Available online at www.sciencedirect.com

SCIENCE DIRECT®

International Journal of Industrial Organization
24 (2006) 667–682

International Journal of Industrial Organization

www.elsevier.com/locate/econbase

Evidence on preferences and subjective beliefs of risk takers: The case of smokers

Ahmed Khwaja [a,*], Frank Sloan [b,c], Martin Salm [b]

[a] *One Towerview Dr., Fuqua School of Business, Duke University, Durham, NC 27708, USA*
[b] *Department of Economics, Duke University, USA*
[c] *NBER, USA*

Received 11 July 2005; received in revised form 14 September 2005; accepted 8 October 2005
Available online 17 February 2006

Abstract

One reason that cigarette consumption is highly regulated is because of the paternalistic view that smokers would not make rational choices even if fully informed about the risks. A deficiency of this view is that in the presence of preference heterogeneity regulating smoking may lead to smokers finding ways to circumvent the regulations. Though there is widespread recognition that preference heterogeneity may exist there is very little documentation of it. In this study, we provide empirical evidence on the relationship between smoking status, and time and risk preference, valuation of health, and subjective beliefs about future macroeconomic events, using panel data from the Health and Retirement Study. We find that smokers are more impatient than nonsmokers and are more pessimistic about future macroeconomic events, which may reinforce their present orientation. Smokers are also more risk tolerant. This suggests that smokers may more willingly bear risk, and trade off current utility against future costs of smoking. However, they do not value being in excellent health differently from others. Our results also suggest that being more present-oriented and risk tolerant is not caused by smoking, but represents innate characteristics. An implication of our results for product regulation is that restricting access to cigarettes is likely to be circumvented by smokers through other means. In particular, our results are consistent with the finding that smokers in states with higher taxes smoke longer cigarettes that are also higher in nicotine and tar content.

JEL classification: D81; D91; L51; L66

Keywords: Tobacco regulation; Time preference; Risk preference; Subjective beliefs

* Corresponding author. Tel.: +1 919 660 1989; fax: +1 919 660 7971.
E-mail address: ahmed.khwaja@duke.edu (A. Khwaja).

0167-7187/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.ijindorg.2005.10.001

1. Introduction

Cigarette consumption is highly regulated (Viscusi, 2002). There are two possible reasons for such regulation. First, smokers may be inadequately informed about the risks of smoking, and the goal of regulation is to inform these individuals about such risks; once informed, they will make rational choices in their own self interest.[1] Alternatively, there is a paternalistic rationale.[2] Smokers would not make rational choices even if fully informed of the risk, and it is the job of product regulation to prevent people from making choices that the rest of the public would not make. A deficiency of the paternalistic view is that to the extent that smokers have different preferences, they will simply find ways to circumvent the regulations.

Three examples are illustrative. First, the experience during Prohibition in the U.S. was that regulations were circumvented by illegal activity. Second, in seminal work on safety regulation, Peltzman (1975), and later Blomquist (1991), found that seatbelt regulation did not reduce motor vehicle fatalities, suggesting that automobile drivers traded the risk reduction from seatbelts usage for more hazardous driving. Third, in subsequent work, Peltzman (1987) also found no empirical support for the view that mandatory prescription legislation lowered accidental poisonings or adverse drug reactions.[3]

Such evidence suggests that individuals plausibly differ in their willingness to accept risk in return for some other benefit. Thus, there is a relationship between the level of safety of a product and individual behaviors, and greater safety regulation may be offset by a decrease in caution on the part of individuals. This implies that even paternalistic regulators need to account for individuals' risk preferences in setting safety standards and designing regulations.

Furthermore, there is a long history of interest among economists in decisions made by individuals under conditions of risk and uncertainty (e.g., Knight, 1921). However, there is very little evidence about the economic primitives of preferences and beliefs in such contexts. Smoking is a perfect example of a real world risky decision under uncertainty with important implications for individual wellbeing. The risk arises from the effect of smoking on current and future health, which entails an uncertainty in that the risk may differ substantially among individuals at the time the smoking decision is made.[4]

In this study, we provide empirical evidence on the relationship between smoking status and following preference parameters and subjective beliefs using the Health and Retirement Study (HRS). Although economists accept the notion that there is heterogeneity in preferences and subjective beliefs, which has important implications for product regulation, empirical evidence on such heterogeneity is very limited.[5] Thus, our study is important in documenting such

[1] We examine this issue in a companion paper, Khwaja et al. (2005).

[2] In fact Gruenspecht and Lave (1989, p. 1532) write that, "Paternalism is also clear in decisions that something beyond providing information to workers about risk is required to optimize occupational safety. . .Indeed, few people other than economists and libertarians seems to regard it as even questionable that governments would not act to regulate large risks rather than provide workers with information."

[3] Not all safety regulations have been found to be ineffective, see, e.g., Magat and Moore (1996), who present evidence on effective regulations in the case of bicycles.

[4] Important contributions to the economic literature on smoking have recognized the significance of dynamics and uncertainty in the decision to smoke (e.g., Becker and Murphy, 1988; Becker et al., 1994; Orphanides and Zervos, 1995; Gruber and Köszegi, 2001). Chaloupka and Warner (2000) provide a comprehensive review of the theoretical and empirical literature on smoking.

[5] One exception is the literature on value of life derived from observed tradeoffs between wages and job risk, e.g., Thaler and Rosen (1976) and Viscusi (1979).

variation. If smokers are more impatient than others, are more willing to bear risk, or place a different value on being in good health, then regulation would need to accommodate these differences. To the extent that there is regulation, and consumer preferences are to be honored, such regulation should be based on the external costs of smoking rather than the internal costs to smokers themselves. Under paternalism, our analysis is important in that it helps to explain untended consequences of regulation that are likely to occur when constraints are imposed, e.g., other risk taking behaviors in lieu of smoking. In fact, Evans and Farrelly (1998) find that smokers adjust their smoking behavior in states with higher taxes. Smokers in such states are more likely to smoke longer cigarettes that are also higher in nicotine and tar content.

In particular we examine (1) Time preference: If smokers are more impatient, then they would prefer the current utility from smoking over the future health costs of this habit. Hence, variation in discount factors by smoking status, as has been found for economic decisions in other contexts (Harrison et al., 2002; Kapteyn and Teppa, 2003; Bickel and Johnson, 2003), is a potentially important determinant to consider in making smoking regulations. (2) Expectations about future macroeconomic outcomes: Smokers may differ systematically from nonsmokers in beliefs about future economic events, such as inflation and business cycles. If smokers are systematically pessimistic about future states of the world, they might affect their present and future consumption patterns. (3) Risk preference: Smokers may be more risk tolerant, holding other factors constant (Barsky et al., 1997). Thus, they may be more willing to trade off the benefits of smoking for the elevated health risk. (4) Health valuation: Smokers may place a lower value on good health (Viscusi and Herch, 2001). If so, this would explain their decisions to smoke.

We use panel data from the first six waves (1992–2002) of the HRS. Our samples include persons irrespective of their smoking status. There are two important advantages of using HRS. First, the HRS is unique in containing detailed information about health behaviors, time preferences, risk tolerance, health valuation, and subjective beliefs about the future. Second, we are able to use the longitudinal nature of data to observe whether preferences and beliefs change with changes in smoking status over time.

We find that smokers are more present-oriented and have a higher risk tolerance than others. Consistent with the former, we find that smokers are pessimistic about future economic events, such as business cycle downturns, high inflation, and loss of Social Security benefits. Smokers do not differ from others in terms of valuing health. In sum, our findings suggest that smokers are distinguished by being myopic and having greater risk tolerance. An implication of our results for product regulation is that restricting access to cigarettes is likely to be circumvented by smokers through other means. In particular, our results are consistent with the finding that smokers in states with higher taxes smoke longer cigarettes that are also higher in nicotine and tar content (Evans and Farrelly, 1998).

This paper is organized as follows. Section 2 describes data and empirical specification. Results and discussion follow in Section 3. In Section 4, we discuss implications of this study and conclude.

2. Data and empirical specification

2.1. Data

Our data come from the first six waves (1992–2002) of the Health and Retirement Study (HRS). The HRS is a national panel study of birth cohorts 1931–1941 and their spouses, if

married (www.hrsonline.isr.umich.edu). Participants in the HRS have been interviewed every 2 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. In 1998, three new cohorts born before 1924 (AHEAD), between 1924 and 1930 (CODA) and between 1942 and 1947 (WB) were added to the sample. We also use experimental modules, administered to sub-samples of respondents, from some of the HRS waves in this study. The modules vary by survey year. Also, some of the questions were in some waves only administered to part of the sample. The total number of observations (person years) from the HRS through wave 6 included in any part of our analysis was 54,082; the number of observations in any particular analysis ranged from 236 (willingness to pay for perfect health) to 21,804 (expectations about future inflation). For additional detail, see Juster and Suzman (1995).

2.2. Empirical specification

In the empirical analysis of the relationship between smoking status, and heterogeneity in preferences and subjective beliefs, we follow Barsky et al. (1997) and specify that for each individual i at time t, the dependent variable (Y_{it}) is a function of the explanatory variables (X_{it}) and binary indicators of smoking status, i.e., current smoking ($c_{it}=1$ if current smoker and 0 otherwise) and former smoker ($f_{it}=1$ if current smoker and 0 otherwise), with the never smokers being the base category,

$$Y_{it} = \alpha c_{it} + \beta f_{it} + X_{it}'\pi + \mu_t + \epsilon_{it}. \tag{1}$$

The error term (ϵ_{it}) is assumed to be orthogonal to all the regressors and μ_t captures time fixed effects. Eq. (1) is estimated using OLS when the dependent variable is continuous. In instances when the dependent variable is discrete, we use either a probit or an ordered probit regression to estimate Eq. (1).

To examine the effects of unobserved heterogeneity in explaining the differences in the preferences and subjective beliefs, we also use a second specification,

$$Y_{it} = \alpha c_{it} + \beta f_{it} + X_{it}'\pi + \mu_t + \eta_t + \epsilon_{it}. \tag{2}$$

In this case, η_i is an individual specific fixed effect for individual i, and e_{it} is orthogonal to the regressors. We also allow for $\mathrm{cov}(X_{it},\eta_i)\neq 0$, $\mathrm{cov}(c_{it},\eta_i)\neq 0$ and $\mathrm{cov}(f_{it},\eta_i)\neq 0$. We estimate Eq. (2) by taking first differences (FD) to eliminate the individual specific fixed effect (η_i) to obtain

$$\begin{aligned}(Y_{it} - Y_{it-1}) = \alpha(c_{it} - c_{it-1}) + \beta(f_{it} - f_{it-1}) + (X_{it}' - X_{it-1}')\pi + (\mu_t - \mu_{it-1}) \\ + (\epsilon_{it} - \epsilon_{it-1}),\end{aligned} \tag{3}$$

which is then used to recover the parameters of interest using OLS with Huber–White robust standard errors. This specification is used for a discrete dependent variable in only one case and that is discussed in more detail below.

2.3. Dependent variables

We now describe the dependent variables (Y_{it}) in greater detail. The precise questions for these dependent variables are presented in Appendix A.

Table 1
Summary statistics

Variables	Observations	Mean	Standard deviation
Dependent variables			
Financial planning horizon (five categories)	21,200	3.09	1.23
Subjective probability of economic depression	13,659	0.45	0.29
Subjective probability of double-digit inflation	21,804	0.51	0.28
Subjective probability of Social Security cuts	11,262	0.60	0.31
Subjective probability of bioterrorism	3768	0.62	0.28
Relative risk tolerance	20,975	0.24	0.14
Trade any dollars for perfect health[a]	420	0.64	0.48
Willingness to pay for perfect health ($/month)[b]	236	625.96	1525.52
Willingness to pay for Alzheimer drug ($/month)[b]	316	176.42	235.20
Willingness to pay for cancer drug ($/month)[b]	271	238.95	294.63
Explanatory variables			
Current smoker (0–1)	54,082	0.23	0.42
Former smoker (0–1)	54,082	0.38	0.482
Subjective probability of living to 75	54,082	0.65	0.29
Age	54,082	57.02	5.39
White	54,082	0.82	0.38
Female	54,082	0.59	0.49
Years of education	54,082	12.04	3.09
Subjective probability of Alzheimer's disease	316	0.30	0.27
Subjective probability of cancer	271	0.38	0.28
Stressful job (0–1)	54,082	0.19	0.32
Divorced within last 2 years (0–1)	53,981	0.07	0.25
Widowed within last 2 years (0–1)	53,981	0.01	0.11
Death of parent within last 2 years (0–1)	44,012	0.01	0.10

[a] The five categories are: next few months, next year, next few years, next 5–10 years, more than 10 years.
[b] Based on nonzero values.

2.3.1. Time preference

The HRS asked respondents in the main survey about their financial planning horizons, with possible responses being the next few months, the next year, the next few years, the next 5–10 years, and more than 10 years.[6] We use this as our measure of time preference.

We use these five categories to define an ordered dependent variable with longer time horizons being a higher order. In wave 1, all self-responding persons were asked this question. In waves 2 and 3, these questions were not asked. In wave 4, persons born before 1931 were not asked these questions, but those born in 1931 or subsequently or spouses were asked these questions. One of 10 HRS cohort respondents was randomly selected for this question. In waves 5, one of 12 respondents was randomly selected for this question. All entry cohort subsamples were eligible for selection. In wave 6, if person was 65 or older, the questions were skipped.

There are 21,200 usable observations on financial planning horizon. The mean time-horizon category was 3.09 (Table 1). To examine consistency of responses to the time preference question across waves, we present within-individual correlations among stated time horizons among the waves of HRS in which the question was asked (Table 2, Panel A). Almost all of the correlations are statistically significant at the 1% level; they range from 0.1 to 0.3. There is

[6] Henceforth, we only indicate when questions are part of modules. The default category is the main survey.

Table 2
Correlations of responses between waves

A. Financial planning horizon

	Wave 1	Wave 4	Wave 5	Wave 6
Wave 1				
Wave 4	0.10* (0.01)			
Wave 5	0.16** (0.00)	0.21** (0.00)		
Wave 6	0.12** (0.00)	0.19** (0.00)	0.30** (0.00)	

B. Subjective probability of economic depression

	Wave 1	Wave 2	Wave 3
Wave 1			
Wave 2	0.31** (0.13)		
Wave 3	0.29** (0.00)	0.42** (0.00)	

C. Subjective probability of double-digit inflation

	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5
Wave 1					
Wave 2	0.24** (0.00)				
Wave 3	0.23** (0.00)	0.36** (0.00)			
Wave 4	0.21** (0.00)	0.31** (0.00)	0.33** (0.00)		
Wave 5	0.22** (0.00)	0.30** (0.00)	0.35** (0.00)	0.36** (0.00)	

D. Subjective probability of social security cuts

	Wave 1	Wave 3
Wave 1		
Wave 3	0.19** (0.00)	

E. Relative risk tolerance

	Wave 1	Wave 4	Wave 5	Wave 6
Wave 1				
Wave 4	0.07 (0.07)			
Wave 5	0.15** (0.00)	0.25** (0.00)		
Wave 6	0.11** (0.00)	0.20** (0.00)	0.24** (0.00)	

p-values in brackets.
* Significant at 5%.

correlation between the responses over time, but there is also some variation in time preference over the years.

An experimental module in wave 1 attempted to recover the intertemporal elasticity of substitution. Although this measure reflects the underlying theoretical concept better than the "financial planning horizon," we recover elasticities of substitution that were nearly zero for both smokers and nonsmokers (as in Barsky et al., 1997, see footnote 31, p. 567). Thus, we do not rely on these results.[7]

[7] See Kapteyn and Teppa (2003) for an extension of Barsky et al. (1997). Their study did not evaluate the link between smoking and time preference.

2.3.2. Expectations of future economic events

The HRS asked about subjective probabilities of a depression in the U.S. economy in the next 10 years (all six waves), of double-digit inflation in the next 10 years (first five waves), reductions in Social Security benefits in the next 10 years (all waves but the second),[8] and an incident of bioterrorism affecting 100 persons or more in the next 5 years (wave 6). Mean probabilities with sample sizes in parentheses are 0.45 for depression ($N=13{,}659$), 0.51 for double-digit inflation ($N=21{,}804$), 0.60 for a cut in Social Security benefits ($N=11{,}262$), and 0.62 for an incident of bioterrorism ($N=3768$). In waves 4–6, expectations about economic depression, social security, and bioterrorism were only asked to first-time respondents.

We also computed correlations for responses to the expectation questions across waves. For economic depression, the correlations ranged from 0.29 to 0.42, all statistically significant at the 1% level (Table 2, Panel B). For double-digit inflation, correlations ranged from 0.21 and 0.36, again all significant at the 1% level (Panel C). For the subjective probability of Social Security cuts, only asked to an overlapping set of correspondents in waves 1 and 3, the correlation is 0.19, significant at the 1% level. These correlations are generally in the same range as the correlations for time and risk preference, with a similar interpretation about variation over time.

2.3.3. Risk preferences

In waves 1, 4, 5 and 6, HRS asked questions to measure the respondent's risk preference. The questions on risk preferences were asked to the same sample as the previously discussed question on financial planning horizon. Relative risk tolerance is calculated using responses to a gamble based on lifetime earnings.[9] The measure ranges from 0.15 and 0.57; a higher value represents higher relative risk tolerance. The question was changed in wave 4 to eliminate the status quo bias. We pooled observations from all the waves, but include wave fixed effects to account for this change and other time-specific effects. Except for the correlation between waves 1 and 4, the correlations across waves are all statistically significant at the 1% level and range between 0.11 and 0.25 (Table 2, Panel B). The lower correlation between the answers in waves 1 and 4 could be due to the change in the question. We interpret these results in the same way as for time preference.

2.3.4. Health valuation

Wave 5 of HRS includes standard gamble questions in an experimental module. Respondents were asked to assume that they would live for 10 years in the current state of health with same medical expenses and insurance premiums as at the interview date. The individual was asked whether s/he would be willing to pay any amount for additional treatment to be in perfect health. There are 876 respondents of whom 420 were willing to pay something for perfect health.[10] The 420 persons were asked for the maximum amount they would be willing to pay each month for this additional treatment.

Wave 6 includes questions in the experimental module on willingness to pay for drugs to cure (1) Alzheimer's disease and (2) cancer. Respondents provided their subjective probabilities of

[8] However, only in waves one and three were the same individuals asked the question.

[9] The questions separate the respondents into four distinct risk preference categories, ranked from I to IV. For a discussion of the method for calculating relative risk tolerance of each group and other measures used in the analysis described below, see Barsky et al. (1997).

[10] In the standard gamble analysis, we drop six observations; four show inconsistent answers and two answers are outliers ($1,000,000).

getting each of these diseases, and the amount that they would be willing to pay per month for a drug that would cure each of these diseases.

2.4. Explanatory variables

For the continuous dependent variables, we use ordinary least squares. For the discrete dependent variables, we use ordered probit and ordinary least squares using the specifications described in Eqs. (1) and (3). We control for smoking status at the time of the interview: current smoker (23% of sample); and former smoker (38% of sample). Never smoker is the omitted reference group. Explanatory variables, X_{it}, (with means in the parentheses) are age (57.0), and indicators for race and gender, i.e., white (82%), and female (59%). In the analysis of willingness to pay for drugs that cure Alzheimer's disease and cancer, we included subjective probabilities for getting Alzheimer's (0.30) and for cancer (0.38). Nineteen percent of persons reported that they worked at stressful jobs. Seven percent were divorced within the last 2 years, 1% were widowed, and 1% had a parent die within the last 2 years. The mean subjective probability of living to age 75 was 0.65. Mean years of education completed was 12.04 years.

Two other variables were included in preliminary analysis, but excluded from the analysis presented below because of their potential endogeneity: self-reported health status and household income. Since for the HRS sample, which has a mean age of 64.7, educational attainment could be considered plausibly exogenous, we also estimated a specification in which in addition to the explanatory variables we also included educational attainment. This did not change our results so these estimates are not reported. For each of the dependent variables for which we have a panel we include time fixed effects in the regressions as well as control for individual specific unobserved heterogeneity using first difference estimation.

3. Empirical results and discussion

3.1. Time preference

Holding other factors constant, current smokers are more impatient based on the financial planning horizon in both OLS (Table 3, col. 1) and ordered probit regressions (col. 2). The time horizon for former smokers does not differ from that for never smokers. Individuals with a higher subjective probability of living to 75 have a longer financial planning horizon.

When controlling for individual fixed effects,[11] financial planning horizons of current smokers do not differ from others, implying that the difference between current smokers and others in the financial planning horizon is time-invariant heterogeneity and not dependent on quitting. With individual fixed effects, the former smoker variable does not appear since no one went from being a non-smoker to a current smoker within a 2-year time interval. Though our results provide evidence that there is a correlation between smoking status and financial planning

[11] It is well documented that the specification in Eq. (3) may not work well when the dependent variable is discrete, which for us is the case with financial planning horizon. However, we find that in this case the OLS and ordered probit regressions for the specification in equation 1 produce nearly identical results (Table 3, cols. 1 and 3). Hence, we use the specification in Eq. (3) to examine the effects of unobserved heterogeneity in the relationship between smoking status and financial planning horizon using OLS, with the appropriate caveats.

Table 3
Future orientation

	Financial planning horizon		
	(1) OLS	(2) Ordered probit	(3) First differences
Current smoker	−0.088* (0.023)	−0.068* (0.021)	−0.124 (0.086)
Former smoker	0.002 (0.02)	0.001 (0.018)	
Subjective probability live to 75	0.003* (0.0003)	0.003* (0.0002)	0.021 (0.058)
Age	−0.01* (0.001)	−0.009* (0.002)	
White	0.297* (0.024)	0.245* (0.021)	
Female	−0.134* (0.018)	−0.117* (0.016)	
Years of education	0.055* (0.003)	0.047* (0.003)	
Observations	21,200	21,200	6365
R-squared	0.059	0.019	0.001

[a]Significant at 10%; [b]Significant at 5%.
Huber–White standard errors in brackets.
Coefficients for wave fixed effects are not shown.
* Significant at 1%.

horizon (even controlling for the subjective expected longevity of the individual) we are not able to establish causality. However, that is not the primary focus of this paper.[12]

Several approaches exist for assessing time preference, including estimating discount rates (e.g., Harrison et al., 2002), intertemporal elasticity of substitution, e.g., Kapteyn and Teppa (2003), and time horizons for decision-making, which is the approach we use. Using wave 1 of HRS, we tried estimating the intertemporal elasticity of substitution, but as in Barsky et al. (1997), we found the estimate for the whole sample was close to zero. Likely explanations include inadequacy of the question as well as the small sample ($N=198$).[13] We do find that smokers differ from never smokers with respect to two measures of planning horizons for decision-making, implying that smokers are more present-oriented.

We do not examine time preferences in the health domain which is both an advantage and a disadvantage. Using a financial measure is more general as it pertains to non-health decisions, which would be affected by the decision to smoke. A discount factor for health may be more likely to be endogenous to the decision to smoke. This may be one reason that the financial planning horizon is time invariant to the decision to smoke, which gives us greater confidence in the OLS results. Moreover, in economics, there is no theoretical rationale for different discount factors across domains though the psychological literature has made such a distinction, even in the context of smoking (Bickel and Johnson, 2003; Chapman, 2003). It would be of empirical interest to determine whether smokers are more impatient in the health domain as well as to recover direct measures of impatience, i.e.,

[12] In work not reported we examine the causal relationship between smoking status and the various dependent variables in this study. We used cross-state and inter-temporal differences in cigarette prices and in regulations that may impact smoking behavior, e.g., work place smoking bans. However, we found these to be weak instruments.

[13] Of these, 12% of responses yielded no information about elasticities of intertemporal substitution because respondents choose either the steepest falling or steepest rising consumption path for all interest rates. Another 29% chose combinations of consumption paths exhibiting behavior that is inconsistent with rational intertemporal choice; for example, they choose a lower future consumption if the real interest rates increases. The most common answers from the remaining 116 valid responses was to choose a flat consumption path for all three interest rates or a slightly upward moving consumption rate for all interest rates (together 72% of responses).

discount rates or intertemporal elasticities of substitution, but our data limit us from undertaking such an examination.

3.2. Expectations of future economic events

Holding other factors constant, smokers are 4.17 percentage points higher than never smokers in expecting an economic depression in the U.S. in the OLS specification (Table 4, col. 1). There are no differences in expectations between former and never smokers. In the regression for economic depression, controlling for time-invariant unobserved heterogeneity, the effect of being a current smoker on expectations is about as large and statistically significant at the five percent level (col. 2). Thus, beliefs about the state of the future economy do vary with changes in smoking status. In the OLS regression, the subjective probability of living to 75 is negatively related to the subjective probability of an economic depression probably reflecting pessimism. However, the coefficient on this variable changes sign once time-invariant individual personal characteristics are accounted for in the first differences regression. Then individuals who have a higher subjective expected longevity also attach a higher probability to experience an economic depression.

Expectations of double-digit inflation are 4.65 percentage points higher for current than for never smokers (col. 3). The coefficient for former smokers is not statistically significant. Accounting for individual heterogeneity, current smokers have a statistically significant higher expectation of double-digit inflation (col. 4), but the effect is smaller that in the OLS specification. For double-digit inflation, there is no difference in subjective beliefs depending on the individual's subjective probability of survival. However, as with the probability of economic depression, with first differences, there is a strong positive effect of subjective probability of living to 75 on the subjective probability of expected double-digit inflation.

Expectations of cuts in Social Security benefits are 3.24 percentage points higher for current relative to never smokers, and but there is not statistically significant difference from those of former smokers (col. 5). In the corresponding fixed effects analysis (col. 6), there is no difference based on smoking status. The results of the subjective probability of living to 75 are similar to the double-digit inflation case, except that the result in the first difference analysis is not statistically significant at conventional levels. Finally, in the analysis of expectations of bioterrorism, both current (4.44) and former smokers (2.00) are pessimistic relative to never smokers (col. 7). This analysis also accounted for other potential determinants of expectations about future events including measures of stress, such as job related stress.

Previous studies have examined whether smokers differ from nonsmokers in how they assess the probabilities of future health events such as the subjective probability of surviving beyond a certain age (Smith et al., 2001), or the objective risk of getting lung cancer (Viscusi, 1990). Subjective probabilities of survival and other events may be endogenous to the smoking decision. This is not likely for the types of macroeconomic events evaluated in this study. In general, we find that smokers are more pessimistic about future economic events, implying a lower future expected utility. This could explain the decision to smoke, which reduces the person's longevity, and is consistent with a person's preference for current over future consumption.

3.3. Risk preference

Compared to never smokers, current and former smokers are more risk tolerant (OLS specification, Table 5, col. 1). In the specification including fixed effects (col. 2), the current

Table 4
Expectations about future events

	Subjective probability of economic depression		Subjective probability of double-digit inflation		Subjective probability of Social Security cuts		Subjective probability of bioterrorism
	(1) OLS	(2) First differences	(3) OLS	(4) First differences	(5) OLS	(6) First differences	(7) OLS
Current smoker	4.172* (0.685)	3.801** (1.804)	4.647* (0.601)	2.759** (1.368)	3.235* (0.744)	−1.003 (2.723)	4.442* (1.321)
Former smoker	−0.862 (0.585)		−0.162 (0.505)		0.353 (0.651)		2.002*** (1.024)
Subjective probability live to 75	−0.035* (0.010)	1.975*** (1.149)	−0.003 (0.008)	4.616* (0.897)	0.003 (0.011)	2.265 (1.621)	−0.017 (0.019)
Age	−0.035 (0.053)		−0.103** (0.044)		−0.364* (0.057)		0.071 (0.093)
White	−4.85* (0.732)		−1.62* (0.625)		5.27* (0.791)		5.784* (1.330)
Female	3.69* (0.644)		3.504* (0.514)		−1.788* (0.671)		0.063 (0.987)
Years of education	−0.612* (0.106)		−0.423* (0.090)		1.125* (0.110)		0.33*** (0.185)
Stressful job	−1.406* (0.301)	−0.432 (0.420)	−1.281* (0.250)	−0.177 (0.278)	−1.516* (0.345)	−0.259 (0.686)	−2.102* (0.584)
Divorced	0.749 (1.915)	3.703 (3.523)	−0.639 (1.563)	−1.069 (2.625)	0.09 (2.097)	7.641*** (4.441)	3.486 (3.630)
Widowed	0.558 (1.914)	0.627 (3.232)	0.907 (1.547)	−0.061 (2.119)	0.716 (2.483)	0.63 (5.098)	−5.693*** (3.292)
Death of parent	0.921 (0.842)	−0.129 (1.512)	−0.0002 (0.683)	0.5 (1.103)	0.396 (1.092)	−3.303 (2.478)	−1.283 (1.566)
Observations	13,659	6931	21,804	14,317	11,262	4539	3768
R-squared	0.1	0.07	0.05	0.02	0.04	0.002	0.02

Huber–White standard errors in brackets.
Coefficients for wave fixed effects are not shown.
* Significant at 1%.
** Significant at 5%.
*** Significant at 10%.

Table 5
Risk tolerance

	Relative risk tolerance	
	(1) OLS	(2) First differences
Current smoker	0.007* (0.003)	−0.011 (0.011)
Former smoker	0.005**	
Subjective probability live to 75	0.000006 (0.00002)	−0.012** (0.007)
Age	−0.001* (0.000)	
White	−0.003 (0.003)	
Female	−0.018* (0.002)	
Years of education	0.002* (0.000)	
Observations	20,975	6206
R-squared	0.01	0.001

[a]Significant at 5%.
Huber–White standard errors in brackets.
Coefficients for wave fixed effects are not shown.
* Significant at 1%.
** Significant at 10%.

smoker variable no longer has an effect on risk tolerance. This implies that the effect of smoking status in the OLS regression represents a time-invariant individual effect.

Barsky et al. (1997) used the answers to a lifetime income gamble question in the first two waves of the HRS to construct measures of risk tolerance. They found a positive correlation between risk tolerance and smoking status. We include three additional waves in our study and find a similar relationship between smoking and risk tolerance. In addition, exploiting the panel, we find that there is no significant change in risk tolerance for individuals who change their smoking status. This result implies that risk tolerance is a time-invariant characteristic.

3.4. Health valuation

We check for differences in health valuation in four different ways (Table 6).[14] We first estimate whether individuals are willing to trade any dollars for perfect health, conditioning on their current health. We find no difference in health valuation by smoking status. In the analysis of amounts willing to pay for drug to cure cancer and Alzheimer's disease, smoking status makes no difference but persons' subjective probability of getting these diseases has a positive and significant effect on willingness to pay for a drug to cure these diseases.

Health valuations can be measured by two different approaches, revealed and stated preference. Preferences are revealed by observing actual choices people make, given tradeoffs between risks and compensation for those risks. Stated preferences are elicited based on survey responses to hypothetical situations. A possible problem of the stated preference approach is that respondents might act differently in an actual than in a

[14] Since the variables "Trade any dollars for perfect health," "Willingness to pay for Alzheimer drug," and "Willingness to pay for Cancer drug" are discrete, we use probit and ordered probit regressions to estimate the specification in Eq. (1) for these dependent variables, respectively.

Table 6
Health valuation

	Trade any dollars for perfect health	Willingness to pay for perfect health	Willingness to pay for Alzheimer drug	Willingness to pay for cancer drug
	(1) Probit	(2) OLS	(3) Ordered probit	(4) Ordered probit
Current smoker	0.166 (0.173)	−0.099 (0.277)	0.114 (0.156)	0.18 (0.174)
Former smoker	0.161 (0.147)	0.058 (0.231)	0.161 (0.136)	−0.108 (0.141)
Subjective probability live to 75	−0.007* (0.003)	0.001 (0.004)	0.003 (0.002)	0.003 (0.002)
Age	−0.015 (0.011)	0.0002 (0.020)	0.017 (0.012)	0.003 (0.014)
White	−0.476** (0.185)	0.74** (0.293)	−0.009 (0.217)	−0.106 (0.207)
Female	−0.024 (0.141)	0.118 (0.217)	−0.082 (0.127)	−0.101 (0.135)
Years of education	0.012 (0.025)	0.054*** (0.032)	0.051** (0.021)	0.059** (0.025)
Subjective probability of cancer				0.006** (0.003)
Subjective Probability of Alzheimer's Disease			0.006** (0.003)	
Observations	420	236	316	271
R-squared	0.03	0.06	0.02	0.02

Huber–White standard errors in brackets.
Coefficients for wave fixed effects are not shown.
* Significant at 1%.
** Significant at 5%.
*** Significant at 10%.

hypothetical situation (Freeman, 2003). But in revealed preference studies, there may be measurement error in the risk variables, unobserved heterogeneity (e.g., omitted job and/or individual characteristics), and choices about the risk and compensation for such risk may be jointly determined.

Viscusi and Herch (2001) examined wage-risk tradeoffs for smokers and nonsmokers. They used three-digit industry measures of job risk. However, there is likely to be within-industry and within-firm variation in such risk, introducing a measurement error. Persons who take risky jobs may engage in other risky behaviors leading to unobserved heterogeneity. Correlations between health outcomes and current job may also reflect exposure to risks in a past job. They estimate the wage premium for workplace risk separately for smokers and nonsmokers and find that nonsmokers receive a much higher premium for industry-wide injury risk than smokers. Smokers are penalized for prior injuries while nonsmokers are not. They also find that smokers work in higher risk industries. This implies that in equilibrium the wage offer curve is flatter for smokers than for nonsmokers. There are two different explanations for their results: Smokers could have lower valuations for good health. Viscusi and Herch (2001) estimated that the value of a lost workday injury is from between $14,000 and $20,000 (1987 dollars) for smokers and between $31,000 and $35,000 for nonsmokers. Another explanation is that smokers are more risk tolerant and therefore require a lower risk premium. In sum, they were unable to distinguish between the two potential explanations.

A contribution of our study is that we examine risk preferences and health valuations separately, based on a stated preference approach to measuring health valuations. Using several alternative dependent variables, we find no significant differences in health valuations between smokers and never smokers. Our results suggest that the findings of Viscusi and

Herch (2001) may be explained not by lower health valuations of smokers, but by their higher risk tolerance.

4. Conclusion

Smoking provides an interesting case study of preferences and subjective beliefs of risk takers in an important, real-world context as well as offering implications for health and safety regulation. Smokers are more impatient than nonsmokers, measured indirectly in terms of their length of financial planning horizon. They are also more pessimistic about future economic events, which may reinforce their present-orientation. Smokers are also more risk tolerant. This suggests that smokers may more willingly bear risk and trade off current utility against future costs of smoking, plausibly in part because they are more pessimistic about the future. However, they do not value being in excellent health differently from others. Our results also suggest that being more present-oriented and risk tolerant is not caused by smoking; but represents innate characteristics. An implication of our results for product regulation is that restricting access to cigarettes is likely to be circumvented by smokers through other means. In particular, our results are consistent with the finding that smokers in states with higher taxes smoke longer cigarettes that are also higher in nicotine and tar content (Evans and Farrelly, 1998). In fact, as Breyer (1982, p. 148) writes, "How can the regulator predict public behavior if he restricts access to, say, saccharin or peanut butter or even cigarettes? Will some, many, or all former consumers turn to other riskier products? Might former smokers turn to alcohol or former saccharin users eat more sweets?"

In conclusion, our findings have important implications for health and safety regulation. If the role of such regulation is to help people make better choices given their preferences and subjective beliefs, the regulatory process should account for our finding that smokers have relatively high discount rates and are more risk tolerant than are nonsmokers. More generally, our results imply that health and safety regulations should be based on empirical verification of assumptions about preferences and subjective beliefs that are typically made in the regulatory process.

Acknowledgement

We are grateful for the comments of the editor, Pat Bajari, and an anonymous referee which have considerably improved the paper. Khwaja and Sloan acknowledge support for this research in part by a grant from the Robert Wood Johnson Foundation's Substance Abuse Research Program. "Why Mature Smokers Don't Quit."

Appendix A. HRS questions

A.1. Time preference

1) Financial planning horizon. In deciding how much of their family income to spend or save, people are likely to think about different financial planning periods. In planning your (family's) saving and spending, which of the following time periods is most important to you (and your husband/wife/partner), the next few months, the next year, the next few years, the next 5–10 years, or longer than 10 years?

A.2. Expectations about future events

1) Probability of Economic Depression. What do you think are the chances that the U.S. economy will experience a major depression sometime during the next 10 years or so? (0 is absolutely no chance, 100 is absolutely certain)

2) Probability of Double-digit Inflation. What do you think are the chances that the U.S. economy will experience double-digit inflation sometime during the next 10 years or so? (0 is absolutely no chance, 100 is absolutely certain)

3) Probability of Social Security Cuts. How about the chances that Congress will change Social Security sometime in the next 10 years or so, so that it becomes less generous than now? (0 is absolutely no chance, 100 is absolutely certain)

4) Bioterrorism. What do you think is the percent chance that there will be a major incident of bioterrorism in the United States in the next 5 years, directly affecting 100 people or more? (0 is absolutely no chance, 100 is absolutely certain).

A.3. Risk tolerance

1) Relative risk tolerance. Suppose that you are the only income earner in the family. Your doctor recommends that you move because of allergies, and you have to choose between two possible jobs. The first would guarantee your current total family income for life. The second is possibly better paying, but the income is also less certain. There is a 50–50 chance the second job would double your total lifetime income and a 50–50 chance that it would cut it by a third. Which job would you take—the first job or the second job?

This question was used from wave 4 onwards. It was phrased slightly different in wave 1. Depending on the answer the question continues with questions that replace an income cut of a third with an income cut of 20% or 50%.

A.4. Health valuation

1) Trade any money for perfect health. Imagine that you will live for exactly ten more years in your current state of health. Assuming that your current medical expenses and insurance premiums stay the same as they are now, would you be willing to pay any more every month for additional medical treatment if it allowed you to live those ten years in perfect health?

2) Amount of money willing to pay for perfect health. What is the greatest amount you would be willing to pay each month to live in perfect health? Would you be willing to pay $50/ $200/ $500/$1000/ $2000/ $5000 per month?

3) Dollars per month willing to pay for Alzheimer drug. Suppose that a drug were discovered that guaranteed that someone would never develop Alzheimer's Disease, and that the treatment was 100% effective as long as a person took one pill every month for the rest of their life. Suppose further that there are no side effects. Would you be willing and able to pay $5/ $25/ $100/ $250/ $1000 per month for such a pill, or the same amount in higher insurance payments to cover it?

4) Dollars per month willing to pay for Cancer drug. Suppose that the same sort of drug were to be discovered that we talked about earlier. It would guarantee that someone would never develop cancer, and it would be 100% effective as long as a person took one pill every month for the rest of their life. This pill has no side effects. Would you be willing and able to pay 5/25/

$100/ 250/1000 per month for a pill, or the same amount in higher insurance payments to cover it, that would guarantee that you would not develop a fatal cancer?

References

Barsky, R.B., Juster, F.T., Kimball, M.S., Shapiro, M.D., 1997. Preferences, parameters, and behavioral heterogeneity: an experimental approach in the health and retirement study. Quarterly Journal of Economics CXII (3), 537–579.

Becker, G.S., Murphy, K.M., 1988. A theory of rational addiction. Journal of Political Economy 96 (4), 675–700.

Becker, G.S., Grossman, M., Murphy, K.M., 1994. An empirical analysis of cigarette addiction. American Economic Review 84, 396–418 (June).

Bickel, W.K., Johnson, M.W., 2003. Delay discounting: a fundamental behavioral process of drug dependence. In: Loewenstein, G., Read, D., Baumeister, R. (Eds.), Time and Decision. Russell Sage Foundation, New York, pp. 419–440.

Blomquist, G., 1991. Motorist use of safety equipment: expected benefits or risk incompetence? Journal of Risk and Uncertainty 4 (2), 135–152.

Breyer, S., 1982. Regulation and its Reform. Harvard University Press, Cambridge, MA.

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

Chapman, G.B., 2003. Time discounting of health outcomes. In: Loewenstein, G., Read, D., Baumeister, R. (Eds.), Time and Decision. Russell Sage Founadation, New York, pp. 395–417.

Evans, W.N., Farrelly, M.C., 1998. Compensating behavior of smokers: taxes, tar, and nicotine. Rand Journal of Economics 29 (3), 578–595.

Freeman III, A.M., 2003. The Measurement of Environmental and Resource Values. Resources for the Future, Washington.

Gruber, J., Köszegi, B., 2001. Is addiction 'rational'? Theory and evidence. Quarterly Journal of Economics 116 (4), 1261–1303.

Gruenspecht, H.K., Lave, L.B., 1989. The economics of health, safety and enviromental regulation. In: Schmalensee, R., Willig, R.D. (Eds.), Handbook of Industrial Organization. Elsevier, Amsterdam, pp. 1507–1550.

Harrison, G.W., Lau, M.I., Williams, M.B., 2002. Estimating individual discount rates in Denmark: a field experiment. American Economic Review 92 (2), 1606–1617.

Juster, F.T., Suzman, R., 1995. An overview of the health and retirement study. Journal of Human Resources 30 (Suppl. 0), S7–S56.

Kapteyn, A., Teppa, F., 2003. Hypothetical intertemporal consumption choices. Economic Journal 113, C140–C153.

Khwaja, A., Sloan, F., Chung, S., 2005. Individual Expectations and Behaviors: Evidence on the Relationship Between Mortality Expectations and Smoking Decisions. Duke University.

Knight, F.H., 1921. Risk, Uncertainty, and Profit. Houghton Mifflin Co., Boston, MA.

Magat, W.A., Moore, M.J., 1996. Consumer product safety regulation in the United States and in the United Kingdom: the case of bicycles. Rand Journal of Economics 27 (1), 148–164.

Orphanides, A., Zervos, D., 1995. Rational addiction with learning and regret. Journal of Political Economy 103, 739–758.

Peltzman, S., 1975. Effects of automobile safety regulation. Journal of Political Economy 83, 677–725.

Peltzman, S., 1987. The health effects of mandatory prescriptions. Journal of Law and Economics 30, 207–239.

Smith, V.K., Taylor Jr., D.H., Sloan, F.A., 2001. Longevity expectations and death: can people predict their own demise? American Economic Review 91 (4), 1126–1134.

Thaler, R., Rosen, S., 1976. The value of saving a life: evidence from the labor market. In: Terleckyz, N. (Ed.), Household Production and Consumption. Columbia University Press, New York.

Viscusi, W.K., 1979. Employment Hazards: An Investigation of Market Performance. Harvard University Press, Cambridge, MA.

Viscusi, W.K., 1990. Do smokers underestimate risks? Journal of Political Economy 98, 1253–1269.

Viscusi, W.K., 2002. Smoking Filled Rooms: A Post Mortem on the Tobacco Deal. U. of Chicago Press, Chicago.

Viscusi, W.K., Herch, J., 2001. Cigarette smokers as job risk takers. Review of Economics and Statistics 83 (2), 269–280.