	0.0 (0.0, 0.0)
11 to 20	1864	1758	100.0	100.0	0.0 (0.0, 0.0)
Over 20	695	580	100.0	100.0	0.0 (0.0, 0.0)
Cigarettes Unknown	575	491			
Insurance Status					
Medicaid	6478	6180	36.1	36.7	0.6 (-2.9, 4.2)
Other public	474	452	34.4	25.2	-9.2 (-24.6, 6.2)
Private	5417	6899	18.2	20.7	2.5 (-0.2, 5.1)
Uninsured	1714	1197	25.2	25.2	0.0 (-7.2, 7.3)
Insurance Unknown	255	255	23.6	28.7	5.1 (-13.8, 24.0)
Maternal Age					
Under 20 years	2188	2825	30.5	39.4	9.0 (3.8, 14.2)
20 to 29 years	7903	7570	28.7	27.9	-0.9 (-3.8, 2.1)
30 years and over	4247	4588	20.4	20.7	0.3 (-3.0, 3.6)
Maternal Race					
White	9877	9877	29.9	29.9	0.0 (-2.5, 2.5)
Black	2903	3033	12.4	13.0	0.6 (-3.1, 4.3)
Other	1522	1978	20.3	26.0	5.7 (-0.7, 12.0)
Race Unknown	36	95	29.7	32.2	2.5 (-30.8, 35.9)
Maternal Education (Age>23)					
0-8 years	220	199	22.9	22.8	-0.1 (-16.5, 16.4)
9-11 years	714	631	46.9	46.6	-0.3 (-11.6, 10.9)
12 years	3304	2919	30.4	31.7	1.3 (-3.6, 6.1)
13-15 years	2290	2378	22.2	22.9	0.7 (-4.0, 5.4)
16 years or more	2175	2711	10.3	9.6	-0.7 (-4.0, 2.7)
Education Unknown	167	321	24.9	25.5	0.6 (-17.8, 19.0)
Intendedness					
Intended Birth	8407	8794	24.0	23.3	-0.8 (-3.3, 1.8)
Unintended Birth	5931	6189	29.7	32.1	2.4 (-0.9, 5.7)
All Women	14338	14983	26.3	26.7	0.4 (-1.7, 2.5)

Table 4b

Smoking Participation During Pregnancy by Characteristics of the Mother in 10 PRAMS States, 1993 & 1998

	1993	1998	1993	1998	1998-93 (95% CI)
Parity	N	N	%	%	
First Birth	6243	6524	13.6	12.5	-1.1 (-3.4, 1.2)
Second or Later Birth	7848	7908	18.8	16.2	-2.6 (-5.0, -0.2)
Parity Unknown	247	551	23.5	20.0	-3.5 (-17.5, 10.5)
Cigarettes Smoked Before Pregnancy					
No cigarettes	9535	10118	0.3	0.2	-0.1 (-0.4, 0.2)
10 and fewer	1669	2036	37.9	34.9	-3.1 (-9.9, 3.7)
11 to 20	1864	1758	73.7	70.2	-3.5 (-9.4, 2.4)
Over 20	695	580	85.9	75.2	-10.7 (-19.9, -1.6)
Cigarettes Unknown	575	491	34.3	38.1	3.7 (-13.6, 21.0)
Insurance Status					
Medicaid	6478	6180	24.5	23.3	-1.2 (-4.3, 1.9)
Other public	474	452	15.4	9.6	-5.8 (-15.1, 3.5)
Private	5417	6899	9.8	9.5	-0.3 (-2.3, 1.7)
Uninsured	1714	1197	18.4	14.7	-3.7 (-10.1, 2.7)
Insurance Unknown	255	255	20.8	17.2	-3.6 (-20.1, 12.8)
Maternal Age					
Under 20 years	2188	2825	18.0	19.8	1.8 (-2.6, 6.2)
20 to 29 years	7903	7570	18.0	14.4	-3.5 (-5.9, -1.2)
30 years and over	4247	4588	13.8	13.5	-0.3 (-3.1, 2.5)
Maternal Race					
White	9877	9877	18.8	16.6	-2.2 (-4.2, -0.2)
Black	2903	3033	8.5	7.3	-1.2 (-4.3, 1.9)
Other	1522	1978	11.8	12.0	0.2 (-4.1, 4.5)
Race Unknown	36	95	26.2	18.7	-7.6 (-39.4, 24.3)
Maternal Education (Age>23)					
0-8 years	220	199	17.6	20.8	3.2 (-12.3, 18.7)
9-11 years	714	631	39.6	35.2	-4.4 (-15.3, 6.5)
12 years	3304	2919	20.7	18.4	-2.3 (-6.4, 1.8)
13-15 years	2290	2378	11.8	12.4	0.6 (-3.0, 4.2)
16 years or more	2175	2711	4.3	2.7	-1.6 (-3.5, 0.3)
Education Unknown	167	321	21.2	20.4	-0.8 (-19.0, 17.3)
Intendedness					
Intended Birth	8407	8794	15.0	12.6	-2.4 (-4.4, -0.3)
Unintended Birth	5931	6189	19.1	18.1	-1.1 (-3.9, 1.8)
All Women	14338	14983	16.7	14.7	-1.9 (-3.6, -0.2)

Table 4c

Smoking Participation Before Pregnancy by Characteristics of the Mother in 10 PRAMS States, 1993 & 1998

	1993	1998	1993	1998	1998-93 (95% CI)
Parity	N	N	%	%	
First Birth	6243	6524	19.7	20.5	0.8 (-2.0, 3.6)
Second or Later Birth	7848	7908	23.4	21.9	-1.5 (-4.2, 1.1)
Parity Unknown	247	551	21.0	30.4	9.3 (-4.1, 22.8)
Cigarettes Smoked Before Pregnancy					
No cigarettes	9535	10118	0.8	1.1	0.3 (-0.2, 0.7)
10 and fewer	1669	2036	66.1	65.3	-0.8 (-7.6, 6.1)
11 to 20	1864	1758	82.6	84.3	1.7 (-3.2, 6.7)
Over 20	695	580	90.5	85.3	-5.3 (-12.4, 1.9)
Cigarettes Unknown	575	491	63.3	66.0	2.7 (-13.6, 19.0)
Insurance Status					
Medicaid	6478	6180	31.5	31.5	0.0 (-3.4, 3.4)
Other public	474	452	18.0	13.2	-4.8 (-14.4, 4.8)
Private	5417	6899	13.2	15.4	2.1 (-0.2, 4.5)
Uninsured	1714	1197	24.0	20.6	-3.4 (-10.5, 3.6)
Insurance Unknown	255	255	22.4	28.5	6.1 (-12.4, 24.5)
Maternal Age					
Under 20 years	2188	2825	25.9	32.1	6.1 (1.2, 11.1)
20 to 29 years	7903	7570	23.9	22.4	-1.4 (-4.2, 1.3)
30 years and over	4247	4588	16.3	16.4	0.1 (-2.9, 3.1)
Maternal Race					
White	9877	9877	24.2	23.9	-0.3 (-2.6, 2.0)
Black	2903	3033	12.3	11.2	-1.1 (-4.6, 2.4)
Other	1522	1978	16.7	19.9	3.2 (-2.6, 8.9)
Race Unknown	36	95	29.1	22.4	-6.7 (-39.3, 25.9)
Maternal Education (Age>23)					
0-8 years	220	199	19.7	16.9	-2.8 (-17.0, 11.3)
9-11 years	714	631	46.5	42.4	-4.2 (-15.3, 7.0)
12 years	3304	2919	25.6	25.7	0.1 (-4.5, 4.6)
13-15 years	2290	2378	16.8	17.3	0.5 (-3.7, 4.7)
16 years or more	2175	2711	6.4	6.1	-0.3 (-3.1, 2.5)
Education Unknown	167	321	23.0	19.8	-3.2 (-21.3, 14.9)
Intendedness					
Intended Birth	8407	8794	19.4	17.6	-1.8 (-4.2, 0.5)
Unintended Birth	5931	6189	25.2	27.6	2.4 (-0.8, 5.6)
All Women	14338	14983	21.8	21.5	-0.3 (-2.2, 1.6)

Table 5

Quit Rates by Characteristics of the Mother in 10 PRAMS States, 1993 & 1998

	1993	1998	1993	1998	1998-93 (95% CI)
Parity	N	N	%	%	%
First Birth	1,792	1,939	47.7	57.3	9.6 (2.8, 16.5)
Second or Later Birth	2,365	2,258	31.0	37.5	6.6 (0.6, 12.5)
Parity Unknown	71	177	24.2	43.1	18.9 (-4.4, 42.3)
Cigarettes Smoked Before Pregnancy					
10 and fewer	1,669	2,036	62.1	65.1	3.1 (-3.7, 9.9)
11 to 20	1,864	1,758	26.3	29.8	3.5 (-2.4, 9.4)
Over 20	695	580	14.1	24.8	10.7 (1.6, 19.9)
Insurance Status					
Medicaid	2,353	2,317	32.5	37.4	4.9 (-1.1, 10.9)
Other public	112	109	59.4	65.4	6.0 (-23.9, 35.9)
Private	1,168	1,476	47.2	55.5	8.3 (0.6, 15.9)
Uninsured	535	407	33.2	45.9	12.7 (-2.9, 28.3)
Insurance Unknown	60	65	11.4	40.8	29.5 (-8.9, 67.8)
Maternal Age					
Under 20 years	690	1,098	43.1	50.7	7.6 (-2.2, 17.4)
20 to 29 years	2,428	2,231	38.5	49.8	11.3 (5.1, 17.5)
30 years and over	1,110	1,045	33.6	36.3	2.7 (-5.8, 11.1)
Maternal Race					
White	3,319	3,281	38.2	46.0	7.8 (2.9, 12.7)
Black	385	381	34.5	44.9	10.3 (-4.5, 25.2)
Other	511	692	47.2	54.9	7.7 (-6.1, 21.6)
Race Unknown	13	20	11.7	42.0	30.3 (-9.0, 69.7)
Maternal Education (Age>23)					
0-8 YRS	57	42	31.4	9.8	-21.5 (-49.3, 6.2)
9-11 YRS	364	314	15.4	24.4	9.0 (-3.7, 21.7)
12 YRS	1,133	967	32.2	44.1	11.9 (2.8, 21.0)
13-15 YRS	576	558	47.6	47.4	-0.2 (-12.3, 11.9)
>= 16 YRS	254	280	59.1	71.8	12.7 (-3.8, 29.2)
Education Unknown	40	72	7.5	24.5	17.0 (-1.5, 35.4)
Intendedness					
Intended Birth	2,329	2,249	38.9	47.4	8.5 (2.3, 14.7)
Unintended Birth	1,899	2,125	36.9	44.8	7.9 (1.3, 14.5)
All Women	4,129	4,320	38	46.2	8.2 (3.7, 12.7)

Table 5b

Relapse Rates by Characteristics of the Mother in 10 PRAMS States, 1993 & 1998

	1993	1998	1993	1998	1998-93 (95% CI)
Parity	N	N	%	%	%
First Birth	733	1,005	45.2	48.7	3.5 (-6.3, 13.3)
Second or Later Birth	644	741	49.5	57.5	8.0 (-3.0, 19.0)
Parity Unknown	24	74	16.5	66.0	49.5 (20.8, 78.2)
Cigarettes Smoked Before Pregnancy					
10 and fewer	878	1,196	47.4	51.8	4.4 (-5.1, 13.9)
11 to 20	431	498	43.6	57.3	13.7 (2.0, 25.5)
Over 20	92	126	52.6	47.7	-4.9 (-32.5, 22.7)
Insurance Status					
Medicaid	670	847	54.3	59.3	5.0 (-5.7, 15.8)
Other public	53	69	10.7	25.2	14.4 (-5.1, 34.0)
Private	489	733	38.7	49.5	10.8 (0.0, 21.5)
Uninsured	181	161	59.9	47.0	-12.9 (-35.0, 9.1)
Insurance Unknown	8	10	95.5	77.7	-17.7 (-64.0, 28.5)
Maternal Age					
Under 20 years	249	532	57.5	55.4	-2.1 (-16.3, 12.1)
20 to 29 years	835	962	47.3	54.0	6.8 (-3.1, 16.7)
30 years and over	317	326	35.8	47.6	11.9 (-2.5, 26.2)
Maternal Race					
White	1,065	1,347	44.2	52.0	7.8 (-0.1, 15.8)
Black	129	151	69.7	66.9	-2.8 (-24.8, 19.2)
Other	202	315	54.0	47.1	-7.0 (-28.7, 14.8)
Race Unknown	5	7	84.5	39.3	-45.2 (-118, 27.7)
Maternal Education (Age>23)					
0-8 YRS	15	6	70.6	43.0	-27.6 (-105, 49.2)
9-11 YRS	55	71	76.5	71.2	-5.3 (-32.2, 21.7)
12 YRS	316	303	42.0	52.5	10.5 (-5.0, 25.9)
13-15 YRS	217	242	41.7	46.5	4.7 (-13.1, 22.5)
>= 16 YRS	126	189	33.6	47.0	13.5 (-11.2, 38.1)
Education Unknown	10	21	18.0	9.8	-8.3 (-35.9, 19.3)
Intendedness					
Intended Birth	788	940	41.9	48.3	6.4 (-3.2, 16.1)
Unintended Birth	613	880	52.3	58.4	6.1 (-4.5, 16.7)
All Women	1,385	1,796	46.5	52.9	6.4 (-0.8, 13.6)

Table 6

Reasons Given for Cigarette Tax Increases in PRAMS States, 1993-1998

State	Date	Initial tax	New tax	Published reason for tax
Alaska	Oct. 1, 1997	$0.29	$1.00	Deter smoking, revenue for schools
Maine	Nov. 1, 1997	$0.37	$0.74	To fund anti-tobacco campaign
New York	June 1, 1993	$0.39	$0.56	Deter smoking, general revenue
Washington	June 1, 1993	$0.34	$0.54	Deter crime and use of drugs, alcohol
Washington	June 1, 1994	$0.54	$0.565	Deter crime and use of drugs, alcohol
Washington	June 1, 1995	$0.565	$0.815	Deter youth violence
Washington	June 1, 1996	$0.815	$0.825	Deter youth violence

Sources: national and local periodicals

Table 7

Month Women Report Quitting

Month	Percent	Cumulative Percent
First	22.6	22.6
Second	27.7	50.4
Third	19.4	69.8
Fourth	13.8	83.6
Fifth	5.4	88.9
Sixth	2.6	91.5
Seventh	4.0	95.5
Eighth	1.3	96.8
Ninth	3.0	99.8
Not ascertained	0.2	100.0

Source: 1998 NHIS Smoking and Pregnancy Supplement

Table 8

	Smoked Before Pregnancy		
Independent Variables	All Women	Only Among Women More Than 20 Miles From Lower Price	Tax As Instrument For Price
High School	-0.033546	-0.033812	-0.039243
	(0.007805)**	(0.008028)**	(0.008809)**
Some College	-0.104187	-0.103068	-0.119682
	(0.008115)**	(0.008364)**	(0.009957)**
College	-0.217227	-0.217746	-0.237194
	(0.007396)**	(0.007517)**	(0.010353)**
Income 10k to 20k	-0.014638	-0.012391	-0.016830
	(0.008229)	(0.008511)	(0.008632)
Income 21k to 30k	-0.033582	-0.030130	-0.038888
	(0.009255)**	(0.009517)**	(0.009238)**
Income 31k to 40k	-0.016868	-0.013189	-0.023150
	(0.016713)	(0.016914)	(0.014443)
Income 41k to 50k	-0.109341	-0.107693	-0.120844
	(0.032783)**	(0.033058)**	(0.033251)**
Income Over 50k	-0.131058	-0.127745	-0.136722
	(0.031333)**	(0.031842)**	(0.029172)**
Black	-0.241025	-0.243306	-0.288479
	(0.005472)**	(0.005445)**	(0.006766)**
Other Race	-0.077830	-0.075743	-0.080832
	(0.009506)**	(0.009700)**	(0.010313)**
Under 20 Years Old	-0.065927	-0.067899	-0.072674
	(0.007956)**	(0.008109)**	(0.009478)**
Over 30 Years Old	0.019673	0.021036	0.016789
	(0.006834)**	(0.007005)**	(0.006191)**
Medicaid	0.067214	0.070688	0.066657
	(0.008191)**	(0.008443)**	(0.008060)**
Other Public Insurance	0.061802	0.065514	0.057337
	(0.018495)**	(0.018922)**	(0.016206)**
Uninsured	-0.007226	-0.009497	-0.010002
	(0.011247)	(0.011268)	(0.010539)
Unintended Birth	0.044271	0.044906	0.042721
	(0.005963)**	(0.006120)**	(0.005775)**
Married	-0.110520	-0.109617	-0.110252
	(0.008188)**	(0.008392)**	(0.008010)**
First Birth	0.020677	0.021791	0.019650
	(0.005966)**	(0.006150)**	(0.005540)**
Unemployment Rate	-0.006655	-0.007229	-0.005939
	(0.004672)	(0.004857)	(0.004511)
Smoking Restrictions	-0.015410	-0.014593	-0.013624
	(0.016061)	(0.016591)	(0.014190)
Real Tax Before	-0.000796	-0.000937	
	(0.000639)	(0.000658)	
Real Price			-0.000854
			(0.000652)
Elasticity	-0.31	-0.37	-0.40
Observations	93020	87154	93020
R-squared			0.12

Table 9

	Smoked During Pregnancy			
Independent Variables	Birth Certificate Indicator	PRAMS Indicator	Only Among Women More Than 20 Miles From Lower Price	Tax As Instrument For Price
High School	-0.044551	-0.044914	-0.044222	-0.069959
	(0.004570)**	(0.005241)**	(0.005405)**	(0.007981)**
Some College	-0.082853	-0.089756	-0.087972	-0.135509
	(0.004298)**	(0.004971)**	(0.005166)**	(0.008668)**
College	-0.135861	-0.150686	-0.149586	-0.201174
	(0.003846)**	(0.004419)**	(0.004574)**	(0.008855)**
Income 10k to 20k	-0.007995	-0.011765	-0.010765	-0.017615
	(0.005394)	(0.005932)*	(0.006155)	(0.007421)*
Income 21k to 30k	-0.041612	-0.037639	-0.036095	-0.045948
	(0.006057)**	(0.006707)**	(0.006911)**	(0.007699)**
Income 31k to 40k	-0.044378	-0.039689	-0.038676	-0.040629
	(0.009229)**	(0.011207)**	(0.011313)**	(0.010694)**
Income 41k to 50k	-0.073653	-0.054943	-0.054970	-0.081700
	(0.016821)**	(0.024974)*	(0.025078)*	(0.027913)**
Income Over 50k	-0.061104	-0.085391	-0.084273	-0.109072
	(0.022333)**	(0.018587)**	(0.018853)**	(0.020780)**
Black	-0.105052	-0.130291	-0.130818	-0.179700
	(0.003341)**	(0.003609)**	(0.003708)**	(0.005853)**
Other Race	-0.039543	-0.055732	-0.053689	-0.064270
	(0.005818)**	(0.005967)**	(0.006196)**	(0.007791)**
Under 20 Years Old	-0.036550	-0.048127	-0.048489	-0.077559
	(0.004808)**	(0.005325)**	(0.005455)**	(0.008174)**
Over 30 Years Old	0.031740	0.041687	0.041796	0.037276
	(0.004982)**	(0.005427)**	(0.005564)**	(0.005169)**
Medicaid	0.057239	0.048893	0.051391	0.054915
	(0.006018)**	(0.006306)**	(0.006544)**	(0.006821)**
Other Public Insurance	0.028512	0.028362	0.027618	0.027377
	(0.013199)*	(0.014152)*	(0.014368)	(0.012296)*
Uninsured	0.015944	0.005875	0.001887	0.001563
	(0.008678)	(0.008844)	(0.008671)	(0.008527)
Unintended Birth	0.012282	0.019379	0.020675	0.020568
	(0.004057)**	(0.004446)**	(0.004574)**	(0.004877)**
Married	-0.061185	-0.069736	-0.066333	-0.079093
	(0.005653)**	(0.006202)**	(0.006376)**	(0.006984)**
First Birth	-0.037786	-0.029787	-0.029220	-0.028899
	(0.004016)**	(0.004436)**	(0.004582)**	(0.004507)**
Unemployment Rate	0.000769	-0.002873	-0.002455	-0.003634
	(0.003443)	(0.003774)	(0.003940)	(0.004160)
Smoking Restrictions	0.000780	-0.017968	-0.018363	-0.013761
	(0.011380)	(0.012266)	(0.012644)	(0.012228)
Real Tax	0.000072	-0.000327	-0.000465	
	(0.000452)	(0.000475)	(0.000486)	
Real Price				-0.000498
				(0.000780)
Observations	94394	94263	88295	94263
Elasticity	0.05	-0.22	-0.31	-0.40
R-squared				0.10

Robust standard errors in parentheses
* significant at 5%; ** significant at 1%

Table 10

Independent Variables	Smoked After Delivery		
	Main Model	Only Among Women More Than 20 Miles From Lower Price	Tax As Instrument For Price
High School	-0.046751	-0.046234	-0.065083
	(0.006670)**	(0.006857)**	(0.008821)**
Some College	-0.107805	-0.106351	-0.142138
	(0.006662)**	(0.006871)**	(0.009808)**
College	-0.198326	-0.197875	-0.233609
	(0.005779)**	(0.005920)**	(0.010020)**
Income 10k to 20k	-0.018058	-0.016553	-0.023874
	(0.007262)*	(0.007505)*	(0.008513)**
Income 21k to 30k	-0.048432	-0.046505	-0.055765
	(0.008230)**	(0.008453)**	(0.008950)**
Income 31k to 40k	-0.055329	-0.052802	-0.054620
	(0.013596)**	(0.013753)**	(0.012611)**
Income 41k to 50k	-0.097753	-0.096895	-0.137929
	(0.028767)**	(0.028927)**	(0.028309)**
Income Over 50k	-0.122964	-0.120554	-0.129903
	(0.025268)**	(0.025633)**	(0.026700)**
Black	-0.187026	-0.188593	-0.236458
	(0.004402)**	(0.004464)**	(0.006699)**
Other Race	-0.064971	-0.062516	-0.071586
	(0.008552)**	(0.008756)**	(0.009792)**
Under 20 Years Old	-0.046940	-0.046817	-0.060031
	(0.007078)**	(0.007228)**	(0.009426)**
Over 30 Years Old	0.021975	0.022321	0.019033
	(0.006329)**	(0.006487)**	(0.005901)**
Medicaid	0.060262	0.062540	0.064578
	(0.007497)**	(0.007724)**	(0.007906)**
Other Public Insurance	0.036378	0.035500	0.036848
	(0.015942)*	(0.016186)*	(0.014242)**
Uninsured	-0.000814	-0.002827	-0.003830
	(0.010367)	(0.010332)	(0.009911)
Unintended Birth	0.031043	0.032242	0.029897
	(0.005420)**	(0.005569)**	(0.005614)**
Married	-0.090987	-0.087692	-0.092482
	(0.007429)**	(0.007650)**	(0.007918)**
First Birth	-0.023024	-0.022761	-0.022054
	(0.005384)**	(0.005545)**	(0.005270)**
Unemployment Rate	-0.003804	-0.003880	-0.002160
	(0.004718)	(0.004884)	(0.004972)
Smoking Restriction	-0.017182	-0.010573	-0.018534
	(0.016579)	(0.017092)	(0.015718)
Real Price			-0.001826
			(0.000780)*
Real Tax	-0.001212	-0.001203	
	(0.000573)*	(0.000582)*	
Elasticity	-0.58	-0.58	-1.05
Observations	93195	87272	89022
R-squared			0.12

Table 11

Independent Variables	Cigarettes per Day Before Pregnancy Among Smokers		
	Main Model	Only Among Women More Than 20 Miles From Lower Price	Tax As Instrument For Price
High School	-1.389024	-1.409679	-1.392304
	(0.344800)**	(0.359824)**	(0.344936)**
Some College	-3.457930	-3.475876	-3.461687
	(0.410744)**	(0.425735)**	(0.411118)**
College	-5.901693	-5.949206	-5.903017
	(0.563615)**	(0.585851)**	(0.563922)**
Income 10k to 20k	-0.963380	-1.031616	-0.968531
	(0.359218)**	(0.373718)**	(0.359202)**
Income 21k to 30k	-2.100440	-2.308254	-2.100832
	(0.440725)**	(0.455624)**	(0.440841)**
Income 31k to 40k	-3.521614	-3.687572	-3.526970
	(0.715183)**	(0.720689)**	(0.715678)**
Income 41k to 50k	-4.079125	-4.261714	-4.070802
	(2.557918)	(2.578642)	(2.563922)
Income Over 50k	0.069755	-0.004098	0.081654
	(2.758183)	(2.747503)	(2.765697)
Black	-6.048101	-5.868782	-6.049609
	(0.404186)**	(0.415606)**	(0.404135)**
Other Race	-3.193423	-3.122572	-3.194436
	(0.518049)**	(0.531884)**	(0.518144)**
Under 20 Years Old	-1.823216	-1.863508	-1.820390
	(0.387802)**	(0.405195)**	(0.387660)**
Over 30 Years Old	1.699177	1.649087	1.700448
	(0.316664)**	(0.325860)**	(0.316776)**
Medicaid	1.485124	1.331315	1.482901
	(0.346118)**	(0.357672)**	(0.346374)**
Other Public Insurance	0.565750	0.524726	0.554076
	(0.843403)	(0.865741)	(0.849096)
Uninsured	-0.115320	-0.241046	-0.117540
	(0.485000)	(0.491672)	(0.484934)
Unintended Birth	0.253210	0.260429	0.249710
	(0.255905)	(0.265502)	(0.256005)
Married	-0.547135	-0.429718	-0.544265
	(0.307396)	(0.318346)	(0.307613)
First Birth	-0.416688	-0.374045	-0.418276
	(0.271321)	(0.280110)	(0.271273)
Unemployment Rate	0.144057	0.083058	0.165489
	(0.213668)	(0.223709)	(0.213743)
Smoking Restrictions	1.293552	1.263115	1.292551
	(0.820852)	(0.866621)	(0.820865)
Real Tax	-0.023547	-0.018334	
	(0.027965)	(0.028538)	
Real Price			-0.026390
			(0.031395)
Elasticity	-0.15	-0.12	-0.20
Observations	27101	25041	27101
R-squared	0.08	0.08	0.08

Robust standard errors in parentheses
* significant at 5%; ** significant at 1%

Table 12

Independent Variables	Cigarettes per Day During Pregnancy Among Smokers		
	Main Model	Only Among Women More Than 20 Miles From Lower Price	Tax As Instrument For Price
High School	-1.459545	-1.408362	-1.450787
	(0.361208)**	(0.378960)**	(0.361365)**
Some College	-2.497634	-2.426016	-2.497728
	(0.416517)**	(0.432668)**	(0.416462)**
College	-4.224020	-4.226736	-4.205782
	(0.613810)**	(0.637476)**	(0.613911)**
Income 10k to 20k	-0.435567	-0.496084	-0.433576
	(0.396572)	(0.409762)	(0.396383)
Income 21k to 30k	-1.226072	-1.286068	-1.226260
	(0.466865)**	(0.482070)**	(0.466392)**
Income 31k to 40k	-0.811226	-0.837058	-0.822025
	(0.943577)	(0.945852)	(0.943171)
Income 41k to 50k	-3.477040	-3.584021	-3.463062
	(2.146243)	(2.187844)	(2.142254)
Income Over 50k	-2.909546	-2.894561	-2.869242
	(3.242694)	(3.220016)	(3.259607)
Black	-4.165819	-3.980370	-4.157194
	(0.452537)**	(0.472812)**	(0.452528)**
Other Race	-2.044090	-2.019663	-2.010703
	(0.541520)**	(0.549466)**	(0.541491)**
Under 20 Years Old	-1.225099	-1.114217	-1.224283
	(0.424573)**	(0.446977)*	(0.424442)**
Over 30 Years Old	1.596836	1.609435	1.591107
	(0.350121)**	(0.360337)**	(0.350000)**
Medicaid	0.585750	0.531530	0.583153
	(0.388994)	(0.404700)	(0.388711)
Other Public Insurance	0.657705	0.763994	0.644056
	(0.853084)	(0.869995)	(0.854615)
Uninsured	-0.420703	-0.604408	-0.424610
	(0.549615)	(0.532630)	(0.550067)
Unintended Birth	0.633994	0.547054	0.630987
	(0.280663)*	(0.291721)	(0.280658)*
Married	0.146562	0.210161	0.147648
	(0.331027)	(0.340344)	(0.331043)
First Birth	-2.151691	-2.154647	-2.156332
	(0.284717)**	(0.295937)**	(0.284819)**
Unemployment Rate	-0.187141	-0.228117	-0.166721
	(0.229087)	(0.242122)	(0.228988)
Smoking Restrictions	0.257238	0.793727	0.271192
	(0.872077)	(0.855424)	(0.872092)
Real Tax	-0.037560	-0.037386	
	(0.024311)	(0.024539)	
Real Price			-0.057012
			(0.036891)
Elasticity	-0.36	-0.36	-0.65
Observations	17322	15919	17322
R-squared	0.07	0.07	0.07

Robust standard errors in parentheses
* significant at 5%; ** significant at 1%

Table 13

Independent Variables	Cigarettes per Day After Delivery Among Smokers		
	All Women	Only Women More Than 20 Miles From Lower Price	Tax As Instrument For Price
High School	-1.923742	-1.953660	-2.000530
	(0.333128)**	(0.347345)**	(0.330470)**
Some College	-3.961435	-3.921947	-4.014893
	(0.401771)**	(0.417544)**	(0.392628)**
College	-6.080061	-6.211862	-6.102438
	(0.574897)**	(0.591278)**	(0.573155)**
Income 10k to 20k	-0.280514	-0.301579	-0.212368
	(0.350303)	(0.365078)	(0.355825)
Income 21k to 30k	-0.829654	-0.826060	-0.898832
	(0.449252)	(0.462635)	(0.443829)*
Income 31k to 40k	-1.593085	-1.621676	-1.355232
	(0.886102)	(0.888649)	(0.895922)
Income 41k to 50k	1.759197	1.746680	4.923498
	(3.259641)	(3.296315)	(3.383426)
Income Over 50k	-4.682775	-4.599442	-4.583533
	(2.444452)	(2.407667)	(2.429948)
Black	-5.148740	-4.979582	-5.537836
	(0.394866)**	(0.414293)**	(0.358794)**
Other Race	-3.297708	-3.266684	-3.275594
	(0.463484)**	(0.473055)**	(0.490696)**
Under 20 Years Old	-0.952464	-0.918122	-1.007522
	(0.364163)**	(0.379388)*	(0.372291)**
Over 30 Years Old	1.185265	1.189221	0.997286
	(0.313282)**	(0.322860)**	(0.306287)**
Medicaid	0.960197	0.940260	0.924516
	(0.340603)**	(0.353747)**	(0.343440)**
Other Public Insurance	2.017833	1.811796	2.113361
	(0.667753)**	(0.669840)**	(0.680121)**
Uninsured	0.124399	-0.011068	0.010703
	(0.537792)	(0.544097)	(0.552861)
Unintended Birth	0.065996	-0.062323	0.136420
	(0.251817)	(0.261814)	(0.252987)
Married	-0.475316	-0.469256	-0.567596
	(0.296527)	(0.307435)	(0.292290)
First Birth	-1.518333	-1.434245	-1.443808
	(0.262868)**	(0.271347)**	(0.259228)**
Unemployment Rate	-0.168573	-0.149387	-0.169239
	(0.241315)	(0.253037)	(0.241339)
Smoking Restriction	0.240577	0.300277	0.237176
	(0.858158)	(0.893313)	(0.860506)
Real Tax	-0.021930	-0.023920	
	(0.021642)	(0.021825)	
Real Price			-0.025881
			(0.028613)
Elasticity	-0.16	-0.17	-0.22
Observations	93195	87272	89022
R-squared			0.12

Robust standard errors in parentheses
* significant at 5%; ** significant at 1%

Table 14

Independent Variables	Cigarettes per Day Before Pregnancy		
	Main Model	Only Among Women More Than 20 Miles From Lower Price	Tax As Instrument For Price
High School	-1.234991	-1.225432	-1.236606
	(0.204359)**	(0.212610)**	(0.204354)**
Some College	-3.060881	-3.036819	-3.064381
	(0.218128)**	(0.227176)**	(0.218219)**
College	-4.930331	-4.940957	-4.932111
	(0.223815)**	(0.232652)**	(0.223890)**
Income 10k to 20k	-0.604428	-0.565961	-0.608683
	(0.182034)**	(0.188934)**	(0.182060)**
Income 21k to 30k	-1.181647	-1.182124	-1.183783
	(0.192448)**	(0.199051)**	(0.192542)**
Income 31k to 40k	-1.212436	-1.199990	-1.214685
	(0.250078)**	(0.253859)**	(0.250101)**
Income 41k to 50k	-2.941205	-2.940170	-2.936035
	(0.592607)**	(0.593306)**	(0.593110)**
Income Over 50k	-2.610489	-2.566602	-2.613259
	(0.590624)**	(0.596560)**	(0.591204)**
Black	-5.807288	-5.812073	-5.807235
	(0.139207)**	(0.143512)**	(0.139206)**
Other Race	-2.041196	-2.011595	-2.041655
	(0.189322)**	(0.198034)**	(0.189349)**
Under 20 Years Old	-1.739652	-1.764302	-1.738798
	(0.203325)**	(0.210158)**	(0.203293)**
Over 30 Years Old	0.656353	0.661194	0.655484
	(0.128245)**	(0.132327)**	(0.128259)**
Medicaid	1.578374	1.595302	1.579147
	(0.171994)**	(0.178972)**	(0.172010)**
Other Public Insurance	1.088402	1.123373	1.085771
	(0.301922)**	(0.312901)**	(0.302314)**
Uninsured	-0.307485	-0.354577	-0.306627
	(0.195328)	(0.198678)	(0.195328)
Unintended Birth	0.733292	0.735873	0.732390
	(0.120455)**	(0.124508)**	(0.120467)**
Married	-1.953805	-1.892503	-1.950323
	(0.176112)**	(0.183018)**	(0.176219)**
First Birth	0.144476	0.168589	0.144598
	(0.110143)	(0.113589)	(0.110164)
Unemployment Rate	-0.060182	-0.080981	-0.045639
	(0.093280)	(0.096691)	(0.093983)
Smoking Restrictions	0.115213	0.135116	0.117034
	(0.308807)	(0.318785)	(0.308730)
Real Tax	-0.019543	-0.020620	
	(0.012108)	(0.012388)*	
Real Price			-0.020572
			(0.012755)
	-0.47	-0.50	-0.60
Observations	93020	87154	93020
R-squared	0.12	0.12	0.12

Robust standard errors in parentheses
* significant at 5%; ** significant at 1%

Table 15

Independent Variables	Cigarettes per Day During Pregnancy		
	Main Model	Only Among Women More Than 20 Miles From Lower Price	Tax As Instrument For Price
High School	-1.172711	-1.137753	-1.171954
	(0.131661)**	(0.136081)**	(0.131667)**
Some College	-2.015015	-1.965417	-2.013745
	(0.135692)**	(0.140560)**	(0.135689)**
College	-2.700353	-2.665660	-2.698138
	(0.138975)**	(0.144005)**	(0.138974)**
Income 10k to 20k	-0.287282	-0.263276	-0.286348
	(0.107629)**	(0.110977)*	(0.107593)**
Income 21k to 30k	-0.651187	-0.640434	-0.650563
	(0.107767)**	(0.111456)**	(0.107762)**
Income 31k to 40k	-0.553594	-0.543030	-0.554557
	(0.141616)**	(0.143398)**	(0.141586)**
Income 41k to 50k	-1.428544	-1.434447	-1.423346
	(0.309246)**	(0.309734)**	(0.309139)**
Income Over 50k	-1.516379	-1.503287	-1.514395
	(0.266747)**	(0.269278)**	(0.267044)**
Black	-2.332334	-2.309482	-2.332954
	(0.083193)**	(0.085262)**	(0.083187)**
Other Race	-0.937682	-0.928446	-0.936199
	(0.103632)**	(0.108285)**	(0.103488)**
Under 20 Years Old	-1.162279	-1.129742	-1.162103
	(0.120073)**	(0.124453)**	(0.120050)**
Over 30 Years Old	0.571653	0.581450	0.570473
	(0.082431)**	(0.085101)**	(0.082469)**
Medicaid	0.726639	0.747677	0.726490
	(0.100394)**	(0.104996)**	(0.100384)**
Other Public Insurance	0.446822	0.450953	0.448251
	(0.187043)*	(0.193915)*	(0.187057)*
Uninsured	-0.093068	-0.144403	-0.093952
	(0.113300)	(0.110718)	(0.113284)
Unintended Birth	0.344358	0.342427	0.343736
	(0.074228)**	(0.076702)**	(0.074222)**
Married	-0.769831	-0.716903	-0.772359
	(0.109611)**	(0.112568)**	(0.109563)**
First Birth	-0.605420	-0.597640	-0.606239
	(0.060689)**	(0.062845)**	(0.060731)**
Unemployment Rate	-0.079589	-0.079039	-0.072662
	(0.057419)	(0.059794)	(0.057749)
Smoking Restrictions	-0.038972	0.031752	-0.039785
	(0.185930)	(0.180005)	(0.185986)
Real Tax	-0.009097	-0.011266	
	(0.006822)	(0.006877)	
Real Price			-0.013964
			(0.010473)
Elasticity	-0.56	-0.69	-1.03
Observations	94263	88295	94263
R-squared	0.08	0.08	0.08

Robust standard errors in parentheses
* significant at 5%; ** significant at 1%

Table 16

Independent Variables	Cigarettes per Day After Delivery		
	All Women	Only Among Women More Than 20 Miles From Lower Price	Tax As Instrument For Price
High School	-1.699321	-1.680403	-1.751597
	(0.180773)**	(0.188138)**	(0.183621)**
Some College	-3.204555	-3.161717	-3.250431
	(0.191143)**	(0.199361)**	(0.192852)**
College	-4.472179	-4.463122	-4.496135
	(0.196673)**	(0.204339)**	(0.197419)**
Income 10k to 20k	-0.437437	-0.389438	-0.431144
	(0.154773)**	(0.160500)*	(0.157613)**
Income 21k to 30k	-0.947968	-0.918341	-0.957478
	(0.164178)**	(0.169742)**	(0.164625)**
Income 31k to 40k	-0.961827	-0.928412	-0.932342
	(0.209714)**	(0.213065)**	(0.211930)**
Income 41k to 50k	-1.845770	-1.837234	-1.825478
	(0.595182)**	(0.596276)**	(0.636626)**
Income Over 50k	-2.492633	-2.448488	-2.385340
	(0.345736)**	(0.349069)**	(0.366730)**
Black	-4.309059	-4.307226	-4.352799
	(0.120770)**	(0.124831)**	(0.120207)**
Other Race	-1.606982	-1.588795	-1.637936
	(0.152794)**	(0.159498)**	(0.158872)**
Under 20 Years Old	-1.263198	-1.231310	-1.243706
	(0.175109)**	(0.182106)**	(0.180672)**
Over 30 Years Old	0.428692	0.437140	0.395685
	(0.107973)**	(0.111691)**	(0.108014)**
Medicaid	1.204552	1.242191	1.197334
	(0.145824)**	(0.152115)**	(0.148385)**
Other Public Insurance	0.993322	0.930580	1.046178
	(0.259993)**	(0.261455)**	(0.267901)**
Uninsured	-0.154672	-0.190310	-0.158009
	(0.176086)	(0.178372)	(0.178431)
Unintended Birth	0.446673	0.422598	0.458093
	(0.103405)**	(0.107053)**	(0.105227)**
Married	-1.435461	-1.387366	-1.435478
	(0.150108)**	(0.155858)**	(0.152390)**
First Birth	-0.620242	-0.596701	-0.626639
	(0.090933)**	(0.094106)**	(0.091906)**
Unemployment Rate	-0.099684	-0.110260	-0.084528
	(0.090827)	(0.094469)	(0.091446)
Smoking Restrictions	-0.213433	-0.104920	-0.248394
	(0.301167)	(0.306364)	(0.302247)
Real Tax	-0.023800	-0.024536	
	(0.010239)*	(0.010460)*	
Real Price			-0.031753
			(0.013811)*
Elasticity	-0.78	-0.80	-1.25
Observations	93202	87287	89022
R-squared	0.12	0.12	0.12

Robust standard errors in parentheses
* significant at 5%; ** significant at 1%

Table 17

Independent Variable	**Dependent Variable**			
	Participation		Cigarettes Per Day	Cigarettes Per Day
	All Women	Women Further Than 20 Miles From Lower Price	Smokers	All Women
Tax During Pregnancy	-0.000344	-0.000436	-0.037515	-0.008384
	(0.000603)	(0.000617)	(0.024199)	(0.006772)
Before *minus* During	-0.000326	-0.000291	0.013968	-0.011159
	(0.000644)	(0.000667)	(0.033890)	(0.011197)
After *minus* During	-0.000824	-0.000694	0.016586	-0.015096
	(0.000580)	(0.000599)	(0.028740)	(0.009509)
Observations	285,861	241,814	68,619	285,864

Table 18

Independent Variable	Dependent Variable		
	Ln (P_1/P_3)	Ln (P_2/P_3)	Ln (P_1/P_2)
High School	0.347	0.516	-0.170
	(0.051)**	(0.069)**	(0.061)**
Some College	0.929	0.840	0.089
	(0.063)**	(0.086)**	(0.073)
College	2.070	1.265	0.805
	(0.089)**	(0.115)**	(0.086)**
Income 10k to 20k	0.115	0.099	0.016
	(0.057)*	(0.075)	(0.063)
Income 21k to 30k	0.335	0.362	-0.027
	(0.070)**	(0.091)**	(0.071)
Income 31k to 40k	0.379	0.515	-0.137
	(0.141)**	(0.173)**	(0.124)
Income 41k to 50k	0.797	0.084	0.713
	(0.390)*	(0.547)	(0.417)
Income Over 50k	1.223	0.620	0.604
	(0.469)**	(0.589)	(0.408)
Black	1.860	0.161	1.699
	(0.064)**	(0.090)	(0.071)**
Other Race	0.645	0.355	0.289
	(0.082)**	(0.103)**	(0.082)**
Under 20 Years Old	0.473	0.387	0.086
	(0.062)**	(0.079)**	(0.065)
Over 30 Years Old	-0.315	-0.499	0.183
	(0.047)**	(0.065)**	(0.054)**
Medicaid	-0.450	-0.214	-0.235
	(0.055)**	(0.073)**	(0.060)**
Other Public Insurance	-0.274	0.111	-0.385
	(0.114)*	(0.157)	(0.126)**
Uninsured	-0.003	-0.084	0.081
	(0.081)	(0.107)	(0.085)
Unintended Birth	-0.219	0.040	-0.259
	(0.040)**	(0.053)	(0.044)**
Married	0.682	0.218	0.464
	(0.050)**	(0.066)**	(0.057)**
First Birth	0.191	0.630	-0.439
	(0.042)**	(0.055)**	(0.044)**
Unemployment Rate	-0.003	0.098	-0.101
	(0.034)	(0.047)*	(0.039)**
Smoking Restrictions	0.182	0.174	0.008
	(0.115)	(0.163)	(0.135)
Real Tax During	0.003	0.006	-0.003
	(0.004)	(0.006)	(0.005)
Observations	92314	92314	92314

Robust standard errors in parentheses
* significant at 5%; ** significant at 1%

State = 1 if a non-smoker; State = 2 if smokes before but not during;
State = 3 if smokes before and during pregnancy.

Table 19

Independent Variable	Dependent Variable					
	Ln (P_1/P_4)	Ln (P_2/P_4)	Ln (P_3/P_4)	Ln (P_1/P_3)	Ln (P_2/P_3)	Ln (P_1/P_2)
High School	0.3489	0.6272	0.4500	-0.1011	0.1772	-0.2783
	(0.0515)**	(0.0956)**	(0.0843)**	(0.0774)	(0.1119)	(0.0899)**
Some College	0.9230	1.0308	0.7004	0.2225	0.3304	-0.1078
	(0.0646)**	(0.1118)**	(0.1091)**	(0.0982)*	(0.1341)*	(0.1014)
College	2.0906	1.5388	0.9992	1.0914	0.5397	0.5517
	(0.0910)**	(0.1393)**	(0.1506)**	(0.1285)**	(0.1667)**	(0.1158)**
Income 10k to 20k	0.1270	0.1825	0.0404	0.0865	0.1420	-0.0555
	(0.0574)*	(0.0956)	(0.0933)	(0.0837)	(0.1136)	(0.0860)
Income 21k to 30k	0.3576	0.5099	0.2374	0.1202	0.2725	-0.1523
	(0.0717)**	(0.1094)**	(0.1186)*	(0.1031)	(0.1321)*	(0.0924)
Income 31k to 40k	0.4081	0.7751	0.2497	0.1584	0.5254	-0.3670
	(0.1447)**	(0.2008)**	(0.2238)	(0.1859)	(0.2315)*	(0.1573)*
Income 41k to 50k	0.9269	0.3056	0.1174	0.8096	0.1882	0.6213
	(0.4124)*	(0.6420)	(0.7655)	(0.6759)	(0.8323)	(0.5096)
Income Over 50k	1.2152	0.8551	0.2788	0.9364	0.5763	0.3600
	(0.4757)*	(0.6585)	(0.8206)	(0.7115)	(0.8460)	(0.4854)
Black	1.9204	-0.0485	0.3454	1.5750	-0.3938	1.9688
	(0.0670)**	(0.1310)	(0.1044)**	(0.0881)**	(0.1425)**	(0.1171)**
Other Race	0.6811	0.3003	0.4868	0.1943	-0.1865	0.3808
	(0.0861)**	(0.1275)*	(0.1313)**	(0.1127)	(0.1468)	(0.1088)**
Under 20 Years Old	0.4714	0.3008	0.4867	-0.0152	-0.1859	0.1707
	(0.0625)**	(0.1014)**	(0.0964)**	(0.0852)	(0.1170)	(0.0910)
Over 30 Years Old	-0.3059	-0.4145	-0.5750	0.2690	0.1605	0.1086
	(0.0481)**	(0.0806)**	(0.0861)**	(0.0778)**	(0.1013)	(0.0707)
Medicaid	-0.4472	-0.2876	-0.1553	-0.2919	-0.1323	-0.1596
	(0.0561)**	(0.0911)**	(0.0947)	(0.0841)**	(0.1106)	(0.0800)*
Other Public Insurance	-0.2864	0.1264	0.0278	-0.3142	0.0986	-0.4129
	(0.1180)*	(0.2132)	(0.1757)	(0.1460)*	(0.2292)	(0.1890)*
Uninsured	0.0101	-0.0063	-0.1496	0.1597	0.1434	0.0163
	(0.0832)	(0.1319)	(0.1367)	(0.1203)	(0.1579)	(0.1133)
Unintended Birth	-0.2242	0.0358	0.0557	-0.2799	-0.0199	-0.2600
	(0.0410)**	(0.0680)	(0.0666)	(0.0596)**	(0.0807)	(0.0604)**
Married	0.6819	0.2452	0.2056	0.4763	0.0396	0.4367
	(0.0507)**	(0.0855)**	(0.0834)*	(0.0767)**	(0.1030)	(0.0778)**
First Birth	0.2183	0.8693	0.4365	-0.2182	0.4329	-0.6511
	(0.0433)**	(0.0691)**	(0.0700)**	(0.0614)**	(0.0823)**	(0.0601)**
Unemployment Rate	-0.0050	0.1286	0.0688	-0.0738	0.0598	-0.1336
	(0.0350)	(0.0585)*	(0.0601)	(0.0537)	(0.0713)	(0.0516)**
Smoking Restrictions	0.1499	-0.0406	0.2959	-0.1460	-0.3365	0.1905
	(0.1175)	(0.2147)	(0.2019)	(0.1800)	(0.2537)	(0.1919)
Real Tax During	0.0025	0.0106	-0.0034	0.0059	0.0140	-0.0081
	(0.0044)	(0.0067)	(0.0088)	(0.0079)	(0.0094)	(0.0057)
Observations	90747	90747	90747	90747	90747	90747

Robust standard errors in parentheses

* significant at 5%; ** significant at 1%

State = 1 if a non-smoker; State = 2 if smoked before but not during or after pregnancy; State = 3 if smoked before and after but not during pregnancy; State = 4 if smoked before, during, and after pregnancy.

Table 20

Independent Variables	Quit During Pregnancy		
	Main Model	Fixed Effects	Pre-pregnancy Consumption
High School	0.128469	0.068445	0.117974
	(0.016444)**	(0.019199)**	(0.017043)**
Some College	0.210746	0.082976	0.176067
	(0.020593)**	(0.024051)**	(0.021247)**
College	0.303006	0.097995	0.244879
	(0.025276)**	(0.032615)**	(0.027649)**
Income 10k to 20k	0.024446	0.007576	0.017988
	(0.018069)	(0.020222)	(0.018528)
Income 21k to 30k	0.087058	0.029596	0.065344
	(0.022272)**	(0.023972)	(0.022768)**
Income 31k to 40k	0.117340	0.036417	0.090014
	(0.042736)**	(0.045868)	(0.044680)*
Income 41k to 50k	-0.029198	-0.121359	-0.080804
	(0.127769)	(0.130372)	(0.130125)
Income Over 50k	0.189143	0.122243	0.210965
	(0.144587)	(0.165729)	(0.160149)
Black	0.076779	-0.103308	-0.013155
	(0.021279)**	(0.020250)**	(0.021848)
Other Race	0.095177	-0.019079	0.046449
	(0.027380)**	(0.026197)	(0.027723)
Under 20 Years Old	0.095202	0.055898	0.075690
	(0.019625)**	(0.021894)*	(0.019970)**
Over 30 Years Old	-0.123514	-0.097847	-0.114597
	(0.014739)**	(0.015960)**	(0.015079)**
Medicaid	-0.053056	-0.001294	-0.037016
	(0.017036)**	(0.018387)	(0.017504)*
Other Public Insurance	0.039386	0.090409	0.053613
	(0.038997)	(0.042939)*	(0.036623)
Uninsured	-0.034109	-0.041856	-0.034369
	(0.025265)	(0.025839)	(0.025996)
Unintended Birth	0.008479	0.005361	0.007134
	(0.012570)	(0.013805)	(0.012918)
Married	0.052213	0.039173	0.052306
	(0.014700)**	(0.016073)*	(0.014963)**
First Birth	0.145301	0.104826	0.149421
	(0.013496)**	(0.014763)**	(0.013725)**
Unemployment Rate	0.024014	0.007303	0.016863
	(0.011513)*	(0.012360)	(0.011741)
Smoking Restrictions	0.048560	0.096413	0.075237
	(0.040250)	(0.048810)*	(0.042410)
Real Tax During	0.001654	0.001682	0.001681
	(0.001458)	(0.001473)	(0.001342)
Fixed Effect		-0.052104	
		(0.001297)**	
11 to 20 Cigarettes Before			-0.299012
			(0.012288)**
Over 20 Cigarettes Before			-0.313518
			(0.013574)**
Elasticity	0.41	0.41	0.41
Observations	26573	26573	26573

Table 21

Independent Variables	Relapse After Pregnancy		
	Real Tax After Pregnancy	Including Fixed-Effect as Regressor	Taxes After *minus* Taxes During
High School	-0.0501	-0.0182	-0.0495
	(0.0281)	(0.0298)	(0.0282)
Some College	-0.0876	-0.0074	-0.0860
	(0.0333)**	(0.0351)	(0.0336)*
College	-0.1241	-0.0015	-0.1242
	(0.0411)**	(0.0457)	(0.0410)**
Income 10k to 20k	-0.0367	-0.0273	-0.0352
	(0.0287)	(0.0294)	(0.0286)
Income 21k to 30k	-0.0689	-0.0416	-0.0678
	(0.0330)*	(0.0336)	(0.0329)*
Income 31k to 40k	-0.1239	-0.0767	-0.1227
	(0.0568)*	(0.0600)	(0.0569)*
Income 41k to 50k	0.0182	0.0319	0.0169
	(0.1968)	(0.1738)	(0.1971)
Income Over 50k	-0.1400	-0.1957	-0.1372
	(0.2109)	(0.2235)	(0.2113)
Black	0.1132	0.1702	0.1134
	(0.0334)**	(0.0317)**	(0.0334)**
Other Race	0.0453	0.0907	0.0439
	(0.0373)	(0.0375)*	(0.0373)
Under 20 Years Old	0.0604	0.0805	0.0602
	(0.0295)*	(0.0301)**	(0.0295)*
Over 30 Years Old	-0.0436	-0.0463	-0.0439
	(0.0253)	(0.0264)	(0.0253)
Medicaid	0.0252	-0.0188	0.0270
	(0.0262)	(0.0266)	(0.0263)
Other Public Insurance	-0.0278	-0.0382	-0.0174
	(0.0550)	(0.0515)	(0.0536)
Uninsured	-0.0368	-0.0371	-0.0366
	(0.0402)	(0.0403)	(0.0401)
Unintended Birth	0.0052	0.0153	0.0057
	(0.0203)	(0.0211)	(0.0204)
Married	-0.0262	-0.0345	-0.0261
	(0.0249)	(0.0259)	(0.0249)
First Birth	-0.1008	-0.1210	-0.1003
	(0.0210)**	(0.0215)**	(0.0210)**
Unemployment Rate	-0.0293	-0.0369	-0.0286
	(0.0194)	(0.0206)	(0.0195)
Smoking Restrictions	-0.0049	-0.0170	0.0027
	(0.0725)	(0.0782)	(0.0724)
Real Tax After	-0.0037	-0.0042	
	(0.0022)*	(0.0019)*	
Fixed effect		0.0470	
		(0.0030)**	
Tax Difference, After-Before			-0.0005
			(0.0029)
Elasticity	-0.77	-0.86	-0.11
Observations	9827		9827

Table 22

The Effect on the Tax Coefficient of Adding Successively More Covariates

Coefficient on Real Tax	Standard Error	Covariates Added
-0.000803	-0.000674	State, Year
-0.000868	-0.000660	Education
-0.000965	-0.000656	Income
-0.001069	-0.000648	Race
-0.001069	-0.000648	Age
-0.000804	-0.000644	Insurance Status
-0.000721	-0.000639	Intended, Married, First Birth, State Unemployment Rate
-0.000796	-0.000639	Smoking Restrictions Index

Table 23
Maternal Characteristics (in %)

Insurance Before Pregnancy	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Medicaid	41.4	41.7	41.8	39.8	39.6	35.8
Other public	2.3	1.8	1.7	2.2	2.1	1.6
Private	46.1	46.4	45.6	50.3	51.0	55.9
Uninsured	9.0	8.9	6.5	6.6	6.4	5.9
Insurance Unknown	1.2	1.2	4.5	1.2	0.9	0.8
p-value for independence of year and insurance = 0.0000						
Maternal Education (Age>23)						
0 to 8 years	2.36	2.25	2.11	2.59	2.3	2
9 to 11 years	7.31	6.71	6.68	7.27	7.32	6.89
12 years	34.26	33.53	31.74	30.34	30.73	31.2
13 - 15 years	25.07	24.9	27.15	26.77	26.15	25.19
16 years or more	29.72	30.87	29.76	30.1	31.52	32.05
Unknown	1.28	1.73	2.56	2.93	1.99	2.67
p-value for independence of year and education = 0.1692						
Maternal Age						
Under 20 years	13.6	13.9	13.6	13.5	13.2	12.5
20 to 29 years	55.6	52.6	52.9	51.7	51.6	52.1
30 years and over	30.8	33.5	33.5	34.8	35.2	35.4
p-value for independence of year and age = 0.0001						
Maternal Race						
White	75.0	75.7	76.4	76.1	76.1	77.1
Black	21.4	20.2	19.3	19.7	19.8	17.8
Other	3.3	3.7	3.7	3.6	3.7	4.4
Race Unknown	0.3	0.4	0.7	0.6	0.4	0.8
p-value for independence of year and age = 0.0002						
Married	65.8	67.8	68.4	67.5	67.3	67.4
p-value for independence of year and married = 0.1614						
First Birth	44.2	43.4	42.8	42.0	42.3	41.8
p-value for independence of year and parity = 0.1395						

Figure 1: Smoking Participation among Non-pregnant Women in BRFSS (BF) & PRAMS

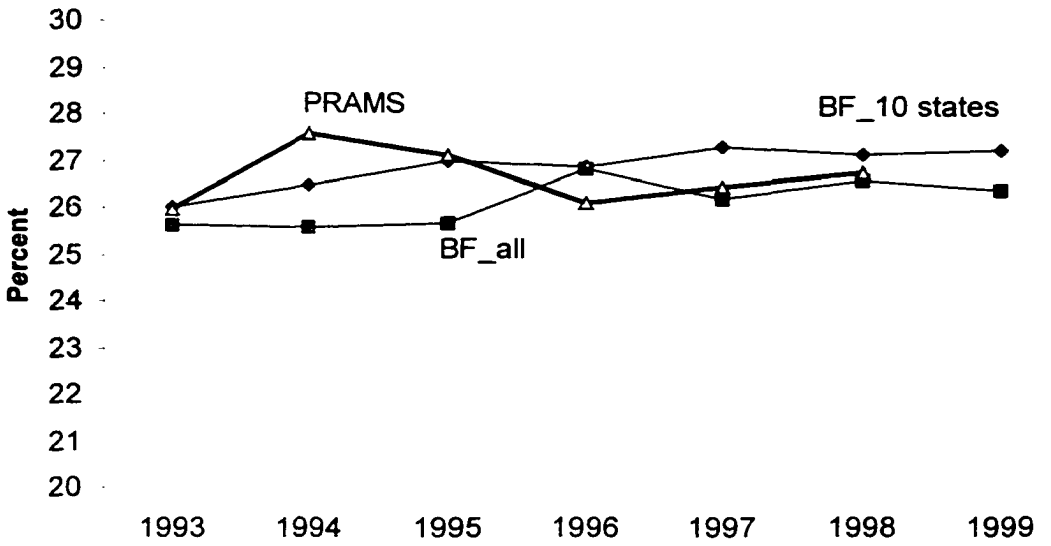


Figure 2: Smoking Participation during pregnancy from PRAMS, BRFSS (BF) and Birth Certificates (BC)

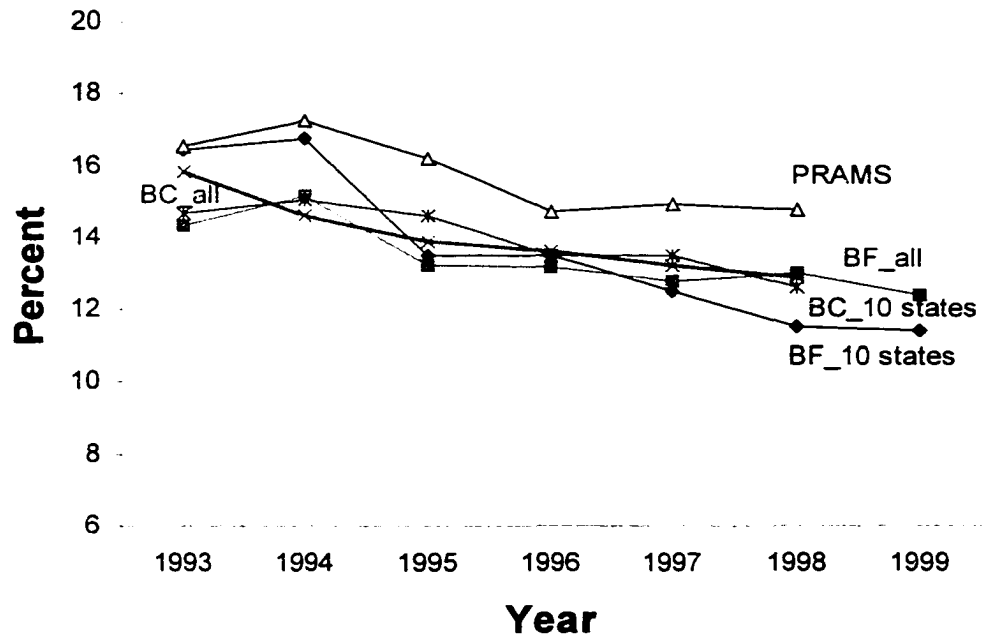
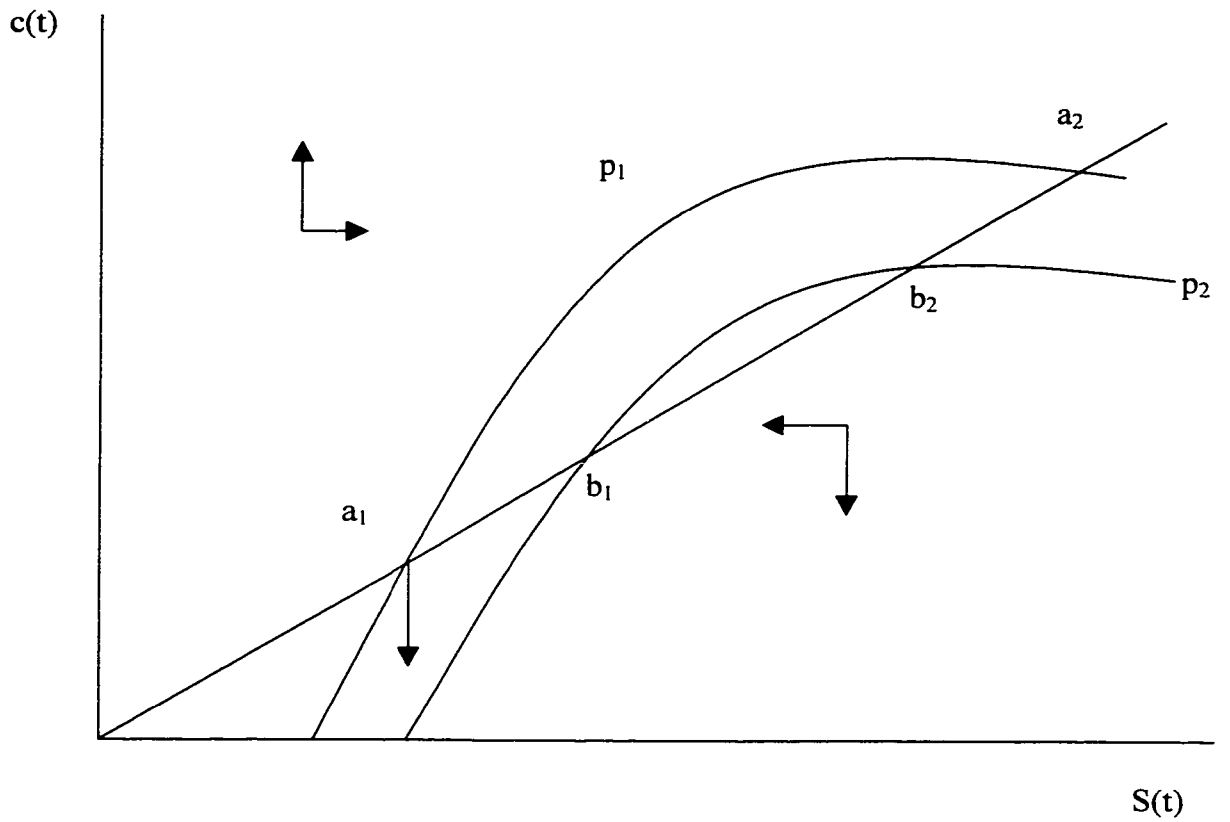


Figure 3



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