Learning about Individual Risk and the Decision to Smoke[1]

Ahmed Khwaja, Fuqua School of Business, Duke University
Frank Sloan, Department of Economics, Duke University and NBER
Sukyung Chung, School of Public Health, University of North Carolina at Chapel Hill

JEL Classification: D81, I12

Abstract

We formulate a simple model of individual learning about the objective risk of smoking and personal susceptibility to that risk. Exploiting the longitudinal feature of the Health and Retirement Study, we examine the implications of the model. Information in the form of health shocks to self and spousal health shocks affect the decision to smoke. Health shocks are an important determinant of two-year mortality. Smoking raises the probability of death and other adverse health events in the future. Controlling for unobserved heterogeneity, smokers quit in response to personalized information from major health shocks, the same factors that explain the objective mortality risk, but smoking decisions do not respond to spousal health shocks. Smoking mitigates job-related and family stress; stressful events explain continued smoking by increasing the benefit of smoking. . We find evidence that smokers learn over time about the objective risk and their individual susceptibility to this risk, and this in turn affects their decisions to smoke.

[1] This research was supported in part by a grant from the National Institute on Aging (1R01-AG-16816) and a grant from the Robert Wood Johnson Foundation, "Why Mature Smokers Do Not Quit." We thank Dan Silverman, Kip Viscusi, an anonymous referee, and participants of the faculty workshop at the Fuqua School of Business for several helpful suggestions. . All remaining errors are our own. Author email addresses: ahmed.khwaja@duke.edu, fsloan@hpolicy.duke.edu and sukyungc@email.unc.edu.

I. Introduction

Given information about the harms of smoking and increased barriers to smoking, such as more widespread implementation of workplace smoking bans (Evans et al. 1999),[2] many adults continue to smoke. Empirical evidence suggests that it is never too late to quit. A recent longitudinal study based on nearly 900,000 persons found that among smokers who quit at age 65, men gained 1.4 to 2.0 years of life, and women gained 2.7 to 3.7 years (Taylor et al. 2002). Although continued smoking has led to a rather pessimistic view that smokers are oblivious to the risks associated with smoking, many adults over the age of 50 do quit (Sloan et al. 2003). Moreover, following major health shocks, smokers do update their risk profiles (Smith et al. 2001).

In this paper, we assess how changes in the distribution of health risks of current and former smokers affect their decision to smoke. There is a paucity of empirical research that relates changes in the risk distribution directly to adults' decision to smoke, accounting for various other factors that also determine smoking choices. We formulate a model in which people learn about the population-level objective risk of smoking to health outcomes as well as their individual susceptibility to smoking-related diseases. We test the implications of this model using data on the *actual* cigarette consumption of a panel of individuals spanning eight years, 1992-2000. Our data come from the first five waves of the Health and Retirement Study (HRS) on persons aged 51 to 61 and their spouses who could be any age (and ranged from 25 to 90 in our sample). These persons are either current smokers or had previously smoked and quit.

In this age group, much of the information about the consequences of previous health behaviors is revealed in the form of health shocks (Sloan et al. 2003). This information in turn

[2] Evans et al. (1999) found that such bans do reduce smoking.

leads people to revise their expectations and change behaviors. We use information in the HRS on health shocks to self, spouse and parents and the effects of these events on the decision to smoke.

In sum, our findings suggest that people do learn about their personal susceptibility to smoking along with learning about the population-level objective risks. The former is a more effect deterrent of smoking than the latter. Further, learning does not differ by educational attainment. The rest of the paper is organized as follows. In Section II, we discuss our conceptual framework. Section III describes data and empirical specification. Results follow in Section IV. In Section V, we discuss some of the implications and limitations of our research and conclude.

II. Conceptual Framework

Individuals are assumed to have a finite life-span $t = 1,\ldots, T$, where T is the maximum expected length of life. They make repeated decisions to smoke (c_t) in each period t with learning about the objective risk of smoking and their susceptibility to these risks.[3] There are two states of the world, good (g) and bad (b). Individuals are expected utility maximizers with von Neumann-Morgenstern preferences over an aggregate consumption commodity, $X_{t,j}$, where $j = g, b$ and $X_{t,g} > X_{t,b}$. The probability of being in a bad state is an increasing function of the level of cumulative smoking (A_t), i.e., $p_{t,b}'(A_t) > 0$. Individuals can be of one of two types. The probability of being in a bad state is higher for type *1* individuals relative to type *2;* thus, the probability distribution of type *1* is first-order stochastically dominated by that of type *2*, i.e., $p_{t,b}^{1}(A_t) > p_{t,b}^{2}(A_t)$ for all A_t. For all levels of smoking, individuals have a prior belief about

[3] Viscusi and Magat (1987) present a similar formulation in graphical terms. Orphanides and Zervos (1995) formulate model in which young smokers do not know their individual susceptibility to becoming addicted when they first start smoking but learn about this over a period of time.

which type they are. With probability q_t (>0), they assume that they are type *1* and with probability (1-q_t), they are type *2*. Individuals update prior beliefs about their types using Bayes rule on the basis of health shocks. Persons never are certain about their type. Individuals learn over time about the objective risks of smoking to each type from general sources of information and experiences of other persons that they know.

The individual's maximization problem is written as follows. The good state (g) is characterized by the individual being alive; in the bad state (b), the individual is dead. Death is an absorbing state. Further, all individuals die by period T, $p_{T,b}^{1}(A_T) = p_{T,b}^{2}(A_T) = 1$.

The individual's objective function is

$$\max_{\{c_t\}_{t=1}^{T}} \sum_{t=1}^{T} \beta^{t-1}\left\{q_t * \left[p_{t,b}^{1}(A_t) * U(Y_{t,b}) + (1 - p_{t,b}^{1}(A_t)) * U(Y_{t,g})\right] + (1-q_t) * \left[p_{t,b}^{2}(A_t) * U(Y_{t,b}) + (1 - p_{t,b}^{2}(A_t)) * U(Y_{t,g})\right]\right\}$$

where $Y_{t,g} = X_{t,g} - d*c_t + m*c$ and $Y_{t,b} = X_{t,b}$. The price of cigarettes is *d; m* is the monetary equivalent of the utility derived from smoking a cigarette, and β is the discount factor. In the good state, $Y_{t,g}$ is the person's consumption of the aggregate commodity at time *t*, net of the expenditures on cigarettes and the benefits of smoking. In the bad state, $Y_{t,b}$ is the monetary equivalent of the utility of bequests. The law of motion for the cumulative stock of smoking is $A_t = (1-\delta)A_{t-1} + c_t$, where δ is the rate of depreciation. The initial condition is $A_0 = \overline{A}$.

The timing structure operates as follows. At the beginning of the period, the individual forms a prior belief about the risk of smoking and about his type. The individual then decides how much to smoke in the current period comparing the relative payoffs of the alternatives. At the end of the period, nature reveals state of the world (good or bad), and the individual then experiences health events and learns from others and updates his beliefs about the risks and his type. If the individual is alive, he repeats this decision making process in the next period.

The individual's smoking decision is a function of his beliefs about his risk type, probability of being in a bad state of health (for each type), the price of cigarettes and the utility from smoking, and consumption in each of the states, $c_t = f\left(q_t, p^1_{t,b}, p^2_{t,b}, d, m, X_{t,g}, X_{t,b}\right)$ (1).

Unlike models of addiction (e.g., Becker and Murphy 1988), the demand function for cigarettes does not explicitly depend on the cumulative stock of smoking. The cumulative stock only affects the decision to smoke through its effect on the probability of being a bad state of health. Under standard assumptions, equation (1) implies that the decision to smoke is negatively related to the probability of being a type 1 individual, the probability of being in the bad state (for either type of individual), the price of cigarettes, and positively related to the monetary equivalent of the utility of smoking and consumption in the two states.

Our empirical analysis relates the probability of smoking at an interview to the measures of the objective risk of smoking, individual susceptibility to smoking-related health events, cigarette prices, and measures of benefits from smoking.

In our empirical analysis, we estimate the reduced form of the structural demand equation (1). We include a measure of cigarette price. To proxy for the benefits of smoking, we include various measures of stress. We have no direct measure of the cumulative smoking stock, but we control for this using individual fixed effects. We measure updating of beliefs about the objective risk of smoking by using information on spousal health shocks and time fixed effects. To measure the updating of beliefs about type, we use information on personal health shocks.

In a study based on the first two waves of HRS, Smith et al. (2001) assessed the impact of new personalized information acquired through health shocks on longevity expectations. The dependent variables were self-assessed probabilities of living to 75 or more. In general,

personalized information was important in determining individuals' beliefs about their longevity. When persons experienced smoking-related health shocks, they reduced their subjective probabilities of living to age 75. Onset of functional impairments also led to reductions in these probabilities. Rather than focus on updating of the probability of survival to age 75, our study analyses the effects of the updating process on the smoking decision directly.

III. Data and Empirical Specification

A. Analysis of the Probability of Smoking and Cigarette Consumption. Our data come from the first five waves (1992-2000) of the Health and Retirement Study (HRS). The HRS is a national panel study of birth cohorts 1931 through 1941 and their spouses, if married (www.hrsonline.isr.umich.edu). Participants in the HRS have been interviewed every two years since 1992. Individuals in the first wave of the HRS range from 51 to 61 years of age; spouses received an identical interview and could be of any age. We also use experimental modules from some of the HRS waves in this study to gauge differences in health valuations and time preference by smoking status. The total number of observations available from the HRS through wave 5 for persons on whom there are at least two observations in successive waves on the same individual is 41,871. Between 1992 and 2000, 1,138 persons died; in addition, there are 8,737 missing observations due to incomplete responses on variables pertinent to our study, including no information on location after a move.

We use three sub-samples. The first consists of persons who *ever smoked.* An ever smoker at any wave is defined as someone who "smoked more than 100 cigarettes in (their) lifetime(s)" as of that wave (N=25,618).[4] The second, *current smokers*, is a sub-sample of the

[4] HRS asked at wave 1: "Have you ever smoked cigarettes?" Interviewer had the following instruction. "By smoking, we mean more than 100 cigarettes in R's lifetime. Do not include pipes or cigars." Those responding "yes" were asked "Do you smoke

ever smoker sample of respondents who smoked at the time the interview was conducted (N=8,542). The third, *intermittent smokers*, consists of persons who quit or restarted smoking at any point between wave 1 and wave 5, but who changed their smoking status at least once during the five waves (N=7,096). After dropping observations for which location information was unavailable, a total of 21,715 observations are finally selected as ever smokers, 7,130 for current smoker, and 5,784 for intermittent smoker sample. In our study, never smokers are excluded because the probability of initiating smoking at age 50 or over is virtually zero (Sloan et al. 2003).

Dependent variables are (1) a binary variable of *current* smoking status, which is used to estimate a linear probability model and (2) *current* number of cigarettes smoked per day conditional on being a current smoker. In both specifications, we included individual and time fixed effects. The time fixed effects are for waves 3-5 with wave 2, the omitted reference group. Wave 1 variables were used for lagged values.

Explanatory variables are age, educational attainment, gender, race, marital status (at previous wave), stressors, health shocks, and spouse health shocks and deaths, and cigarette price for the person's state of residence (from Orzechowski and Walker 2002). In each specification, individual fixed effects control for the level of the *addictive stock* of smoking (Becker and Murphy 1988) and other time invariant unobserved characteristics of the individual. Time (wave) fixed effects account for changes in general information about smoking and other factors. Our sample only includes individuals who did not change their state

---

cigarettes now?" and "About how many cigarettes or packs do you smoke in a day now?" These questions were repeated at each wave.

of residence since we do not have information on the state of residence after a move.[5] One important implication is that the individual fixed effects consequently embed state fixed effects.

While individual fixed effects account for addictive stock, they also control for other health behaviors the probability of health events.[6] Hersch and Viscusi (1998), for example, found that smokers were less likely to engage in such health-enhancing behaviors as using a seatbelt, flossing, and checking blood pressure.

Several explanatory variables provide a measure of the monetary equivalent of the utility of smoking. Individuals who are subject to stress may have a higher utility of smoking (Breslau et al. 1991; Cohen and Lichtenstein 1990; Ludman et al. 2000; Niaura et al. 2002). The stressors we use are job-related stress, divorce or separation, and loss of a parent. The HRS asked respondents about the extent to which they agree with the statement that my job involves a lot of stress on a scale from: strongly agree, agree, disagree, and strongly disagree. We code the variable *Job involves a lot of stress* if the person strongly agreed and worked full time. *Divorced or separated, Death of parent,* and *Death of spouse* are set to one if these events occurred since the last interview. We define stressors in a way to minimize the possibility of

[5] For persons who moved, we do not have information on state of residence after the move and cannot use state information on prices. Thus, we drop these individuals from our analysis (N=4,565), which amount to 17 percent of the ever smoker sample. In analysis not reported, not reported, we include observations on these persons, but without including smoking information. The results are virtually identical to those reported below.

[6] Also, a specification test rejected the OLS specification in favor of fixed effects.

endogeneity. The underlying assumption is that, controlling for individual fixed effects, smoking does not affect these sources of stress.

Health shock variables are defined as having any events between two waves and represent *onset of new*, serious health conditions. For example, if a respondent reported at wave two a heart attack that occurred since wave one, and reported no history of heart attack, this is recorded as a health shock. We classify health shocks as smoking-related, general, other health shocks, new limitations in Activities of Daily Living (see below) and other activity limitations. Identical health shock variables are created for spouses. In addition, we include a variable for death of spouse since the previous interview. As before, we construct the health shock variables in terms of onset between the current and the previous wave to minimize reverse causality of smoking on health shocks. These health shocks provide information that individuals use to update their beliefs about their risk types (q) as well as the objective health risk of smoking (p).

Smoking-related health shocks are those health events found to have an elevated relative risk for death among smokers by the Surgeon General (U.S. Department of Health and Human Services 1989). Using HRS data of each wave, we identify first occurrences of heart attack, congestive heart failure, stroke, and a chronic lung disease that limits activity. *General health shocks* are onset of serious medical conditions that are not conclusively linked to smoking. It includes any kind of cancer except skin cancer,[7] diabetes and serious injuries including hip fracture. To ensure that the health shocks are severe, and as a cross-check on accuracy of responses, we only include reports of these conditions if the respondent also reported having

[7] Cancers grow at particular sites, such as lung or throat, are highly related with smoking. From waves 3-5, HRS does not report cancer site and thus identification of specific type of cancer was not possible.

been hospitalized for at least three days since the previous interview.[8] If the respondent said that s/he was hospitalized for at least three days, but did not report an onset of a new smoking-related or general health problem, we create a separate binary variable, *Other hospitalization*. This would include, for example, respondents who had a second heart attack.

New ADL limitation is a binary variable for onset of any of five ADL limitations: dressing, walking, bathing, eating, and getting in and out of bed. The second set, *New other limitation,* is for new limitations that are likely to be attributable to smoking. These activity limitations are difficulty in: walking one or several blocks, getting up from a chair after sitting for long periods, climbing one or several flights stairs without resting, lifting or carrying weights over 10 pounds, and pulling or pushing large objects like a living room chair. For both variables, the binary indicator is set to one if there is a new limitation. Thus, since the last wave, if a person reported a limitation not previously reported, the variable is set to one.

We include an identical set of health shock variables for spouses of respondents as well as a binary variable for spouses who died within the past two years. The spouse health shock provides information that is used by individuals to update beliefs about the objective risk (p). However, these shocks do not cause an individual to update his beliefs about his risk type (q).

Illness or death of spouse may cause stress, providing a reason to smoke. Thus, the directions of the effect of the spouse health shock variables cannot be deduced in advance. However, if the information content of the spousal health shock is outweighed by either its

[8] Although the data did not indicate that the reported shock was responsible for a particular hospital stay, three day hospital stay restriction could verify that newly reported conditions, whether smoking-related or not, were serious.

altruism or stress content, then one would expect that it would not be negatively related to the smoking decision.

If the respondent's spouse was not an ever smoker, he or she was defined not to have a smoking-related health shock. If the respondent was not married, then the binary health shock variables are set to zero. As mentioned above, we control for marital status at the previous wave to allow us to disentangle the effects of spouse health shocks from not having a spouse.

We deflate cigarette price per pack by the Consumer Price Index—all items (price at 2001=1). On average, price per pack was $2.27; however, there were increases between waves 2 and 5: $1.81 at wave 2, $1.92 at wave 3, $2.25 at wave 4, and $3.23 at wave 5.

IV. Empirical Results

A. Determinants of Smoking: Summary Statistics. Among ever smokers, 33 percent smoked at the interview dates and consumed 6.1 cigarettes daily on average (Table 1). Among current smokers, mean cigarette consumption was 18.7 per day. Among intermittent smokers, 54 percent smoked at the interview date with a mean consumption of 9.5 cigarettes per day. Ever smokers were 60 years of age on average, 47 percent were female, 82 percent were white, 81 percent were married at the previous wave, and 70 percent had 12 or more years of education. Current smokers were younger and more likely than ever smokers to be female and married. They were also less likely to be white and with 12+ years of education. The same is true of intermittent smokers. Also, higher proportions of current smokers experienced job-related stress, death of parent; and were divorced or separated within the last two years relative to ever or intermittent smokers.

B. Probability of Future Health Shocks. In Table 2, we show that, conditional on baseline smoking history, current smokers are more likely to experience death, ADL limitations, other

limitations, smoking-related and general health shocks and other hospitalizations compared to former and never smokers.[9]

Table 3 presents regressions with individual and time fixed effects to analyze the probability of death within two years, conditional on a person's health shocks within the last two years. None of the stress variables affect the probability of dying. For ever smokers, all of the personal health shocks have statistically significant and effects on the probability of death. For current smokers, only smoking-related health shocks and other hospitalizations affect this probability. For intermittent smokers, general and other hospitalization influence the death probability. This evidence demonstrates that health shocks really do increase the probability of death and would be used by individual to learn about the objective risk (p) as well as their own risk type (q).

As expected, spousal health shocks in general have no effect on the probability of death in two years. This further confirms our assumption that spousal health shocks do not provide information about an individual's risk type.

Determinants of Smoking: Regression Results. Personalized information in the form of health shocks reduces the probability of current smoking as well as, in some samples, cigarette consumption (Table 4), mirroring the evidence in the previous table, which was for the objective probability of mortality. Smoking-related and general health shocks and other hospitalizations within the past two years reduce the probability of current smoking as well as the number of cigarettes smoked per day in the ever and in the intermittent smoker samples.[10]

By contrast, although the signs on the coefficients are negative, onset of ADL limitations only has a negative and significant impact in the ever smoker sample for the current number of

[9] This is the only table that includes never smokers.

[10] The number of cigarettes smoked also reflects the individual's smoking status.

cigarettes smoked. Onset of other limitations only has a negative and statistically significant effect in the cigarette consumption equation based on the intermittent smoker sample. These other limitations have a larger marginal effect on two-year mortality than in the analysis of the other samples in the previous table, although the coefficient is not quite statistically significant at conventional levels.

As noted previously, it is not possible to deduce the effects of spouse health shocks due to offsetting effects of stress and information. In fact, in general, spouse shocks do not affect smoking. In the fixed effects specification, the only statistically significant results among the spouse variables are for the intermittent smoker sample. In this case, other hospitalizations have a positive impact on the number of cigarettes smoked.

In general, stress increases the probability of current smoking. A job that involves a lot of stress has a positive and statistically significant influence on smoking in the linear probability specification, even controlling for individual fixed effects in the ever smoker and in the intermittent smoker samples. Significance is lost in the fixed effect specification for the current number of cigarettes smoked per day for all three samples. This suggests that stress has the most important impact on the decision to quit or restart smoking, but a lesser impact on whether people increase or decrease the amount currently smoked. We find similar patterns for many other explanatory variables using the continuous variable, current number of cigarettes smoked, with individual fixed effects.

Death of parent within the past two years has a positive and significant influence on both smoking dependent variables in the fixed effects specification in the ever and intermittent smoker samples. It is not a significant predictor of consumption for current smokers. In fact, for the current smoker sample, none of the explanatory variables has a statistically significant effect on the number of cigarettes smoked. This suggests that in our sample, the variation in the

cigarette consumption is largely in quitting and relapsing rather than in changes in consumption of cigarettes (conditional on smoking). Becoming divorced or separated or widowed does not have a significant impact in any of the fixed effects specifications.

Controlling for individual and time fixed effects, cigarette prices have no effect. Since our sample only includes individuals who did not change their state of residence, the individual fixed effects embed state fixed effects. Thus, the effects of prices would be identified solely through intertemporal variation in prices that differ from national trends. Therefore, our results suggest that the intertemporal within state variation in prices is too limited within the eight-year time span pertaining to our data.

Finally, in analysis not shown, we examine the role of education in learning by including interaction terms between education and each of the health shock variables. None of the interaction terms have a statistically significant impact on the decision to smoke or on consumption of cigarettes (not shown). Hence, we find no evidence that the information signal varies on the basis of education.

In Table 5, we examine the contribution of the personal health shocks and age to the explained variation in the dependent variables in each of our fixed effects specifications. This provides a method for comparing the effect of a change in age to the effect of changes in personal health status on smoking decisions. We find that the effects of changes in health status are much larger the effect of change in age. This suggests that new information, through health shocks, has a much greater impact on the decision to smoke than the process of aging itself. Without the time fixed effects, we would expect that the contribution of age to the explained variation in the dependent variables would be much larger, which is what we find (results not shown). The contribution of the personal health shocks is approximately of the same magnitude as in Table 5.

V. Implications, Limitations and Conclusion

Our results are consistent with our conceptual framework, which postulates that adult smokers learn about their risk types as well as the objective risk relating smoking to adverse health outcomes from personal health shocks. This learning is reflected in their smoking decisions. People who receive personal information in the form of various types of health shocks are more likely to quit and less likely to restart. Spousal health shocks do not affect smoking behavior, possibly because of offsetting effects of stress and information. We also document the quitting costs of smoking (equivalent to benefits foregone when a person stops smoking) in terms of relieving stress from work and events such as death of parent, increase the probability of continued smoking as well as relapses.

Our evidence provides an explanation of why many people do not quit in response to general information messages about the harms of smoking. To these individuals, it is not the risk of smoking, but rather the uncertainty about their types that is a more important determinant of their smoking decisions. Rather than provide general information, such persons may be responsive to information about their genetic susceptibility to smoking-related diseases.

Our study has emphasized the role of learning about risk types and the objective risk of smoking on the decision to smoke. There are other possible explanations: biological or psychological addition (e.g., Ney and Gale 1989); differences in preferences for good health (e.g., Viscusi and Evans 1990; Viscusi and Hersch 2001); risk tolerance (e.g., Barsky et al. 1997); and discount factors and time inconsistent preferences (e.g., Gruber and B. Köszegi 2001). Each of these factors are worthy of study in their own right.

One important limitation of our study is that we cannot disentangle learning about risk types from learning about the adverse health effects of smoking from the information provided

by personal health shocks. Future research to disentangle these two conceptually distinct processes of learning would be worthwhile.

References

Barsky, R. B., F. T. Juster, M. S. Kimball, and M. D. Shapiro. 1997. "Preferences, Parameters, and Behavioral Heterogeneity: An Experimental Approach in the Health and Retirement Study," *Quarterly Journal of Economics* CXII(3): 537-79.

Becker, G. S. and K. M. Murphy. 1988. "A Theory of Rational Addiction," *Journal of Political Economy* 96(4): 675-700.

Breslau, N.M., Kilbey, M., and Andreski, P. 1991. "Nicotine Dependence, Major Depression, and Anxiety in Young Adults," *Archives of General Psychology* 48: 1069-74.

Cohen, S. and E. Lichtenstein. 1990. "Perceived Stress, Quitting Smoking, and Smoking Relapse," *Health Psychology* 9: 466-78.

Evans, W. N., M.C. Farrelly, and E. Montgomery.1999. "Do Workplace Smoking Bans Reduce Smoking? *American Economic Review*, 89(4): .728-747

Gruber, J. and B. Köszegi. 2001. "Is Addiction 'Rational'? Theory and Evidence," *Quarterly Journal of Economics* 116(4): 1261-1303.

Hersch, J. and W. K. Viscusi. 1998. "Smoking and Other Risky Behaviors," *Journal of Drug Issues* 28(3): 645-661.

Ludman, E.J., C. M. McBride, J. D. Nelson, S. J. Curry, L. C. Grothaus, H. A. Lando, and P.L. Pirie. 2000. "Stress, Depressive Symptoms, and Smoking Cessation Among Pregnant Women," *Health Psychology* 19(1): 21-7.

McIntosh, M. C., G. Leigh, and N. Baldwin. 1994. "Screening for Hazardous Drinking: Using the CAGE and Measures of Alcohol Consumption in Family Practice," *Canadian Family Physician* 40: 1546-53.

Ney, T. and A. Gale, 1989. *Smoking and Human Behavior*. New York: John Wiley.

Niaura, R., W. G. Shadel, D. M. Britt, and D. B. Abrams. 2002. "Response to Social Stress, Urge to Smoke, and Smoking Cessation," *Addictive Behaviors* 27: 241-50.

Orphanides, A. and D. Zervos. 1995. "Rational Addiction with Learning and Regret," *Journal of Political Economy* 103 :739-758.

Orzechowski and Walker, *The Tax Burden on Tobacco: Historical Compilation.* Vol. 37, Arlington, VA, 2002.

Sloan, F. A., V. K. Smith, and D. H. Taylor, Jr. 2003. *The Smoking Puzzle: Information, Risk Perception, and Choice*. Cambridge, MA: Harvard University Press.

Smith, V. K., D. H. Taylor, Jr., F. A. Sloan, F. R. Johnson, and W. H. Desvousges. 2001. "Do Smokers Respond to Health Shocks?" *Review of Economics and Statistics* 83(4): 675-87.

Taylor, D.H., V. Hasselblad, J. Henley, M.J. Thun, and F.A. Sloan. 2002. "Benefits of Smoking Cessation for Longevity," *American Journal of Public Health* 92(6), June: 990-6.

U.S. Department of Health and Human Services. 1989. *Reducing the Health Consequences of Smoking: 25 Years of Progress,* A Report of the Surgeon General. U.S. Department of Health and Human Services.

Viscusi, W. K. and W. N. Evans. 1990. "Utility Functions that Depend on Health Status: Estimates and Economic Implications," *American Economic Review* 80(3): 353-374.

Viscusi, W. K. and J. Hersch. 2001. "Cigarette Smokers as Job Risk Takers," *Review of Economics and Statistics* 83(2): 269-80.

Viscusi, W. K. and W A. Magat (with J. Huber, C. O'Connor, J.R. Bettman, J.W. Payne, and R.

Staelin). 1987. *Learning about Risk: Consumer and Worker Responses to Hazard Information*. Cambridge, MA: Harvard University Press.

Table 1. Sample Statistics

Variables	Ever smoker Mean (S.D.)		Current smoker Mean (S.D.)		Intermittent smoker Mean (S.D.)	
Dependent variables						
Currently Smoke (1= yes, 0= no)	0.328	(0.470)			0.544	(0.498)
Current Number of cigarettes per day	6.136	(11.250)	18.687	(12.285)	9.486	(12.602)
Age	60.333	(6.003)	58.914	(5.875)	59.700	(5.849)
Female	0.468	(0.499)	0.537	(0.499)	0.497	(0.500)
White	0.816	(0.387)	0.796	(0.403)	0.777	(0.416)
Married (2 year lag)	0.801	(0.399)	0.743	(0.437)	0.756	(0.430)
Education; 12-year or more	0.700	(0.458)	0.645	(0.478)	0.657	(0.475)
Cigarette price, by state ($/pack)	2.232	(0.612)	2.170	(0.580)	2.181	(0.587)
Stressor (last two years)						
Job involves a lot of stress	0.079	(0.269)	0.093	(0.290)	0.076	(0.265)
Death of parents	0.037	(0.188)	0.046	(0.210)	0.041	(0.200)
Divorced or separated	0.008	(0.087)	0.011	(0.103)	0.008	(0.089)
Health shock (last two years)						
Smoking related	0.024	(0.186)	0.022	(0.145)	0.039	(0.193)
General	0.019	(0.135)	0.014	(0.117)	0.056	(0.158)
Other hospitalization	0.101	(0.301)	0.089	(0.285)	0.119	(0.324)
New ADL limitation	0.052	(0.223)	0.054	(0.226)	0.066	(0.249)
New other limitation	0.070	(0.256)	0.071	(0.257)	0.081	(0.272)
Spouse's health shock (last two years)						
Smoking related	0.013	(0.114)	0.016	(0.127)	0.013	(0.115)
General	0.016	(0.124)	0.015	(0.123)	0.014	(0.117)
Other hospitalization	0.069	(0.254)	0.069	(0.253)	0.073	(0.260)
New ADL limitation	0.033	(0.180)	0.038	(0.192)	0.035	(0.183)
New other limitation	0.052	(0.221)	0.049	(0.217)	0.049	(0.217)
Widowed	0.015	(0.120)	0.018	(0.132)	0.018	(0.132)
Observations	21,715		7,130		5,784	

Table 2. Probability of Health Risks Between 1992 -2000 Conditional on Baseline Smoking History†

	Current smoker	*Quit 0-4 years*	*Quit 5-14 years*	*Quit 15+ years*	*Never smoker*	*Overall*
Death** ‡	0.145	0.125	0.093	0.088	0.044	0.090
ADL limitation**	0.196	0.185	0.164	0.137	0.142	0.016
Other limitation	0.223	0.200	0.230	0.212	0.217	0.218
Smoking related health shock**	0.097	0.073	0.076	0.054	0.047	0.067
General health shock**	0.067	0.067	0.064	0.050	0.044	0.055
Other hospitalization**	0.267	0.272	0.253	0.245	0.228	0.247
Observations	3,417	861	1,492	2,184	4,589	12,543

† Overall, 21.3% of the baseline respondents did not complete follow up interviews. However, they do not differ in the baseline smoking history.
‡ Significance of the difference in each health risk across baseline smoking history
** Significant at 1% level

Table 3. Probability of Death in Two Years: Fixed Effects Regressions

Variables	Ever smoker	Current smoker	Intermittent smoker
Stressor			
Job involves a lot of stress	0.005	0.007	0.004
	(0.003)	(0.007)	(0.009)
Death of parent	-0.002	0.002	0.008
	(0.005)	(0.010)	(0.011)
Divorced or separated	-0.022	-0.040	-0.007
	(0.012)	(0.024)	(0.026)
Health shock			
Smoking related	0.038**	0.069*	0.027
	(0.013)	(0.028)	(0.020)
General	0.090**	0.060	0.094**
	(0.015)	(0.036)	(0.030)
Hospitalization	0.032**	0.043**	0.051**
	(0.005)	(0.011)	(0.012)
New ADL limitation	0.016*	0.018	0.009
	(0.007)	(0.013)	(0.015)
New other limitation	0.012**	0.008	0.016
	(0.004)	(0.009)	(0.010)
Spouse's health shock			
Smoking related	-0.009	-0.026	-0.022
	(0.011)	(0.018)	(0.027)
General	-0.005	-0.020	-0.036*
	(0.010)	(0.018)	(0.018)
Other hospitalization	-0.006	-0.022*	-0.022
	(0.005)	(0.010)	(0.012)
New ADL limitation	0.001	0.006	0.018
	(0.006)	(0.011)	(0.015)
New other limitation	0.000	-0.004	-0.003
	(0.005)	(0.008)	(0.014)
Widowed	0.001	0.017	-0.006
	(0.010)	(0.019)	(0.021)
Married (2 year lag)	-0.023*	-0.027	-0.060**
	(0.010)	(0.019)	(0.021)
Age	0.017*	0.019	0.041**
	(0.008)	(0.017)	(0.015)
Wave3	0.079**	0.094*	0.189**
	(0.021)	(0.038)	(0.043)
Wave4	0.148**	0.172*	0.352**
	(0.042)	(0.075)	(0.084)
Wave5	0.212**	0.251*	0.483**
	(0.062)	(0.111)	(0.124)
Constant	1.323*	1.524	3.381**
	(0.596)	(1.044)	(1.174)
Observations	26,277	8,784	7,348
R-squared	0.515	0.579	0.550
F-statistic	57.96	19.32	28.79

Huber-White standard errors in parentheses
* Significant at 5% level; ** significant at 1% level

Table 4. Effects of Stressors and Health Shocks on Smoking†

	Ever smoker			Current smoker	Intermittent smoker	
	OLS	Fixed effects	Fixed effects	Fixed effects	Fixed effects	Fixed effects
Variables	Currently smoke (1 = yes)	Currently smoke (1 = yes)	Current No. of cigarettes	Current No. of cigarettes	Currently smoke (1 = yes)	Current No. of cigarettes
Cigarette price ($/pack)	-0.062**	0.010	0.362	-0.271	0.029	0.969
	(0.011)	(0.016)	(0.387)	(1.056)	(0.067)	(1.329)
Stressor						
Job involves a lot of stress	0.024	0.030**	0.516*	0.246	0.103**	1.459*
	(0.012)	(0.009)	(0.216)	(0.438)	(0.032)	(0.695)
Death of parent	0.038*	0.035**	0.730*	0.389	0.104**	2.000*
	(0.018)	(0.011)	(0.301)	(0.618)	(0.037)	(0.835)
Divorced or separated	0.102**	-0.001	-0.362	0.533	0.017	-0.104
	(0.037)	(0.024)	(0.884)	(1.534)	(0.088)	(2.515)
Health shock						
Smoking related	-0.024	-0.094**	-2.195**	-1.382	-0.243**	-5.913**
	(0.020)	(0.016)	(0.440)	(1.101)	(0.041)	(0.921)
General	-0.055**	-0.082**	-1.483**	-0.275	-0.206**	-2.809*
	(0.021)	(0.016)	(0.512)	(1.652)	(0.044)	(1.364)
Other hospitalization	-0.034**	-0.054**	-1.126**	-0.885	-0.173**	-3.269**
	(0.010)	(0.008)	(0.187)	(0.458)	(0.025)	(0.534)
New ADL limitation	0.001	-0.015	-0.595*	-0.571	-0.044	-1.261
	(0.014)	(0.010)	(0.255)	(0.610)	(0.031)	(0.660)
New other limitation	-0.001	-0.012	-0.316	0.085	-0.032	-1.454**
	(0.012)	(0.008)	(0.193)	(0.480)	(0.027)	(0.546)
Spouse's health shock						
Smoking related	0.101**	-0.016	-0.836	-1.525	-0.063	-0.646
	(0.030)	(0.019)	(0.494)	(0.976)	(0.067)	(1.232)
General	0.016	0.009	-0.225	-0.845	0.046	0.669
	(0.025)	(0.015)	(0.379)	(0.976)	(0.067)	(1.373)
Hospitalization	0.021	0.002	0.163	-0.510	0.022	1.647*
	(0.012)	(0.008)	(0.234)	(0.565)	(0.032)	(0.736)
New ADL limitation	0.058**	0.001	0.166	0.613	-0.014	0.075
	(0.018)	(0.010)	(0.281)	(0.581)	(0.040)	(0.905)
New other limitation	-0.009	-0.005	-0.210	0.319	-0.015	-1.130
	(0.014)	(0.008)	(0.218)	(0.517)	(0.034)	(0.740)
Widowed	0.089**	0.006	-0.145	-0.161	0.030	0.883
	(0.027)	(0.018)	(0.465)	(1.015)	(0.058)	(1.085)
Constant	1.306**	0.078	25.718	42.016	-0.381	64.298
	(0.041)	(1.136)	(30.651)	(65.659)	(3.155)	(75.043)
Observations	21,715	21,715	21,715	7,130	5,784	5,784
R-squared	0.052	0.850	0.815	0.771	0.540	0.644
F-statistic	55.65	16.86	14.86	3.66	19.70	15.35

Huber-White standard errors in parentheses

† Regressors not presented at the table include gender, race (white/non white), education (12 year or more/ less than 12 years), married at previous wave, and year fixed effects (wave 3 to wave 5)

* Significant at 5% level; ** significant at 1% level

Table 5. Variance Decomposition of Health Shock and Age on Smoking: Fixed Effects Regressions

Incremental R-squared (% over overall R-squared)†	Ever smoker		Current smoker	Intermittent smoker	
	Currently smoke (1 = yes)	Current No. of cigarettes	Current No. of cigarettes	Currently smoke (1 = yes)	Current No. of cigarettes
Smoking related health shock	0.0005 (0.064)	0.0005 (0.065)	0.00018 (0.014)	0.0046 (0.850)	0.0044 (0.683)
General health shock	0.0004 (0.042)	0.0002 (0.027)	0.000006 (0.0008)	0.0026 (0.488)	0.0009 (0.148)
Other hospitalization	0.0004 (0.052)	0.0003 (0.041)	0.0002 (0.021)	0.0042 (0.779)	0.0023 (0.350)
New ADL limitation	0.00007 (0.008)	0.0001 (0.018)	0.00008 (0.010)	0.0008 (0.144)	0.0009 (0.134)
New other limitation	0.00006 (0.007)	0.0001 (0.009)	0.0000002 (0.00002)	0.0006 (0.111)	0.0012 (0.177)
Age	0.0000005 (0.00006)	0.000006 (0.0007)	0.000005 (0.0007)	0.00001 (0.002)	0.00005 (0.007)
Overall R-squared	0.8498	0.8150	0.7713	0.5401	0.6394

† Incremental R-squared as a percentage of the overall R-squared is in parentheses.