Time preference and health behaviour: A review

Lydia J.R. Lawless and Rodolfo Nayga and Andreas Drichoutis

Sensory Spectrum, University of Arkansas , University of Ioannina

21. March 2013

Time preference and health behaviour: A review

Lydia J.R. Lawless[1], Rodolfo M. Nayga, Jr.[2], and Andreas C. Drichoutis[3]

[1] Sensory Spectrum, New Providence, NJ, USA

[2] Department of Agricultural Economics, University of Arkansas

[3] Department of Economics, University of Ioannina, Greece

Abstract: Time preferences indicate preferences over streams of future consumption which significantly shape individual decision making including the health domain. In this paper, we review published studies to assess the influence of time preferences on human health behaviour. We first discuss the theoretical background of time preferences; ascertain the differences between private and social discount rates; identify the impact of time preferences on governments of developing nations; and then assess how time preferences influence risky behaviour such as being overweight, smoking, and engaging in risky sexual behaviour. The issue of whether to use proxies or experimental time preference elicitation methods in time preference studies is also addressed.

Keywords: time preference, health domain, risk aversion, discount rate, behaviour

JEL codes: D91, I0

1. Introduction

Often in life, individuals are faced with the choice of immediately consuming or waiting to consume a good. In other words, one chooses between immediate gratification and delayed

gratification. Usually, when one chooses to wait, it is because through waiting, one may be able to receive a larger reward. For example, saving money to buy a new car can both *earn interest* while the money is being saved *and save interest costs* once the car is purchased. Through waiting, one is able to save money and then use it to gain additional utility through the consumption of additional goods. This exemplifies the concept of time preference. Standardly defined, time preference is the amount of future utility that is equivalent to the current utility of consuming a good or service. Time discount rates express the amount of future utility necessary to compensate an individual for waiting.

Research on time preferences and health outcomes has conventionally had applications in shaping public policy, explaining psychological decision making, and uncovering motivations behind seemingly irrational health behaviours [18]. Indeed, time preferences play a major role in the ways our decisions shape our health and our lives. Understanding the impact of time preferences and how to best capture them is a primary goal of time preference research. Much work on time preferences has focused on theoretical modeling (see [4] for a review of the alternative models that have been proposed in the literature), as well as on a plethora of empirical applications. In 2002, Frederick, Loewenstein, and O'Donoghue [33] provided a review of the historical origins of the discounted utility model, biases that occur when measuring time discount rates, and methods of measuring discount rates, some of which Chapman [18] has addressed as well. This paper will not attempt to repeat either of these comprehensive works; rather, they are complemented here through a review of post-2002 work that profiles the influence of time preferences on human (health) behaviour. Specifically, our objectives in this paper are:

1) to examine the influence of time preferences on human (health) behaviour;
2) explain how the societal time discount rate differs from the private time discount rate;

3) determine how time discount rates sway governments in the developing world;
4) assess how time discount rates affect decision making in regard to risky behaviours such as becoming obese, smoking, and engaging in risky sexual behaviour; and
5) discuss the repercussions of time preferences on prevention of poor health.

The articles included in our review are related to either social or private discount rates, time preferences and the developing world, or risky health behaviour. We also included papers with time preference and human behaviour components. Given the review by Frederick, Loewenstein, and O'Donoghue [33], papers published before 2002 were sometimes included to explain results from works published during or after 2002.

2. Time Preferences and Domain Independence

Individuals make intertemporal choices and express preferences in several domains including health, money, and the environment. Researchers have found that monetary and environmental domains may be comparable [37]. However, correlations between health and money domains tend to be generally low and researchers refer to this phenomenon as domain independence. Domain independence may be problematic because, according to normative discounted utility theory, discount rates should not change with decision domain [18]. For individuals, these differences do not appear to be a result of different utility functions for health and money [20] or familiarity with health situations [21]. Possibly, individuals do not consider health and money 'fungible,' or tradable in the strict sense. In public health policy, however, health and money are more easily viewed as fungible because in this case, policy makers are making monetary investments to garner future health benefits [18]. Actually, the issue of

domain independence is a point of contention in the literature. If money and health are tradable, then the same discount rate can be used for both domains. However, since it is conceivable that individuals may not value their health and money in the same way, then arguments for using differential discount rates seem warranted. Lazaro [48] reviewed arguments for both concepts and concluded that neither can be fully accepted without reservation. Lazaro suggests, however, that empirical evidence should be the determinant in choosing which framework to adopt. For example, Lazaro, Barberan, and Rubio [49] examined the time preferences of a representative Spanish sample and found that health outcomes are discounted at a higher rate than monetary outcomes.

The literature suggests that a contributing factor to domain independence is the temptation associated with a particular domain. For example, beer drinkers who are not chip lovers have high discount rates for beer but low discount rates for chips in part because they are *more tempted* by beer. The increased visceral attraction to a particular domain may entice a "hot" state, similar to what a cigarette addict experiences when s/he craves a cigarette [68].

3. Societal and Private Time Discount Rates

Time preferences play a critical role in developing public health policy. When we speak of time preferences and public policy, we must distinguish between individual time preferences and social time preferences. Private time preferences refer to an individual's decisions, while societal time preferences refer to society's preferences for others' well being. When making public policy decisions, the social discount rate is usually regarded as an appropriate measure to use [29; 57]. Some studies have shown that discount rates for health were higher than those for money in both the social and private context [49; 50], though more recent evidence indicates that

social time discount rates for health were lower than social time discount rates for money [54]. As Cairns [13] points out, the differences could be attributed to differing sample populations or differing methods of framing time preference. For example, in the case of higher discount rates for health, there is the possibility that when health outcomes are delayed, subjects are less certain of those outcomes than they are when the delay is associated with monetary outcomes [18]. Social and individual discount rates *within the health domain,* however, seem to be similar [14; 69].

Another issue to consider when using time preferences to develop public policy is the concept of intergenerational time preference, or in other words, how the utility of the current generation is to be weighed against the utility future generations will experience. The role of the government to protect future generations at the expense or sacrifice of the current generation that elected it, is a point of debate (see [34] for a review). Perhaps most important to understand is that the individual discount rate and the intergenerational discount rate are not readily interchangeable.

4. Time Preferences and Governments in the Developing World

Understanding time preferences is vital to understanding governmental policy. For example, high time discount rates contribute to governmental emphasis on acute care, rather than preventative care. Of course, there are facets of governmental policy other than time preferences that can further complicate public policy decision making. Subsidizing treatments and fee-based systems contribute to inefficiency through the overuse of some treatments and overconsumption of treatments in general, respectively [71]. Understanding these interplaying factors can help frame the discussion of public policy.

Developing countries generally have specific public policy decisions that are partially explained by time preferences. For example, time preference concepts can help explain how developing countries choose to allocate their limited resources to specific programs. An example is the AIDS pandemic in Eastern Africa, considered one of the biggest public policy challenges in the developing world. Prevention strategies include the development of an AIDS vaccine and the distribution of condoms. To date, the development of an AIDS vaccine has not received a large amount of funding, perhaps due to the presence of high discount rates. Governments with high societal discount rates do not readily invest in prevention while governments that value the future would have low discount rates and would be likely to invest in prevention. For example, distribution of condoms as a prevention strategy, is only cost effective if the condoms are distributed to specific at-risk groups [32].

We summarized the published health discount rates in developing countries in Table 1. Robberstad [61] elicited time discount rates from Tanzanians for a hypothetical health state linked to malaria. Discount rates were lower for the more severe malarial-like illness, which would be evidence of an absolute magnitude effect where higher discount rates are associated with smaller outcomes [6]. Robberstad [61] suggested that separate discount rates for non-fatal and fatal illnesses are perhaps more appropriate than assigning one discount rate to each condition. Evidence for the magnitude effect and the common difference effect[1] (where time preference rates and time spans are inversely correlated) was demonstrated in a similar study that compared several discounting models [62]. This study found that hyperbolic discounting models specifically those of Mazur [53] and Loewenstein and Prelec [51], fit the data the best. In this example, the authors observed that the choice of model could have significant implications on

[1] The magnitude effect and the common difference effect are two of many psychological biases that influence time discount rates; Chapman [18] further discusses psychological biases.

final public policy decisions. Namely, the discounted utility model at a 3% discount rate more heavily emphasized immediate health solutions than did the hyperbolic model [62].

In addition to analyzing time discount rates, identifying factors that relate to discount rates is an important area of research. A study which was performed in South Africa, an area "with high morbidity and mortality", found that health and survival probability had significant relationships with subjective discount rates [17]. Those in very good health, very poor health, and those who expressed great certainty or uncertainty about how long they would live had high discount rates. In other words, health and survival probability had a u-shaped relationship with the subjective discount rate [17].

In developed countries such as the United States, investment in health research can potentially improve health outcomes across the income spectrum by improving treatment options or better defining a healthy lifestyle [63]. Similarly, investment in preventative measures such as the AIDS vaccine could have great value in developing nations. Understanding the interplaying psychological factors that contribute to changes in time preference is critical for establishing appropriate public policy.

[Table 1 about here]

5. Time Preferences and Risky Behaviour

Countries are continually faced with public health concerns, particularly because their citizenries often undertake risky health behaviours. Among these are smoking, being overweight or obese, and participating in risky sexual behaviour, which all contribute to government expenditures on healthcare. Sexual education programs designed to decrease risky sexual behaviour, anti-smoking initiatives, and anti-obesity campaigns are common in many countries

due to the financial burdens that these behaviours incur. In many western countries, obesity is an especially challenging public health issue.

5.1. Time preferences and obesity

In the United States, the obesity problem is of primary importance because obesity is the second leading cause of preventable deaths [55] due to its contribution to higher incidences of heart disease and diabetes [25]. The figures are comparable for Europe. The rise of obesity is often attributed to technological change, though some authors have also suggested that an increase in time preference rates is also to blame [46; 47; 58]. Technological change has especially decreased the time cost of food preparation, which makes food more readily consumable and more tempting to individuals with self-control problems [26]. Another suggested contributor to obesity is health insurance. The rationale is that people who know that another entity will pay the majority of their health expenses will exhibit riskier health behaviour, which is partially supported by Cutler and Lleras-Muney [27], who found that health insurance status does partially explain the association between education level and health behaviour including being overweight. Note, however, that Kelly and Markowitz [43] did not find a significant relationship between being obese and having health insurance which indicates that more research is warranted before firm conclusions are to be made.

When judging whether a change in time preference has increased obesity rates, many measures of impatience are examined. These measures are considered time preference proxies. Among these are savings rates, which have fallen, and credit card debt, which has risen [12]. To further examine the relationship between personal savings and obesity, Komlos, Smith, and Bogin [46] compared obesity prevalence and lagged personal savings in the US and found that as obesity increased by 112%, personal savings fell by 83% during the last three decades of the

twentieth century. Additionally, obesity prevalence and lagged debt-to-income ratio showed similar trends; the debt-to-income ratio accelerated during the 1980s and 1990s as did obesity prevalence. When comparing countries, those with higher net domestic savings rates have lower incidences of obesity and vice-versa. The culmination of this evidence supports the likely relationship of time preference and obesity, though the authors caution that causal relationships cannot be determined from it. More work is needed to explain why certain subgroups (e.g. women) have more prevalent obesity rates than others [46].

In table 2, we summarize the time preference proxies and elicitation methods used in the obesity studies discussed in this review.

[Table 2 about here]

5.2. Time preferences and smoking

Smoking presents an especially interesting case study because of the persistently high smoking rates in many countries. We first review the theories under which individuals make the decision to smoke in light of its potentially negative consequences. We then discuss related work from UK, the United States, Japan, and Korea.

Cawley [16] and Sloan and Wang [66] discuss three economic models which attempt to explain an individual's choice to participate in addictive behaviour: perfectly rational addiction (introduced by Becker and Murphy [11]), imperfectly rational addiction, and irrational addiction. Cawley [16] synthesizes addictive behaviour into three important tenets: tolerance, withdrawal, and reinforcement. Tolerance drives dissatisfaction with the current level of consumption. Withdrawal contributes to an aversion of quitting because of the negative feelings associated with cessation. Reinforcement encourages increasingly higher consumption because individuals

continually derive satisfaction from consuming an extra unit of a good. Ferguson [30] provides a very detailed discussion about the rational theory of decision-making in the health domain.

The imperfectly rational model can be partially explained in terms of hyperbolic discounting, which, unlike exponential discounting, accounts for changing time preference rates. Under hyperbolic discounting, smokers experience an increasing time discount rate as cessation approaches. Besides time-inconsistent preferences, under the imperfectly rational model, individuals may also "misperceive probabilities of harms following from their current behaviors, have cognitive difficulties in forming probabilities or learning from the experiences of others, and/or have imperfect information about their own probabilities of becoming addicted" [66]. Under the irrational addiction model, decisions about consuming addictive substances are motivated by emotion, rather than logic. Empirical evidence supports the rational and irrational models. For example, cigarette prices influence consumption, which could be indicative of either model type, although impulsivity seems to influence current smokers, which is not consistent with the rational model [66]. Overall, the best fitting theory has not been determined, though evidence has been shown to support facets of each. More empirical work is necessary to fully understand the theoretical underpinnings behind addiction.

Data collected from older English adults attempted to define the relationship between smoking cessation and time preferences [1]. The authors found that as subjects' financial planning periods increased, the chances of smoking decreased, though quitting cessation did not show the same pattern. In this study, subjects were classified by their responses to the question "In planning your/your family's saving and spending, which of the following time periods is more important to you and your husband/wife/partner?" (44). Their choices ranged from the next few weeks to longer than 10 years. As Adams [1] points out, this question is more related

to the monetary domain while smoking cessation is related more to the health domain. Scharff and Viscusi [64] found that the implied time discount rate of smokers was higher than that of nonsmokers (i.e., smokers were less future-oriented than non-smokers) by examining the income individuals received compared to the danger associated with their job. This method also potentially fails to truly isolate the health and monetary domains since as previously discussed, time preferences could change for different domains. Additionally, a number of omitted variables may be confounding the analysis, which includes severity of addiction, smoking-associated-disease diagnosis, self efficacy, information and ideas about the ill-effects of smoking, and social support among others [70]. Smoking and time preferences are interrelated with information and education to the extent that Fersterer and Winter-Ebner [31] used smoking status at age 16 to predict future educational attainment. One must note, however, that not all studies find a significant relationship between time discount rates and smoking (e.g., [38], find that male smokers have significantly higher discount rates than male non-smokers, but smoking has no significant effect on discount rates among women), which may be attributed to differences in the elicitation method [44].

When considering time preferences and their role in smoking (especially with regards to smoking cessation), one should also consider risk aversion, or the likelihood an individual will take on more risk in exchange for the possibility of a larger reward (risk aversion directly affects the concavity of the utility function, see for example [7]). A Japanese study found that lower time discount rates (i.e., more future orientation) and risk aversion predicted quit success significantly [35; 41]. The discrete choice method, in which subjects choose between two different combinations of attributes, was able to consider risk and time preferences at the same time and calculate actual discount rates and risk aversion coefficients. A higher time preference

rate and lower risk aversion coefficient was associated with increased likelihood of smoking [42]. The discrete choice method offers more information than studies which use time preference proxies to determine associations between behaviours and time preferences [35]. Additionally, use of time preference proxies can potentially confound the analysis because some behaviours (e.g., smoking) that are associated with time preferences may also be associated with risk aversion[2]. Besides smoking, other conditions or behaviours such as having too much body weight, not wearing a seatbelt, and drinking heavily have been found to have significant, negative relationships with risk aversion [8]. It is therefore quite difficult to separate time preferences and risk aversion when using proxies.

Through the examination of studies that relate the behaviour of smoking with time preferences (see Table 3), we find that one of the most important questions asked in these studies is how to increase the efficacy of smoking cessation programs and prevent more individuals from ever starting. Although the practical implementation is not clear, an important step mentioned is increasing future orientation [1] and thus instigating a lower discount rate. Hence, the direction public policy should take, may depend on the theoretical framework that supports addictive behaviour. If smoking addiction operates under the rational addiction model, then public service programs designed to communicate the harm that smoking causes to others and self might be beneficial. On the other hand, under the imperfectly rational and irrational models, individuals will most likely regret their present choices later; thus devices designed to promote self control

[2] Andersen et al. [5] show how risk and time preferences are interrelated. In their experiments they showed that it is essential to have one risk preference elicitation task for measuring the curvature of the utility function, another task to identify the discount rate conditional on knowing the utility function, and then jointly estimate the structural model defined over the parameters of the utility function and discount rate. More recently, Andreoni and Sprenger ([9]) extended the methodology proposed by Andersen et al. ([5]) by developing a procedure they called the Convex Time Budget (CTB) method that does not require a separate risk aversion task to identify the curvature of the utility function. The procedure involves giving the subject 100 tokens to allocate between the sooner and later time period, and then varying the exchange rate between tokens and money for sooner or later amounts. See also Cheung ([24]) for a quibble on Andreoni and Sprenger ([9]).

in the present such as increased smoking taxes and smoking bans may be helpful. These devices would also be beneficial under the rational addiction model [66]. Analysis of successful anti-smoking programs should offer guidance into these policies' effectiveness. For instance, efforts from the Korean government in the early twenty-first century seemed to improve quit success and intention. Among their efforts were the combined effects of increased cigarette taxes and anti-smoking campaigns (these were not evaluated separately in the model) [39]. In addition, the study demonstrated the role of promoting general healthy behaviour in public policy. Individuals who exercised more and were moderate drinkers were found to be more likely to intend to quit smoking [39].

[Table 3 about here]

5.3. The interplay between time preferences, health behaviour, and socioeconomic status

The literature discussed above is highly suggestive of a link between time preference and health-related statuses such as smoking habits (or lack thereof) and obesity. The issue addressed here is the interplay among these behaviours in light of potentially confounding demographic considerations (summarized in Table 4). In one study, socioeconomic status (as measured by the Index of Multiple Deprivation) was significantly related to time preferences (as measured by the Consideration of Future Consequences Scale), smoking status, and BMI [3]. Specifically, time preferences were found to affect socioeconomic status and BMI, though not smoking status. In contrast, Adams [2] found that socioeconomic status has a role in determining the level of physical activity and smoking status. Time preferences were also shown to not account for any of the education gradient, e.g., the association between the education chasm and health behaviours including smoking and being overweight [27]. This finding reinforces the importance of

examining time preferences in light of confounding variables such as socioeconomic status as in [3] or income, family structure, or health insurance status as in [27].

The relationship between BMI and smoking per se is highly important as well. The vast majority of longitudinal and cross-sectional work finds an inverse correlation between smoking and BMI [45], though much of this work fails to account for the mitigating effects of time preferences. Since time preference has been found to be an important predictor of BMI [60], exclusion of time preferences in studies examining the link between BMI and smoking can be confronted with omitted variable bias.

[Table 4 about here]

5.4. Time preferences and sexual behavior

Risk-taking sexual behaviours contribute to societal costs both in terms of monetary expenditures on treating sexually transmitted diseases (STD) (e.g., herpes simplex virus, HIV, etc.) and the human suffering associated with these diseases. Chesson et al. [23] examined the relationship between time discount rates and sexual behaviour. Their subjects were asked a series of time preference questions about monetary tradeoffs and were then grouped according to their discount rates. Risky sexual-behaviour-indicators such as 'having gonorrhea or Chlamydia', 'having sex before age 16', and 'pregnancy status' were all significantly associated with high discount rates. In addition, discount rates were found to decrease with age, which is in accordance with findings that teenagers greatly discount the future and show little regard for future health consequences [56].

Perhaps the most important part of this analysis is its potential applications to reducing risky sexual behaviour. Programs which stress the short-term consequences of STDs may be more effective in encouraging young people to pursue healthier choices.

6. Time Preferences and Prevention

Knowing that time preferences are related to human behaviours is not enough. Rather, if we can understand what motivates people psychologically when making intertemporal choices, we can utilize what we know about time preferences to positively affect public health and in some cases predict occurrence of diseases. A prevalent public policy issue that affects many nations is vaccine programs, which have been used to control many diseases that once wrecked havoc around the world. Analyzing the introductions of new vaccine programs through time preference measurements is an effective way of gauging their cost effectiveness.

A meta-analysis performed by Chapman [19] demonstrates that 'hot' or addictive health behaviours such as smoking have been found to be more associated with time preference than 'cold' behaviours such as vaccination. We must note, however, that Chapman's meta-analysis does not include all cold behaviours examined in the literature, in part because the nature of meta-analysis limits its application to studies for which correlations can be computed. Other prevention behaviours designed to prevent cervical and breast cancer, such as self-breast exams, mammograms, and Pap smears, are associated with individuals with higher life expectancy, lower time preference, and more risk aversion [59]. Differences in education and cognitive ability may also partially explain differences in health behaviours including participation in prevention behaviours [15]. The educated may be better informed about risk factors for a particular disease (e.g., breast cancer [22]) or perhaps better able to process information from government-funded prevention campaigns (e.g., HIV/AIDS prevention campaigns in Uganda [28]).

Nevertheless, the distinction between hot and cold behaviour states plays a major role in the irrational model of decision making. Hot or visceral states such as hunger or craving have been shown to decrease future orientation [52]. Individuals with addictions have experienced more hot states than non-addicts, which might also contribute to decreased future-orientation even when not in hot states. Chapman [19] suggests that time preferences are associated with only some health behaviours. Therefore, time preferences maybe capturing part of another psychological component such as impulsiveness or temptation-withstanding-ability, though strong evidence exists for the association between time preference and smoking in particular. Understanding what contributes to the decision to smoke is of great importance when it comes to cancer control, since smoking is a significant risk factor for cancer.

Of course, environmental factors, other than smoking, can contribute to cancer. Thus, individuals often associate programs designed to promote cleaner environments with reduced disease risks. The costs that individuals are willing to pay today to reduce the risk of disease in the future can be determined using contingent valuation methods. For example, in Taiwan, individuals were asked how much they were willing to pay in increased utility costs to promote cleaner water (and thus a lesser chance of liver disease) and in increased cost of consumer goods to promote cleaner air (and thus a lesser chance of lung disease). In both instances, the disease either occurred in a few months or 20 years later. If the negative consequences are delayed, willingness to pay to avoid disease will decrease most likely due to present-biased time preferences. It is also noteworthy that willingness to pay (WTP) is dependent on disease type (cancer vs. non-cancer), the combination of the organ type (liver vs. lung), environmental pathway (water vs. air), and payment method (utility bill vs. consumer goods) [36].

Like time preference elicitation methods, WTP elicitation methods are discussed heavily in the literature. Incorporating WTP in a study that also considers time preference is another step in the direction of considering all the interplaying processes that contribute to human behaviour and decision making.

7. Conclusions

In this review, we tried to demonstrate the important role time preferences play in our everyday lives and in terms of health behavior in particular. Specifically, we tried to synthesize the more recent applications done in the health domain of the time preference literature.

Three basic strategies used to capture time preferences were discussed. They included calculating implied time discount rates based on some observed behaviour in society, employing time preference experiments in which participants' choices indicate their time difference rate, and using time preference proxies. Time preference proxies generally do not provide information on the actual discount rate, which makes them less desirable for studies with the objective of fully understanding time preferences.

Context may partially determine the influence of time preferences. For example, time preferences in developing countries may exhibit differing trends from those of developed countries. Additionally, the social discount rate, which considers society's preferences for others' well being may not be interchangeable with the individual time discount rate, which considers an individual's preferences for himself or herself.

Risk preferences are thought to interplay with time preferences and have been integrated in investigations that examined risky behaviours such as being overweight, smoking, or engaging in risky sexual behaviour.

Time preferences also guide governments and thus guide the course of history. Hence, understanding and accurately measuring them deserves much further time investment.

8. References

1. Adams, J.: The Role of Time Perspective in Smoking Cessation Amongst Older English Adults. Health Psychology 28, 529-534 (2009)

2. Adams, J.: The Mediating Role of Time Perspective in Socio-economic Inequalities in Smoking and Physical Activity in Older English Adults. Journal of Health Psychology 14, 794-799 (2009)

3. Adams, J., White, M.: Time Perspective in Socioeconomic Inequalities in Smoking and Body Mass Index. Health Psychology 28, 83-90 (2009)

4. Andersen, S., Harrison, G.W., Lau, M., Rutstrom, E.E.: Discounting Behavior, A Reconsideration, working paper 2011-3. Center for the Economic Analysis of Risk (2011)

5. Andersen, S., Harrison, G.W., Lau, M.I., Rutstrom, E.E.: Eliciting risk and time preferences. Econometrica 76, 583-618 (2008)

6. Andersen, S., Harrison, G.W., Lau, M., Rutström, E.E.: Discounting behavior and the magnitude effect . Economica ((forthcoming) 2013)

7. Andersen, S., Harrison, G.W., Lau, M.I., Rutstrom, E.E.: Eliciting risk and time preferences. Econometrica 76, 583-618 (2008)

8. Anderson, L.R., Mellor, J.M.: Predicting health behaviors with an experimental measure of risk preference. J. Health Econ. 27, 1260-1274 (2008)

9. Andreoni, J., Sprenger, C.: Estimating time Preferences from convex budgets. American Economic Review 102, 3333-3356 (2012)

10. Ayyagari, P., Grossman, D., Sloan, F.: Education and health: evidence on adults with diabetes. International Journal of Health Care Finance & Economics 11, 35-54 (2011)

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

12. Blaylock, J., Smallwood, D., Kassel, K., Variyam, J., Aldrich, L.: Economics, food choices, and nutrition. Food Policy 24, 269-286 (1999)

13. Cairns, J.: Discounting in economic evaluation. In: Drummond, M., McGuire, A. (eds.) Economic Evaluation in Health Care—Merging Theory with Practice. Oxford University Press, Oxford (2001)

14. Cairns, J., van der Pol, M.: The estimation of marginal time preferences in a UK-wide sample (TEMPUS) project. Health Technology Assessment 4 (2000)

15. Cawley, J., Ruhm, C.: THE ECONOMICS OF RISKY HEALTH BEHAVIORS. NBER WORKING PAPER SERIES Working Paper 17081 (2011)

16. Cawley, J.:
Reefer Madness, Frank the Tank, or Pretty Woman: To What Extent Do Addictive Behaviors Respond to Incentives?. In: Sloan, F.A., Kasper, H. (eds.) Incentives and Choice in Health Care. MIT Press, U.S.A. (2008)

17. Chao, L., Szrek, H., Pereira, N.S., Pauly, M.V.: Time preference and its relationship with age, health, and survival probability. Judgment and Decision Making 4, 1-19 (2009)

18. Chapman, G.B.: Time Discounting of Health Outcomes. In: Lowenstein, G.A., Read, D., Baumestier, R.F. (eds.) Time and Decision: Economic and Psychological Perspectives on Intertemporal Choice, pp. 395-418. Russell Sage Foundation, New York, New York (2003)

19. Chapman, G.B.: Short-term cost for long-term benefit: Time preference and cancer control. Health Psychology 24, S41-S48 (2005)

20. Chapman, G.B.: Temporal discounting and utility for health and money. Journal of Experimental Psychology-Learning Memory and Cognition 22, 771-791 (1996)

21. Chapman, G.B., Nelson, R., Hier, D.B.: Familiarity and time preferences: Decision making about treatments for migraine headaches and Crohn's disease. Journal of Experimental Psychology-Applied 5, 17-34 (1999)

22. Chen, K., Lange, F.: Education, Information and Improved Health: Evidence from Cancer Screening. IZA Discussion Paper No. 3548 (2008)

23. Chesson, H.W., Leichliter, J.S., Zimet, G.D., Rosenthal, S.L., Bernstein, D.I., Fife, K.H.: Discount rates and risky sexual behaviors among teenagers and young adults. J. Risk Uncertainty 32, 217-230 (2006)

24. Cheung, S.L.: Risk preferences are not time preferences: Comment. Institute for the Study of Labor (IZA) Discussion Paper No 6762 (2012)

25. Colditz, G.A.: Economic Costs of Obesity. Am. J. Clin. Nutr. 55, S503-S507 (1992)

26. Cutler, D.M., Glaeser, E.L., Shapiro, J.M.: Why have Americans become more obese?. Journal of Economic Perspectives 17, 93-118 (2003)

27. Cutler, D.M., Lleras-Muney, A.: Understanding differences in health behaviors by education. J. Health Econ. 29, 1-28 (2010)

28. de Walque, D.: How does the impact of an HIV/AIDS information campaign vary with educational attainment? Evidence from rural Uganda. Journal of Development Economics, 686–714 (2007)

29. Drummond, M., Stoddart, G., Torrance, G.: Methods for the economic evaluation of health care programmes. Oxford University Press, Oxford (1987)

30. Ferguson, B.S.: Economic modeling of the rational consumption of addictive substances. Subst. Use Misuse 41, 573-603 (2006)

31. Fersterer, J., Winter-Ebmer, R.: Smoking, discount rates, and returns to education. Economics of Education Review 22, 561-566 (2003)

32. Fleßa, S.: Decision support for AIDS control programmes in eastern Africa. Or Spectrum 25, 265-291 (2003)

33. Frederick, S., Loewenstein, G., O'Donoghue, T.: Time discounting and time preference: A critical review. Journal of Economic Literature 40, 351-401 (2002)

34. Frederick, S.: Valuing future life and future lives: A framework for understanding discounting. Journal of Economic Psychology 27, 667-680 (2006)

35. Goto, R., Takahashi, Y., Nishimura, S., Ida, T.: A cohort study to examine whether time and risk preference is related to smoking cessation success. Addiction 104, 1018-1024 (2009)

36. Hammitt, J.K., Liu, J.T.: Effects of disease type and latency on the value of mortality risk. J. Risk Uncertainty 28, 73-95 (2004)

37. Hardisty, D.J., Weber, E.U.: Discounting Future Green: Money Versus the Environment. Journal of Experimental Psychology-General 138, 329-340 (2009)

38. Harrison, G.W., Lau, M.I., Rutstroem, E.E.: Individual discount rates and smoking: Evidence from a field experiment in Denmark. J. Health Econ. 29, 708-717 (2010)

39. Hong, S., Collins, A.R.: The Impact of Antismoking Policies in Korea on Quit Success and Smoking Intentions. Contemporary Economic Policy 28, 474-487 (2010)

40. Huston, S.J., Finke, M.S.: Diet choice and the role of time preference. J. Consumer Aff. 37, 143-160 (2003)

41. Ida, T., Goto, R.: Simultaneous Measurement of Time and Risk Preferences: Stated Preference Discrete Choice Modeling Analysis Depending on Smoking Behavior. International Economic Review 50, 1169-1182 (2009)

42. Ida, T., Goto, R.: Interdependency among addictive behaviours and time/risk preferences: Discrete choice model analysis of smoking, drinking, and gambling. Journal of Economic Psychology 30, 608-621 (2009)

43. Kelly, I.R., Markowitz, S.: Incentives in Obesity and Health Insurance. Inquiry-the Journal of Health Care Organization Provision and Financing 46, 418-432 (2009)

44. Khwaja, A., Silverman, D., Sloan, F.: Time preference, time discounting, and smoking decisions. J. Health Econ. 26, 927-949 (2007)

45. Klesges, R.C., Meyers, A.W., Klesges, L.M., Lavasque, M.E.: Smoking, Body-Weight, and their Effects on Smoking-Behavior - a Comprehensive Review of the Literature. Psychol. Bull. 106, 204-230 (1989)

46. Komlos, J., Smith, P.K., Bogin, B.: Obesity and the rate of time preference: Is there a connection?. J. Biosoc. Sci. 36, 209-219 (2004)

47. Lakdawalla, D., Philipson, T.: The growth of obesity and technological change. Economics & Human Biology 7, 283-293 (2009)

48. Lazaro, A.: Theoretical arguments for the discounting of health consequences - Where do we go from here?. Pharmacoeconomics 20, 943-961 (2002)

49. Lazaro, A., Barberan, R., Rubio, E.: The economic evaluation of health programmes: why discount health consequences more than monetary consequences?. Appl. Econ. 34, 339-350 (2002)

50. Lazaro, A., Barberan, R., Rubio, E.: Private and social time preferences for health and money: An empirical estimation. Health Econ. 10, 351-356 (2001)

51. Loewenstein, G., Prelec, D.: Anomalies in Intertemporal Choice: Evidence and Interpretation. Quarterly Journal of Economics 107, 573-592 (1992)

52. Loewenstein, G.: Hot-cold empathy gaps and medical decision making. Health Psychology 24, S49-S56 (2005)

53. Mazur, J.E.: An Adjustment Procedure for Studying Delayed Reinforcement. In: Commons, M.L., Mazur, J.E., Nevin, J.A., Rachlin, H. (eds.) The Effect of Delay and Intervening Events on Reinforcement Value, pp. 55–76. Erlbaum, Hillsdale, NJ (1987)

54. Meerding, W.J., Bonsel, G.J., Brouwer, W.B.F., Stuifbergen, M.C., Essink-Bot, M.: Social Time Preferences for Health and Money Elicited with a Choice Experiment. Value in Health 13, 368-374 (2010)

55. Mokdad, A.H., Marks, J.S., Stroup, D.F., Gerberding, J.L.: Actual causes of death in the United States, 2000. Jama-Journal of the American Medical Association 291, 1238-1245 (2004)

56. O'Donoghue, T., Rabin, M.: Risky behavior among youths: some issues from behavioral economics. In: Gruber, J. (ed.) Risky behavior among youths: an economic analysis, pp. 29-67. The University of Chicago Press, Chicago, IL (2001)

57. Olsen, J.A.: On what Basis should Health be Discounted. J. Health Econ. 12, 39-53 (1993)

58. Philipson, T.J., Posner, R.A.: The long-run growth in obesity as a function of technological change. Perspect. Biol. Med. 46, S87-S107 (2003)

59. Picone, G., Sloan, F., Taylor, D.: Effects of risk and time preference and expected longevity on demand for medical tests. J. Risk Uncertainty 28, 39-53 (2004)

60. Robb, C.A., Huston, S.J., Finke, M.S.: The mitigating influence of time preference on the relation between smoking and BMI scores. Int. J. Obes. 32, 1670-1677 (2008)

61. Robberstad, B.: Estimation of private and social time preferences for health in northern Tanzania. Soc. Sci. Med. 61, 1597-1607 (2005)

62. Robberstad, B., Cairns, J.: Time preferences for health in northern Tanzania - An empirical analysis of alternative discounting models. Pharmacoeconomics 25, 73-88 (2007)

63. Rosenman, R.: The public finance of healthy behavior. Public Choice 147, 173-188 (2011)

64. Scharff, R.L., Viscusi, W.K.: Heterogeneous Rates of Time Preference and the Decision to Smoke. Econ. Inq. 49, 959-972 (2011)

65. Shanmugam, K.R.: Rate of time preference and the quantity adjusted value of life in India. Environ. Dev. Econ. 11, 569-583 (2006)

66. Sloan, F.A., Wang, Y.: Economic theory and evidence on smoking behavior of adults. Addiction 103, 1777-1785 (2008)

67. Sloan, F.A., Padron, N.A., Platt, A.C.: Preferences, Beliefs, and Self-Management of Diabetes. Health Serv. Res. 44, 1068-1087 (2009)

68. Tsukayama, E., Duckworth, A.L.: Domain-specific temporal discounting and temptation. Judgment and Decision Making 5, 72-82 (2010)

69. van der Pol, M., Cairns, J.: A comparison of the discounted utility model and hyperbolic discounting models in the case of social and private intertemporal preferences for health. Journal of Economic Behavior & Organization 49, 79-96 (2002)

70. Ward, K.D., Klesges, R.C., Halpern, M.T.: Predictors of smoking cessation and state-of-the-art smoking interventions. J. Soc. Iss. 53, 129-145 (1997)

71. Watts, J.J., Segal, L.: Market failure, policy failure and other distortions in chronic disease markets. Bmc Health Services Research 9, 102 (2009)

72. Zhang, L., Rashad, I.: Obesity and time preference: The health consequences of discounting the future. J. Biosoc. Sci. 40, 97-113 (2008)

Table 1

Estimates of Health Discount Rates for Developing Countries

Mean Private Discount Factor (P_d)	Mean Social Discount Factor (S_d)	Delay of Condition	Elicitation Method	Model	Sample Size	Health State Description	Hypothetical?	Country	Study
0.071	0.068	3-6 yrs	Open-ended Stated Preference	Discounted Utility	n=224 for $\mathbf{P_d}$ n=226 for $\mathbf{S_d}$	Malarial-like disease	Hypothetical	Tanzania	[61]
0.122*	0.122*	3-6 yrs	Open-ended Stated Preference	Harvey (Hyperbolic)	450 pooled sample	Non-fatal but will miss work	Hypothetical	Tanzania	[62]
0.101*	0.101*	3-6 yrs	Open-ended Stated Preference	Mazur (Hyperbolic)	450 pooled sample	Non-fatal but will miss work	Hypothetical	Tanzania	[62]
0.121*	0.121*	3-6 yrs	Open-ended Stated Preference	L&P (Hyperbolic)	450 pooled sample	Non-fatal but will miss work	Hypothetical	Tanzania	[62]
0.076- 0.079	N/A	Age and life expectancy (from tables) considered for each individual	Real-life job choices and associated risks	Expected discounted life years lost by weighted non-linear least squares	522	N/A	Non-hypothetical	India	[65]

*Pooled both social and private discount rates because there was no statistical difference

Table 2

Time Preference Proxies and Elicitation Methods in Obesity Studies

Study	Subject	Elicitation Method/Proxies
[10]	Diabetes Management (Obesity)	Agreement to "I live life one day at a time and don't think much about the future"
[67]	Diabetes Management (Obesity)	Agreement to "I live life one day at a time and don't think much about the future"
[72]	Obesity	Time preference proxies: degree of willpower and "desire but no effort"
[46]	Obesity	Time preference proxies: Savings and debt-to-income ratio
[40]	Obesity	Time preference proxies: "Level of formal education, smoking, exercising and using nutrition labels on a regular basis, and the degree of nutrition knowledge…"

Table 3

Time Preference Proxies and Elicitation Methods in Smoking Studies

Study	Subject	Elicitation Method/Proxies
[64]	Smoking	"Workers' wage fatality risk trade-offs" (Implied time discount rate for nonsmokers was 8.1% compared to 13.8% for smokers)
[42]	Smoking	Discrete choice experiment to measure time and risk preferences
[1]	Smoking	Response to "In planning your/your family's saving and spending, which of the following time periods is more important to you and your husband/wife/partner?"
[35]	Smoking	Discrete choice experiment to measure time and risk preferences
[44]	Smoking	Financial Intertemporal Choices; Health Intertemporal Choices (e.g. "20 extra days in perfect health this year would be just as good as __ extra days in perfect health *x* year(s) from now")
[31]	Smoking and Education	Smoking status at 16 years of age

Table 4

Time Preference Proxies and Elicitation Methods in Combined Smoking and Obesity Studies

Study	Subject	Elicitation Method/Proxies
[27]	Health behaviour including smoking and obesity	Health Intertemporal Choices: "20 extra days in perfect health this year would be just as good as extra days in perfect health *X* years from now? where *X* was 1, 5, 10 and 20."
[2]	Smoking, Obesity (by physical activity)	Response to "In planning your (family's) saving and spending, which of the following time periods is more important to you and (your partner)?"
[3]	Smoking, Obesity	Consideration of Future Consequences Scale
[60]	Smoking, Obesity	Time preference index: "diet choice, vitamin use, education, smoking status, exercise, nutritional knowledge, use of nutrition labels and importance of nutrition"