

Why Chinese discount future financial and environmental gains but not losses more than Americans

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Abstract Understanding country differences in temporal discounting is critical for extending incentive-based environmental policies successfully from developed countries to developing countries. We examined differences between Chinese and Americans in discounting of future financial and environmental gains and losses. In general, environmental use value was discounted significantly more than the monetary values, but environmental existence value was discounted similarly to the monetary values. Confirming previous research, we found that participants discounted gains significantly more than losses. Furthermore, there was a significant interaction between culture and gain/loss outcome: Chinese discounted gains but not losses in both outcome categories more than Americans. Open-ended comments suggest that respondents focused on the uncertainty and foregone returns associated with waiting for future rewards when discounting gains, but focused on the magnitude of the losses and the psychology cost of carrying debts when discounting losses.

Keywords Temporal discounting · Cross-cultural differences · Uncertainty · Environmental decisions · China

JEL Classifications D81 · D91

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In 2006, China became the world's No. 1 industrial emitter of atmospheric carbon dioxide, the most important global-warming pollutant, surpassing the United States by 8% (PBL Netherlands 2007). Similar to many developing countries, China has mainly relied on a command-and-control (CAC) approach to solve conflicts between economic development and environmental protection. With priority given to economic development, the effectiveness of the CAC approach is rather limited. There are wide gaps between regulation on paper and in practice, as the environmental protection bureau lacks financial resources to adequately train personnel and monitor industrial activities.

After decades of rapid economic growth at the cost of the environment and precious resources, the Chinese government is now attempting to adopt a more balanced approach, i.e. the concept of "Scientific Outlook on Development." The new concept was ratified into the Communist Party of China's constitution at the 17th Party Congress in October 2007. One way to perform the "Scientific Outlook on Development" is to develop incentive, or market-based, environmental policies that have been widely applied in industrialized countries. Some examples are emission fees, tradable permits, and voluntary regulations. Although some developing countries have successfully implemented one or more of these popular environmental policy innovations, there are multiple reasons why many others have failed. The most noticeable and widely discussed reasons are deficiencies of infrastructure, expertise, and law enforcement, all of which are essential in applying market-based strategies.

Another important, albeit largely ignored, reason for the failure of applying previously successful incentive-based environmental policies to developing countries is that the most popular of these market-based policies are designed based on the preferences and behavior characteristics of developed countries. This is problematic because there are significant cultural and societal disparities between many developed and developing countries that should be carefully considered. Individuals in developing countries can be expected to have different preferences, and may respond to incentives differently than those in developed countries. To extend the success of the environmental policies from developed countries to developing countries, we need to better understand cultural and social differences and how these may affect decision-making processes. For example, previous research has found that Chinese perceive the risk of the financial options with known probabilities and outcomes to be less than Americans, and as a result seem to be less risk averse in terms of pricing such financial options, although Chinese and American attitudes towards perceived risks were similar (Weber and Hsee 1998). The effectiveness of environmental policies that utilize financial market mechanisms, such as emission permits, could presumably be improved by better understanding the processes of human decisions under risk and uncertainty. Hence, the value of addressing cultural differences in adapting policies for implementation in differing countries may be substantial.

The current study examines the difference between Chinese and Americans in temporal discounting. Discount rates play an extremely important role in many environmental problems, especially when a benefit-cost analysis, the prevailing approach for evaluating environmental projects, is applied. For example, policies targeting century-scale problems, such as climate change, can be very sensitive to discount rates.

Weitzman (2007) sees the biggest uncertainty of all, in the economics of climate change, as the uncertainty about which interest rate to use for discounting. For incentive-based policies on shorter terms, such as emission fees or energy conservation subsidies, both the magnitude and the timing of such policies are contingent on the decision makers' discount rates which largely determine how they respond to the incentives offered immediately or in the future.

Despite the apparent importance of discounting in environmental decision making, and the popular interest in extending incentive-based environmental policies to solve the increasingly dismal environmental problems in China, there is surprisingly little research on discounting differences between Chinese and citizens of developed Western countries. Two exceptions are Tan and Johnson (1996) and Du et al. (2002). Tan and Johnson (1996) found no significant difference in discount rates between Canadian undergraduates and foreign undergraduates of Chinese descent. In Du et al. (2002), 28 American, 28 Chinese, and 23 Japanese made choices between immediate and delayed hypothetical monetary rewards. All participants were graduate students in American universities. Du et al. (2002) report that Americans and Chinese discounted delayed rewards more than Japanese. However, the generality of these findings is questionable, given the small size and the non-representative nature of the samples. Also, these studies did not examine discounting differences in losses, even though previous research has shown important differences in the discounting of gains and losses (Thaler 1981; Appelt et al. 2011) and environmental decisions frequently involve consequences over time that are framed as losses.

In the current study, we investigated cultural differences between Americans and Chinese on discounting environmental and monetary values in both the gain and loss domains. In general, environmental use value was discounted significantly more than the monetary values, but environmental existence value was discounted similarly to the monetary values. Confirming previous research, we found that participants discounted gains significantly more than losses. Furthermore, there was a significant interaction between culture and gain/loss outcome: Chinese discounted gains but not losses in both outcome categories more than Americans. Open-ended comments provided by participants in conjunction with their intertemporal choices suggest that different considerations drove decisions uniquely in the gain and loss domains. Respondents from both countries focused on the uncertainty and foregone returns associated with waiting for future rewards. Living in a rapidly changing society and facing more economic volatility, Chinese were more concerned about the insecurity and uncertain value of future gains, and had higher expectations for returns they could receive were they to invest in the gains without delay. This is consistent with their greater discounting of gains. However, when discounting losses, both Chinese and Americans focused on the magnitude of the losses and the psychology cost of carrying debts, consistent with them displaying similar discount rates. The remainder of the paper is structured as follows. In [Section 1](#) we provide a literature review on discount rate; in [Section 2](#) we present the study design; in [Section 3](#) we explain the data analysis and discuss the findings; and in [Section 4](#) we offer our conclusions.

1 Previous research on discounting

1.1 Unpacking the discount rate

Traditional economic theory on temporal discounting dates back to the Ramsey rule (1928):

$$\rho_t = \delta + \eta g(C_t) \quad (1)$$

Where ρ_t is the discount rate applied to consumption at time t , δ is the pure rate of time preference (PRTP), η is the elasticity of marginal utility of consumption, and $g(C_t)$ is the growth rate of consumption.

The Ramsey rule postulates that discounting of future outcomes is increased by three factors: the impatience of the decision maker (PRTP), the growth rate of the economy, and the elasticity of marginal utility of consumption (consumption smoothing), given that the growth rate is positive.

Out of the three components, η and $g(C_t)$ can be measured empirically. However, there is much debate among economists on the choice of the PRTP value, which reflects society's preference to consume earlier rather than later. A positive value signifies impatience and valuing current consumption more than future consumption. It indicates that we value the consumption of future generations less than ours. The discount rate of 1.4% proposed by Stern (2006) to calculate the costs and benefits of climate change mitigation, which is lower than the discount rates used by others in climate economics, has been justified by arguing that it is ethically inappropriate to have a positive PRTP in public policy. Stern's view has been both supported (Heal 2008; Cline 2008) and criticized (Nordhaus 2007) by others. A more extensive review of research related to the Ramsey rule and climate economics can be found in Heal (2005) and Dasgupta (2008).

1.2 Uncertainty and discounting

One important topic closely related to discounting is uncertainty. According to the Ramsey rule, uncertainty affects discounting in two ways. First, uncertainty about the existence or worth of future rewards increases the discount rate. A very low but positive probability that human beings will be extinct before potential catastrophic consequences of climate change could take place may warrant a small but positive PRTP for climate change policies. If people have doubts about their ability to secure future rewards, such as thinking that unforeseeable events may prevent a bank from cashing a check, the PRTP will also be higher. Although unrelated to impatience, this kind of uncertainty pushes the discount rate up by increasing the PRTP. The second way that uncertainty affects discounting is when uncertainty about growth rate decreases the discount rate. Uncertainty about future levels of wealth can encourage generally risk-averse decision makers to defer consumption in case future needs arise, thus lowering their discount rates.

The first kind of uncertainty (on existence of future rewards), which increases the discount rate, is frequently observed. This introduces an obvious parallel between decision making under uncertainty and decision making over time: people usually

prefer certain outcomes to uncertain ones, and prefer immediate payoffs to delayed ones. Weber and Chapman (2005) investigate the immediacy effect and the certainty effect side by side and show that in separate evaluation settings, uncertainty eliminates the immediacy effect and delay eliminates one form of the certainty effect. This indicates that, at least in some contexts, people associate delay with uncertainty.

The second kind of uncertainty (on future wealth), which decreases the discount rate, is based on a macroeconomic assumption that rational people maximize their total utility over a life span by smoothing out their consumption over time (Romer 2005). However, given that boundedly-rational decision makers have limited attention, processing capacity, and time horizons (Simon 1957), it is probably rare that people make daily decisions based on long-term utility maximization. In a study by Loewenstein and Sicherman (1991), the majority of participants in fact preferred to receive a fixed sum of money by increasing payments over time, as opposed to decreasing payments, in both paycheck and rental income scenarios. This casts doubt on the general applicability of economic assumptions about discounted present-value maximization. Additional decision making components, including affective or visceral factors (such as desire for immediate gratification) and heuristic processing (such as preference for positive trajectories that signal improvement) often influence decisions under uncertainty and time delay. These may account in part for the gap between the economic assumption of long-term utility maximization and real world behaviors.

In our discussion so far, we have concentrated on the discounting of future rewards. When discounting gains, people with high discount rates value the utility from future gains much less than the utility from present gains. Conversely, in the loss domain, a high discount rate means having smaller disutility for future losses than for immediate losses. That is, a high discount rate predicts a preference for smaller sooner gains over larger later gains (and a decision to *not* wait to gain), as well as a preference for larger later losses over smaller sooner losses (and a decision to wait to lose). As in the gain domain, the uncertainty of existence or value of future losses should also increase the discount rate of losses. That is, people should be more willing to wait to pay the losses if they think that there is a possibility that they will not need to pay them at all in the future, or if they are risk-seeking in terms of uncertain future losses. Also similar to the gain domain, the existence of uncertainty in future wealth level should decrease the discount rate in the loss domain for risk-averse decision makers who seek to maximize total utility over their life spans. This is because an uncertain future wealth level would make them more willing to pay off debts now, as long as they can afford it, instead of facing an uncertain consumption budget in the future.

In summary, uncertainty affects discounting behavior in two ways. Uncertainty about the values to be discounted *increases* the discount rate, while the uncertainty in the future wealth level *decreases* the discount rate. These are true in both the gain and loss domains.

1.3 Other factors in discounting

Several other factors besides uncertainty have been shown to affect discounting. These include interest rates on investments (Samuelson 1937) and growth rate of the economy, as well as other more individual-level expectations, such as future resource slack (Zauberman and Lynch 2005). In addition, characteristics of the decision maker can

play a role, such as his or her willingness to substitute utility across time, as well as impatience level, also known as present bias (Laibson 1997). Table 1 presents a non-exhaustive list of contributing factors to discount rate.

1.4 The process of discounting future outcomes

Not only the rate of discounting and its various determinants are up for normative debate and empirical study, but also the way in which a constant or variable discount rate is used. Presented by Samuelson in 1937, the discounted utility model uses a constant rate, such as a risk-free interest rate on the market, to continuously discount all future outcomes. This model had become the standard normative model in economics. More recently, research on hyperbolic discounting has provided evidence that the normative model using a constant discount rate may not be a good descriptive model of the actual discount behavior of people (Laibson 1997; Fischer 1999; O'Donoghue and Rabin 1999; Frederick et al. 2002). In hyperbolic discounting, outcomes are discounted more for shorter delays than longer delays. Such time-inconsistent discounting has been observed in both humans and animals (Ainslie 1974).

If the field of economics spells out normative arguments for discounting, psychology contributes to discounting research descriptively, by investigating how people discount in various circumstances. For instance, research has found that people discount gains more than losses, and discount large values more than small ones (Thaler 1981). One factor that has received scant attention among researchers, despite its relative importance, is the psychological benefits and costs of waiting. People may enjoy looking forward to a future gain, or incur a psychological cost from carrying a debt. In other words, the waiting period itself can have positive or negative consumption utility. Psychological benefits (or costs) of waiting for future gains (or losses) decrease discount rates. That is, the psychological benefit (or cost) makes people more (or less) willing to wait in the gain and loss domains, respectively.

The process by which people discount future outcomes is also important to consider, as specific aspects of the process frequently determine the outcome (Weber and Johnson 2009). It is now broadly accepted that preferences are often constructed in real time, at the moment a decision needs to be made, and not simply retrieved from memory (Lichtenstein and Slovic 2006). Query theory elaborates on the role of sequential memory queries to provide evidential support for such real-time decisions (Weber and Johnson 2009). Applications of query theory to intertemporal choice (Weber et al. 2007) provide a process-level explanation for why people discount gains more when the default action is immediate consumption, compared to when the default action is to wait for larger future rewards (Loewenstein 1988). Appelt et al. (2011) used query theory to explain why people are more likely to choose the default option (wait or not wait) in all discounting decisions, but discount losses *less* when the default is to pay for the loss immediately rather than wait to pay more later (Benzion et al. 1989).

One line of research relevant to the current study is the comparison of discounting in different outcome domains, including money, environmental goods (Bohm and Pfister 2005), health value (Chapman 2003), human life (Cropper et al. 1994), and consumer goods (Estle et al. 2007). Two observations hold. First, hyperbolic discounting has been observed in domains other than financial values. For example, Viscusi et al. (2008) report that when discounting environmental quality, time preference is very high for

Table 1 A Non-exhaustive summary of factors influencing temporal discounting

	Impatience/Present Bias		Economic Growth		Uncertain Future Value		Uncertain Future Wealth		Psychology Benefit/Cost	
	Gain	Loss	Gain	Loss	Gain	Loss	Gain	Loss	Gain	Loss
Decision	Not Wait	Not Wait	Not Wait	Wait	Not Wait	Wait	Wait	Not Wait	Wait	Not Wait
Discounting Rate	↑	↓	↑	↑	↑	↑	↓	↓	↓	↓
	Interest Rate		Wait as Default		Resource Slack		Utility Smoothing		Social Norms	
Decision	Gain	Loss	Gain	Loss	Gain	Loss	Gain	Loss	Gain	Loss
Discounting Rate	Not Wait	Wait	Wait	Wait	Not Wait	Wait	Depends?	Depends?	Depends?	Depends?
	↑	↑	↓	↑	↑	↑	?	?	?	?

immediate benefits and drops off substantially thereafter. Second, the evidence on whether discount rate is domain dependent is mixed. Frederick et al. (2002) propose that discount rates vary based on what it is that individuals are discounting. Chapman (2003) and others report differences between discount rates for future health and money outcomes, based on hypothetical or incentivized choices between present or future outcomes. For example, various studies have found that the discount rate for health is higher than for money (Cairns 1992; Chapman et al. 2001). In contrast, Viscusi and colleagues estimated implicit discount rate for deferred health benefits by analyzing the workers' choices related to job risk and wage associated with the risk and found that the estimated discount rate for health risk was generally consistent with the real interest rate typical workers faced at the time (Moore and Viscusi 1990; Viscusi and Aldy 2003 for a review). Conflicting results also exist in research on the discounting of environmental values vs. financial outcomes. Bohm and Pfister (2005) suggested that people discount financial outcomes more than environmental ones. In contrast, Hardisty and Weber (2009) found no significant difference between people's discounting environmental values and financial values, but found a strong sign effect, in that positive future outcomes were discounted significantly more than negative future outcomes. They noted that differences in discounting between financial and environmental outcomes found by Bohm and Pfister (2005) could be explained by the fact that in that study financial outcomes had been gains and environmental outcomes had been losses.

In the current research, we further differentiate between two types of environmental values, i.e., use value and existence value (Hanley et al. 2007), and two types of monetary values, i.e., self-earned money and "house" money, earned by luck in gambling (Thaler and Johnson 1990). We expect people to focus on different components when facing environmental use value vs. existence value, and self-earned money vs. house/luck money, and exhibit different discounting behaviors. People (in multiple countries and across both genders and all age groups) show distinct risk attitudes in risky decisions in different domains, including in risky monetary decisions that are investments vs. financial gambles (Weber et al. 2002; Markiewicz and Weber 2013). Furthermore, differences in focus as a function of domain or subdomain may interact with whether the outcomes occur in the gain vs. loss domain (Hardisty and Weber 2009). As discussed below, the data confirm this expectation.

2 Study design

2.1 Participants

All participants completed a web-based survey. There were 118 American participants from an online subject pool managed by a Northeastern university behavior lab. It was a national sample with 22% of them being students. As we had difficulty accessing a similar subject pool in China, we posted our survey advertisement on three popular Chinese websites to recruit participants directly. We were able to collect data from 86 Chinese participants before the survey was terminated by the Chinese sites because of internet restrictions posted by the Chinese government. We then posted our survey on three Chinese sites hosted abroad. Visitors to those sites were mainly Chinese who grew up in China, but currently lived abroad, since the Chinese government blocked

the access of those sites from China. We collected data from 127 participants from the Chinese abroad sample. As will be shown in the data section, the behavior of the Chinese abroad sample was very similar to the Chinese in China sample. We excluded 11 American, 9 Chinese in China, and 17 Chinese abroad participants from analysis because they completed the survey in less than 5 min (mean length was 20 min, and 5 min was the minimum time to complete the survey in an internal pilot). One Chinese in China participant was excluded for completing the survey multiple times. Analyses below are based on the remaining 107 Americans, 77 Chinese in China, and 110 Chinese abroad participants.

Among the 107 American participants, 53% of them were female, and 51% of them were between 25 and 44 years old. The Chinese in China sample was gender skewed with 67% being male, mainly because of the gender skewedness among the Chinese internet users (China Internet Network Information Center 2010). More sociodemographic characteristics are reported in Table 2. As shown in the table, both the American and Chinese in China samples were typical internet samples that were younger and more educated than the national populations. The Chinese abroad sample, however, was a special group who were highly educated, due to the fact that it was a very competitive process for the Chinese people to gain the opportunity to study or work abroad. The Chinese abroad sample was also gender skewed with 67% of them being female. We suspect that the major reason was because 1 of the 3 sites we posted our survey on had a reputation to attract female visitors. In spite of the demographic differences between the two Chinese samples, the discount behaviors of the Chinese abroad sample and the Chinese in China sample were very similar, as will be discussed in the results section.

The sociodemographic differences among the three samples were further confirmed by the significant chi-square values in Table 2. For example, the chi-square value for comparing the gender composition of three samples was $\chi^2(2)=20.05$ with a p value less than 0.01, which indicates that we should reject the null hypothesis that the three samples have the same gender composition. Given the significant chi-square values, it is important to take into consideration the apparent sociodemographic disparities among the three samples when analyzing the data and interpreting the results, as will be discussed in the data analysis section later.

2.2 Design

The study had a 2 (Chinese version vs. American version) X 2 (gain vs. loss: between) X 4 (Categories: environmental existence value vs. environmental use value vs. lottery money vs. self-earned/inflicted money: within) design. That is, Chinese and American participants saw each choice either in the gain or in the loss domain (between-subjects), but saw choices in all four domains, shown in blocks, in a sequence that was randomized for each respondent. For the environmental existence values, participants compared either a small increase in the population of a species of fish in a national park at present and a larger increase one year later (Gain domain), or a small decrease in the number of old trees in a forest and a larger decrease one year later (Loss domain). For the environmental use values, participants compared a smaller immediate increase/decrease in air quality with a larger

Table 2 Sociodemographics characteristics of the three samples

Sociodemographics	American	Chinese in China	Chinese Abroad	Chi-square Test
Gender				
Male	45%	67%	30%	$\chi^2(2)=20.05^{***}$
Female	53%	33%	67%	
Age				
18–24	28%	35%	15%	$\chi^2(6)=40.71^{***}$
25–44	51%	62%	82%	
45–64	18%	2%	1%	
65 and above	1%	0%	0%	
Education				
High school diploma	14%	3%	1%	$\chi^2(8)=80.75^{***}$
Associate degree	10%	3%	3%	
Bachelor's degree	50%	30%	20%	
Master's degree	20%	51%	41%	
Doctoral or professional degree	3%	11%	34%	
Profession				
Entrepreneur	4%	3%	0%	$\chi^2(12)=61.46^{***}$
Manager	22%	3%	0%	
Civil servant/employee	11%	21%	16%	
Student	22%	49%	41%	
Working in household	7%	0%	0%	
Unemployed	7%	3%	6%	
Other	19%	19%	26%	
Income				
Less than 10,000 ^a	8%	10%	3%	NA
10,000–20,000	2%	14%	10%	
20,000–40,000	18%	19%	16%	
40,000–60,000	21%	14%	21%	
60,000–150,000	27%	17%	16%	
150,000 and above	8%	6%	11%	
Marital Status				
Never married	40%	68%	60%	$\chi^2(8)=42.11^{***}$
Married	42%	21%	27%	
Living together	9%	6%	9%	
Divorced	5%	0%	0%	
Widowed	2%	0%	0%	
Number of Children				
None	52%	94%	62%	$\chi^2(6)=41.07^{***}$
1 or 2	33%	6%	35%	
3 or more	12%	0%	1%	

* In some categories, the sum of the percentages is less than 100% because of missing values. 10, 5, and 1% significant are represented by *, **, and ***, respectively

^a The currency was in US\$ for the American sample, and Yuan for the Chinese in China sample and the Chinese Abroad sample. The medium income per capital in 2011 in the United States was \$41,560 (U.S. Department of Commerce et al. 2011), and the medium income per capital in 2011 was 19,118 Yuan in urban China and 6194 Yuan in rural China (National Bureau of Statistics of China 2012)

increase/decrease in the future.¹ For the monetary values, participants chose between a smaller amount of monetary gain/loss now and a larger amount of monetary gain/loss later, and the gain/loss was either because of good/bad luck or was self-earned/inflicted. The exact choice scenarios are provided in Appendix A,² but a short summary of each of the eight scenarios is provided below:

Environmental use value in the Gain domain 21 days of improved air quality starting today vs. a longer period a year from today.

Environmental use value in the Loss domain 21 days of decreased air quality starting today vs. a longer period a year from today.

Environmental existence value in the Gain domain increasing the fish population in a national park by 50% today vs. increasing the population by a higher percentage a year from today.

Environmental existence value in the Loss domain cutting down 22 old trees in a forest today vs. cutting a larger number of old trees a year from today.

Lottery money value in the Gain domain \$250 of lottery money today vs. a larger amount of lottery money a year from today.

Lottery money value in the Loss domain paying \$250 of late fees because of lost rent check today vs. paying a larger amount of fees a year from today.

Earned money value in the Gain domain cashing out a \$750 paycheck today vs. cashing it out a year from today and receiving a bonus.

Earned money value in the Loss domain paying someone \$100 for breaking her device today vs. paying her a larger amount of money a year from today.

We used the New Ecological Paradigm (NEP) scale (Dunlap et al. 2000) to measure the participants' pro-environmental orientations, or the degree to which people view humans as a part of nature. Respondents rate their levels of agreement to 15 environment related statements on a 5-point Likert scale. Hence, the range of the NEP score is between 15 and 75, with a higher NEP score indicating more pro-environmental attitude. There are five subscales in the NEP score: Reality of Limits to Growth, Antianthropocentrism, The Fragility of Nature's Balance, Rejection of Exemptionalism, and The Possibility of Ecocrisis.³ The American sample had a higher

¹ This scenario is similar to one of the scenarios used in Hardisty and Weber (2009).

² Appendix A is available at: <http://www.columbia.edu/~mg3030/Discounting%20Appendix%20A.pdf>.

³ Reality of Limits to Growth measures "attitudes regarding the reality of the limits of growth in the environment"; Antianthropocentrism measures "the belief that nature exists primarily for human use and has no inherent value of its own"; Fragility of Nature's Balance measures "attitudes towards the fragility of nature's balance"; Rejection of Exemptionalism measures "attitudes towards the rejection of exemptionalism"; Possibility of Ecocrisis measures "attitudes towards the possibility of an ecocrisis". (Conpsychmeasures.com 2012)

total NEP score, after controlling for the demographics ($p < 0.05$), than the Chinese in China sample. A closer look at the subscales showed that the higher NEP score of the American sample was mainly driven by subscales on the Reality of Limits to Growth and The Fragility of Nature's Balance categories. The Chinese abroad sample had similar environmental attitude, both on the total NEP score and the subscales, as the Chinese in China sample ($p > 0.05$).

2.3 Procedure

Each participant made a series of choices between immediate and one-year delayed outcomes. To measure participants' preferences, we applied two approaches: a choice titration method and a free response method. Choice titration, also referred to as the adaptive staircase method, has a long history in psychophysics (Cornsweet 1962). For example, for the environmental existence value in the gain domain, the participants read the following scenario: "Imagine that you live in an area where there are 20 old dams that are no longer in use. The dams block the migration of fish to pristine spawning grounds in a national park. The local government decides to remove some of these dams. It is estimated that each dam removed will increase the fish population in the national park by 10%. If all of the dams are removed, the fish population will double. For the same cost, construction company A removes 5 dams immediately. Construction company B removes more dams a year from now. Would you prefer A to remove 5 dams immediately, or B to remove 18 dams a year from now?" If the answer was B, then the number of dams B removed decreased from 18 to 13 to 9 to 6, or until the participant switched from B to A. Next, the number of B increased from the switch point to a middle value between the switch point and the next high value. For example, a participant chose B when B was equal to 18 and 13, then switched to A once B dropped to 9. She was then asked to choose between A (removes 5 dams immediately) and B (removes 11 dams a year from now). Note that 11 is a middle value between 9 and 13. If the above participant chose B over A, for her, removing 5 dams now was as good as removing between 11 and 13 dams a year from now. If, however, she chose A over B, then removing 5 dams now was as good as removing between 9 and 11 dams a year from now.

Figure 1 illustrates the decision flow of the procedure. The two numbers in the next to last box in each decision node represent the tradeoff ratio between 5 dams now and a range of dams in the future. The middle value of the range, measured by the titration method, was used to calculate each participant's discount rate unless he or she maxed out the titration scale, in which case we used the free response value.⁴ The free response value was measured by asking participants to type their answers to the following question: "Please fill in the number that makes the following two options equally attractive: Removal of 5 dams immediately vs. Removal of ___ dams a year from now."

⁴ We dropped the outliers that were greater than 3 standard deviations. Out of the 1,171 values from all participants, 26 outliers were dropped and treated as missing values in the analyses.

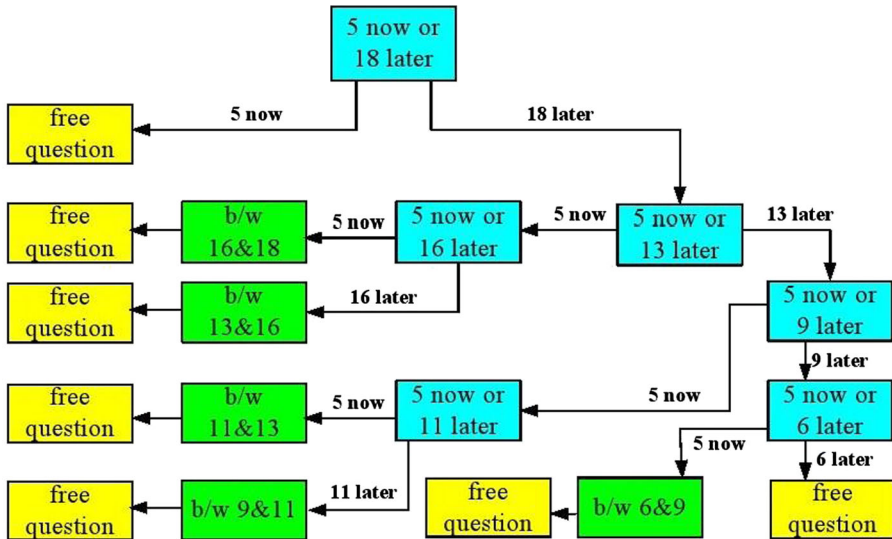


Fig. 1 The decision flow in the environmental existence/gain scenario

In each scenario, the last question asked for the participant’s comments and thoughts on the scenario, after they finished the discounting task. It was an open-ended and non-mandatory question. More details on the range of values showing up in the titration for all questions are reported in Appendix A.

2.4 The Chinese translation

The method of back translation (Brislin 1970) was used to ensure consistency between the Chinese and English versions of the survey. A Chinese native speaker (the first author) translated the questionnaire into Chinese. Two Chinese research assistants translated the Chinese version back into English and made line-by-line comparisons with the original English version. A Chinese professor then reviewed both the Chinese and English versions.

The Chinese version was identical to the English version except for the following. First, the city in the environmental use value (air quality) scenario was San Diego in the English version, and Kunming in the Chinese version. Both cities have relatively stable weather, which is relevant to air quality. Second, there was price information in several scenarios. In the English version prices were in U.S. Dollars, while in the Chinese version they were in Chinese Yuan.⁵

⁵ In most scenarios, we used the same number in U.S. Dollars and Chinese Yuan because they represented the local prices in those scenarios. In the self-inflicted money loss scenario, however, we used the exchange rate because the item had similar prices in the two countries.

3 Data analysis and discussion

3.1 Calculating the discount rates

The hyperbolic discounting formula was used to calculate the participants' discount rates from their choices:

$$V_0 = \frac{V_1}{1 + \delta T} \tag{2}$$

where V_0 is the present value, V_1 is the value judged equivalent in a year as measured either by the titration method or the free response, T is the delay, and delta is the discount rate.

Utilizing the titration method, if a participant in the above dam removal case prefers “9 later” to “5 now”, and prefers “5 now” to “6 later”, then the participant regards “5 now” to be as good as “between 6 and 9 later.” Instead of coercing participants to reach an indifference point, we use the middle value, 7.5, as V_1 . Substituting $V_0=5$, $T=1$ year, into Eq. 2), we get $\delta=50\%$. For those who maxed out the titration range, we use their free responses as V_1 . The free responses were checked against the titration measured range values for consistency. Sixty-five percent of the free responses were exactly within the titration range, 21% of the free responses were within 30% distance from either the high or low boundary value of the titration range. Less than 5% of the free responses were off from the titration range by more than half distance from the boundary values.

3.2 Main effects and interactions

Figure 2 shows the mean discount rates for the commodities of all eight scenarios for American and Chinese participants. A three way ANOVA showed that all three main

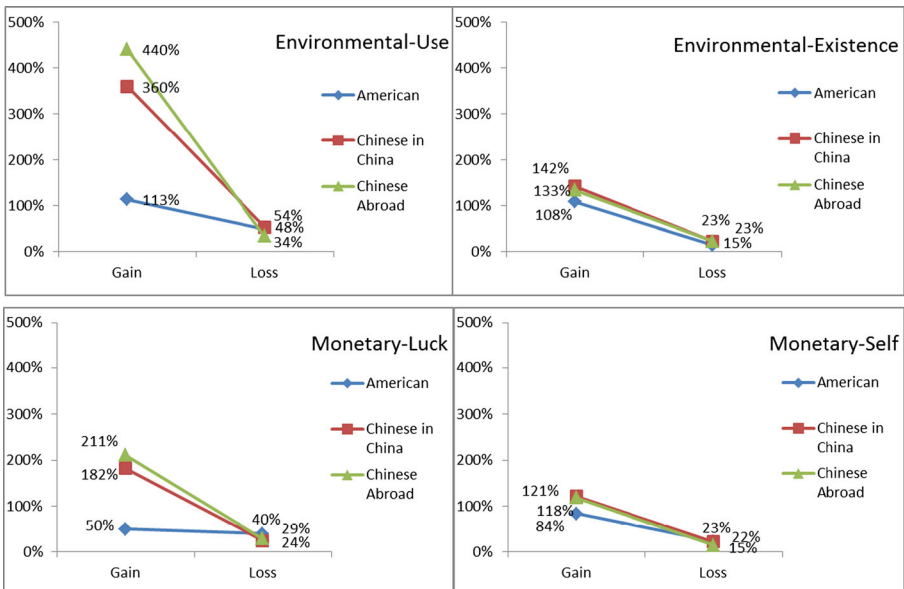


Fig. 2 Mean discount rates in eight scenarios

effects were significant: value category ($F(3, 1141)=10.28, p<0.01$), culture ($F(2,1141)=6.92, p<0.01$), and outcome sign ($F(1,1141)=75.50, p<0.01$). Significant interactions were also found between value category and outcome sign ($F(3,1141)=5.70, p<0.01$), and between culture and outcome sign ($F(2,1141)=7.77, p<0.01$). To further test the magnitudes of the differences and interactions, we ran multiple random-effects regressions that included a random effect variable for each participant controlled for the repeated measures in the regression.⁶ The sociodemographic characteristics and the NEP scores were also included in the regressions as control variables. None of the sociodemographic characteristics or the NEP score was a significant predictor of discounting. Tables 3 and 4 report examples of the random-effect regression model with and without interaction terms, respectively.⁷

There are a few interesting results from the regressions that are worth mentioning here. First, in line with previous research, we found that participants discounted more in the gains than for losses (difference=1.30, $p<0.01$). The differences between different value categories, however, were much less clear. For example, we found that the discount rate for environmental use value was significantly higher than that of environmental existence value (difference=0.97, $p<0.01$). No difference was found between monetary luck value and monetary self value ($p>0.05$). When comparing between the environmental vs. financial category, we found that environmental use value was discounted significantly more than the monetary values, but environmental existence value was discounted similarly to the monetary values, which may explain why previous research has reported mixed results on how people discounted environmental values vs. financial values.

Second, a large and significant interaction between culture and outcome sign (gain/loss) was found ($p<0.05$). Both the Chinese in China sample and the Chinese abroad sample discounted more than Americans in the gain domain (both $p<0.01$), but had similar discount rates in the loss domain (both $p>0.05$). Finally, there were significant three-way interactions, showing that the interaction between Chinese/American and Gain/Loss depends on the value category the participant is discounting.

3.3 Verbal comments on choices

The comments that most participants provided to explain many of their answers were analyzed to help us understand why Chinese participants discounted some but not all future outcomes differently from American participants. As the comments made by the Chinese abroad sample were mixed with their experience living in both China and abroad, we focus on comments by the American sample and the Chinese in China sample.

Both Chinese and Americans reported focusing on the uncertainty of future value and the potential return from investing when considering gains, but on the magnitude of the losses and the psychological cost of carrying debts when discounting losses. Congruent with living in a rapidly changing society, Chinese were more concerned about the uncertainty in actually receiving the future gains than Americans. The most

⁶ Hausman's test indicates that the random effect estimators are consistent and efficient ($\chi^2(8)=7.76, p>0.05$).

⁷ We ran multiple regression models to alternate the dropped values to test different interactions.

Table 3 Random-effect regression model for the discount rates

Variable	Coefficient	Robust Standard Error	t value	Pr(> t)
Dependent Variable				
Discount rate				
Independent Variables				
Constant	-0.14	0.54	-0.26	0.79
Environmental Existence	-0.97	0.26	-3.72	0.00
Monetary Luck	-0.86	0.33	-2.61	0.00
Monetary Self	-1.12	0.26	-4.29	0.00
Chinese	0.43	0.19	2.31	0.02
Chinese Abroad	0.39	0.29	1.32	0.19
Gain	1.30	0.17	7.44	0.00

*Sociodemographic Characteristics and NEP score were included in the regression as control variables, but are not reported in the table as none were significant

frequently mentioned causes for the uncertainty in gains in Chinese participants were inflation, labor mobility, and lack of confidence in the government.

The inflation rate at the time surveys were collected (February 2011) was 4.90% in China, but only 2.11% in the United States (Trading Economics 2011). Out of the 13 Chinese participants who left comments on the two monetary values in the gain domain, 5 participants explicitly or implicitly mentioned inflation as one of their reasons to not wait for larger gains in the future. None of the 20 American participants who left comments in those two scenarios mentioned inflation.

Another source of uncertainty about the value of future gains was labor mobility and job instability in China. These are byproducts of the country's quickly developing and changing economy. For example, in 2007, there were about 136 million migration workers working in cities who did not have a residence license which would enable them to stay permanently (Fang et al. 2009). The number rose to around 240 million in 2010 and is continually climbing (National Bureau of Statistics of China 2011).

A third source of uncertainty arose from the possible unavailability of the future gain. Both Chinese and Americans mentioned such concerns in the earned money gain scenario, including the possibility of bankruptcy by the employer and other such risks. In the lottery money gain scenario, 4 out of 6 comments by Chinese participants mentioned their distrust of the lottery agency. This was not a concern in any of the 6 comments by American participants.

Considering investing the immediate gain and receiving a high return was another reason mentioned by the Chinese for their (high) discount rates. This is a reasonable justification for greater discounting of future gains, given the high interest rate and the abundance of investment opportunities in the rapidly developing Chinese economy. The current benchmark interest rate in China at the time of the survey (February 2011) was 6.06%, while in the United States it was 0.25% (Trading Economics 2011).

In the loss domain, both Chinese and Americans focused on the magnitude of the loss itself and the psychological cost of carrying a debt, displaying similar discount

Table 4 Random-effect regression model with interactions

Variable	Coefficient	Robust Standard Error	t value	Pr(> t)
Dependent Variable				
Discount rate				
Independent Variables				
Constant	-0.30	0.64	-0.47	0.64
Environmental Existence	-0.21	0.16	-1.36	0.17
Monetary Luck	-0.09	0.08	-1.14	0.26
Monetary Self	-0.09	0.17	-0.56	0.58
Chinese	-0.08	0.19	-0.40	0.69
Chinese Abroad	-0.27	0.20	-1.35	0.18
Gain	0.80	0.28	2.85	0.01
Interaction Term				
Environmental Existence *Chinese	0.11	0.23	0.46	0.64
Monetary Luck *Chinese	-0.12	0.17	-0.73	0.46
Monetary Self *Chinese	-0.01	0.23	-0.07	0.95
Environmental Existence *Chinese Abroad	0.18	0.20	0.87	0.39
Monetary Luck *Chinese Abroad	0.03	0.12	0.28	0.78
Monetary Self *Chinese Abroad	-0.06	0.21	-0.27	0.79
Environmental Existence *Gain	0.00	0.40	0.00	1.00
Monetary Luck *Gain	-0.57	0.25	-2.28	0.02
Monetary Self *Gain	-0.35	0.40	-0.86	0.39
Chinese*Gain	2.64	0.89	2.96	0.00
Chinese Abroad*Gain	2.90	1.11	2.61	0.01
Environmental Existence * Chinese*Gain	-2.48	0.96	-2.57	0.01
Monetary Luck * Chinese*Gain	-1.63	0.98	-1.66	0.10
Monetary Self * Chinese*Gain	-2.46	1.01	-2.43	0.02
Environmental Existence * Chinese Abroad*Gain	-2.68	1.12	-2.39	0.02
Monetary Luck * Chinese Abroad *Gain	-1.19	1.59	-0.75	0.45
Monetary Self * Chinese Abroad *Gain	-2.61	1.11	-2.36	0.02

*Sociodemographic Characteristics and NEP score were included in the regression as control variables, but are not reported in the table as none were significant

rates. Out of all 31 comments left by Chinese participants for the four loss scenarios, 11 people mentioned considering the magnitude of the losses, and 5 people brought up the psychological cost of carrying a debt. Similarly, the percentages of those two kinds of comments among the American participants were 9 and 4 out of 29 comments, respectively. Common expressions included, “A loss is a loss, now or later”, “When it comes to loss, I have to lose the least”, “I want to get it over with”, etc. Unlike in the gain scenarios, when discounting losses very few people mentioned the uncertainty of the future losses or potential returns from deferring paying the debts.

The asymmetry in attentional focus on different determinants of discounting in gains and losses and the difference in economic conditions in America and China both help

explain the interaction between Country and Gain/Loss domains observed in our data. They also provide some insight about the mechanisms giving rise to the sign effect of discounting, i.e., the fact that people discount gains more than losses, which has been reported consistently in previous research. Our data suggest that the uncertainty concern and the investment return expectation drove up the discount rate for gains, while the magnitude focus and the psychological cost concern pushed down the discount rate for losses. In contrast, no one mentioned the psychological benefit of waiting for gains or the possibility of avoiding paying a debt if they waited.

Finally, the three-way interactions were large and significant, showing that the interaction between Chinese/American and Gain/Loss depends on the value category the participant is discounting. Given the uncertainty focus when discounting gains, it is not surprising that the interactions were larger when people discounted environmental use value than environmental existence value, as shown in Fig. 2. The uncertainty was probably less of a concern when Chinese participants thought of the population increase of an endangered species (existence value), than when they pondered whether they would be able to enjoy improved air quality (use value) because of the job instability. Similarly, the interaction between Chinese/American and Gain/Loss was larger for monetary luck value than for monetary self-earned/inflicted value. A probable reason for this difference was that while participants from both countries had similar levels of uncertainty concern on the monetary self-earned value (paycheck), the Chinese participants showed a high level of distrust towards the organizations that handled lottery monetary gains, as suggested by their comments.

Note that the above analysis is mostly anecdotal evidence, and the more formal statistical analyses for those statements are not available, given the relatively small sample size of those who volunteered to leave comments. It would be interesting to design a study to encourage people to leave comments and report the decision factors, and to focus on the decision process of discounting instead of comparing the magnitudes of the discounting rates.

4 General discussion and conclusion

Efforts to solve the increasingly devastating environmental problems in many developing countries often propose extending the incentive-based policies effective elsewhere. To do so effectively, it is necessary to investigate the cultural and societal differences on important factors that influence these policies, including discount rate and risk preference.

We examined cultural differences between Chinese and Americans on discounting gains and losses in both environmental and monetary domains. In general, environmental use value was discounted significantly more than the monetary values, but environmental existence value was discounted similarly to the monetary values. Confirming previous research, we found that participants discounted gains significantly more than losses. Furthermore, there was a significant interaction between culture and gain/loss outcome: Chinese discounted gains but not losses in both outcome categories more than Americans. Comments made by the participants suggest that there were asymmetries in attentional focus that were associated with differences in discounting gains vs. losses. Participants focused on the uncertainty of the future values and the foregone return from the delay when discounting gains. Living in a quickly changing and developing society, Chinese were more concerned about the insecurity and uncertainty of future gains, and

had higher expectations for the potential return if they received and invested the gains without delay. Both factors pushed up the discount rate in the Gain domain. However, when discounting losses, both Chinese and Americans focused on the magnitude of the losses and the psychological cost of carrying debts, displaying similar discount rates.

The asymmetry in the cultural difference of discounting in gains vs. losses has important policy implications. For instance, to encourage energy conservation, the U.S. government has offered tax credits for qualified purchases of energy efficient products. If the Chinese government were to adopt this tax incentive policy, the fact that people usually have to wait until the next tax season to receive their credits might reduce the effectiveness of the policy, given our finding that Chinese discount gains significantly more than Americans. When deciding on how much subsidy (tax credit) to issue, the Chinese government should take into consideration both the data from the United States and the cultural differences in discounting between the two countries. A better strategy for China might be to provide subsidies in the form of instant rebates at the point of purchase. On the other hand, when adopting policies involving losses (e.g. emission fees), the discounting difference seems to be less of a concern. There may however exist cultural and societal differences other than factors that influence discounting that could affect the efficiency of these policies. Note that the above implications are based on the assumption that our findings can be generalized to a national level. As mentioned earlier, the current study used internet samples that were generally younger and more educated than the general population. Although the data showed no evidence that demographics like age or education predicted discounting, we suggest that more future studies are needed before generalizing our findings to either a national level or any specific decision making group.

Our finding that Chinese discount gains more than Americans, presumably because of their greater concerns about receiving future gains and because of greater opportunity costs, may seem inconsistent with several other established findings. However, closer consideration suggests that these apparent inconsistencies are further evidence of the fact that time discounting has multiple determinants, as summarized in Table 1. First, our finding of greater discounting of gains by Chinese seems to be in conflict with previous research that has shown East Asian cultures to encourage patience and waiting (Benjamin et al. 2010). According to the Ramsey rule, patience decreases the discount rate in gains. Then why would Chinese have higher discount rates than Americans? We argue that, although patience is an important factor in discounting, there are other factors also at work, as shown in Table 1. The four gain scenarios in the current study were designed to be as realistic as possible. When performing the discounting tasks, the participants focused on the uncertainty perspective instead of the norm of being patient, just as they presumably would do in real life. If, however, a study was designed so that all uncertainty and other factors were removed, and the discounting is mainly determined by patience, the result would probably be that Chinese discount less than Americans.

Second, high discount rates are usually associated with low saving rates. Yet, the average saving rate of urban households in China rose from 18% in 1995 to 29% in 2009 (Chamon et al. 2011), which is very high compared to other nations including the United States.⁸ One of the major motives for saving in China is as a precautionary measure against the uncertainty in future income and rising medical and educational

⁸ The personal saving rate in the United States was 4.5% as of August 2011 (Bureau of Economic Analysis 2011).

expenses. This is consistent with the theoretical discussion earlier in this paper, where uncertainty in future wealth level decreases the discount rate. In the current study, however, no participants expressed concern about uncertain future wealth level, probably because all scenarios were only with a one-year-long delay. It is possible that if the scenarios consist of longer terms and the insecurity concern on the reception of the value is eliminated, Chinese may prefer to save because of uncertain future income and demonstrate lower discount rates.

In conclusion, we return to our earlier suggestion and cautionary note that cultural differences in discounting are a highly nuanced topic and are influenced by many decision factors as well as cultural and societal variables. This is probably true for cultural differences in other dimensions as well, such as risk preference and consumption patterns. Any attempt to apply policies or market mechanisms successful from one country to another country should take into consideration the possible complications from not only the general cultural differences, but also contextual factors contributing to these differences.

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References

- Ainslie, G. W. (1974). Impulse control in pigeons. *Journal of the Experimental Analysis of Behavior*, 21(3), 485–489.
- Appelt, K. C., Hardisty, D. J., & Weber, E. U. (2011). Asymmetric discounting of gains and losses: a query theory account. *Journal of Risk and Uncertainty*, 43(2), 107–126.
- Benjamin, D. J., Choi, J. J., & Strickland, A. J. (2010). Social identity and preferences. *American Economic Review*, 100(4), 1913–1928.
- Benzion, U., Rapoport, A., & Yagil, J. (1989). Discount rates inferred from decisions: an experimental study. *Management Science*, 35, 270–284.
- Bohm, G., & Pfister, H. (2005). Consequences, morality, and time in environmental risk evaluation. *Journal of Risk Research*, 8, 461–479.
- Brislin, R. W. (1970). Back-translation for crosscultural research. *Journal of Cross-Cultural Psychology*, 1(3), 185–216.
- Bureau of Economic Analysis. (2011). Personal income and outlays news release. Retrieved from <http://www.bea.gov/newsreleases/national/pi/2011/pdf/pi0811.pdf>.
- Cairns, J. (1992). Health, wealth and time preference. *Project Appraisal*, 7, 31–40.
- Chamon, M., Liu, K., & Prasad, E. (2011). The puzzle of China's rising household saving rate. <http://www.voxeu.org/index.php?q=node/6028>. Accessed October 2011.
- Chapman, G. B., Brewer, N. T., Coups, E. J., et al. (2001). Value for the future and preventive health behavior. *Journal of Experimental Psychology: Applied*, 7(3), 235–250.
- Chapman, G. B. (2003). Time discounting of health outcomes. In G. Loewenstein, D. Read, & R. F. Baumeister (Eds.), *Time and decision: Economic and psychological perspectives on intertemporal choice* (pp. 395–417). New York: Russell Sage.
- China Internet Network Information Center (CNNIC). 2010. The 27th *Statistical Report on Internet Development in China*. <http://www1.cnnic.cn/IDR/ReportDownloads/201209/P020120904420388544497.pdf>.

- Cline, W. (2008). Comments on the Stern Review. Peter G. Peterson Institute for International Economics. <http://www.iie.com/publications/papers/paper.cfm?ResearchID=874>. Accessed 5 January 2008.
- Cornsweet, T. N. (1962). The staircase-method in psychophysics. *The American Journal of Psychology*, 75(3), 485–491.
- Cropper, M. L., Aydede, S. K., & Portney, P. R. (1994). Preferences for life saving programs: How the public discounts time and age. *Journal of Risk and Uncertainty*, 8, 243–265.
- Dasgupta, P. (2008). Discounting climate change. *Journal of Risk and Uncertainty*, 37, 141–169.
- Du, W., Green, L., & Myerson, J. (2002). Cross-cultural comparisons of discounting delayed and probabilistic rewards. *The Psychological Record*, 52(4), 479–492.
- Dunlap, R. E., Van Liere, K. D., Mertig, A. G., & Jones, R. E. (2000). Measuring endorsement of the New ecological paradigm: a revised NEP scale. *Journal of Social Issues*, 56(3), 425–442.
- Estle, S. J., Green, L., Myerson, J., & Holt, D. D. (2007). Discounting of monetary and directly consumable rewards. *Psychological Science*, 18, 58–63.
- Fang, C., Yang, D., & Meiyuan, W. (2009). Migration and labor mobility in China. United Nations Development Programme Human Development Report.
- Fischer, C. (1999). Read this paper even later: Procrastination with time-inconsistent preferences. Resources for the Future Discussion Paper. dp-99-20.
- Frederick, S., Loewenstein, G., & O'Donoghue, T. (2002). Time discounting and time preference: a critical review. *Journal of Economic Literature*, 40, 351–401.
- Hanley, N., Shogren, J., & White, B. (2007). *Environmental Economics in Theory and Practice*. London: Palgrave.
- Hardisty, D. J., & Weber, E. U. (2009). Discounting future green: Money versus the environment. *Journal of Experimental Psychology: General*, 138(3), 329–340.
- Heal, G. (2005). Intertemporal welfare economics and the environment. In K. G. Mäler & J. R. Vincent (Eds.), *Handbook of Environmental Economics* (Vol. 3, pp. 1105–1145). Amsterdam: North-Holland.
- Heal, G. (2008). Climate economics: a meta-review and some suggestions for further research. *Review of Environmental Economics and Policy*, 3(1), 1–19.
- Laibson, D. (1997). Golden eggs and hyperbolic discounting. *The Quarterly Journal of Economics*, 112, 443–477.
- Lichtenstein, S., & Slovic, P. (2006). *The construction of preference*. New York: Cambridge University Press.
- Loewenstein, G. F. (1988). Frames of mind in intertemporal choice. *Management Science*, 34, 200–214.
- Loewenstein, G., & Sicherman, N. (1991). Do workers prefer increasing wage profiles? *Journal of Labor Economics*, 9(1), 67–84.
- Markiewicz, L., & Weber, E. U. (2013). DOSPERT's gambling risk-taking scale predicts excessive stock trading. *Journal of Behavioral Finance*, 14(1), 65–78.
- Moore, M. J., & Viscusi, W. K. (1990). Models for estimating discount rates for long-term health risks using labor market data. *Journal of Risk and Uncertainty*, 3(4), 381–401.
- National Bureau of Statistics of China. (2011). Statistical communiqué of the People's Republic of China on the 2010 national economic and social development. Retrieved from <http://www.stats.gov.cn/english>.
- National Bureau of Statistics of China. (2012). Income of Urban and Rural Residents in 2011. http://www.stats.gov.cn/tjfx/jdfx/t20120120_402780174.htm.
- Nordhaus, W. (2007). A review of the Stern Review on the economics of global warming. *Journal of Economic Literature*, 45(3), 686–702.
- O'Donoghue, T., & Rabin, M. (1999). Incentives for procrastinators. *The Quarterly Journal of Economics*, 114(3), 769–816.
- PBL Netherlands Environmental Assessment Agency. (2007). China now no. 1 in CO2 emissions; USA in second position. <http://www.pbl.nl/en/dossiers/Climatechange/moreinfo/Chinanowno1inCO2emissionsUSAinsecondposition>. Accessed 18 October 2011.
- Ramsey, F. P. (1928). A mathematical theory of saving. *The Economic Journal*, 38, 543–559.
- Romer, D. (2005). *Advanced macroeconomics* (3rd ed.). New York: McGraw Hill Publishers.
- Samuelson, P. A. (1937). A note on measurement of utility. *The Review of Economic Studies*, 4, 155–161.
- Simon, H. (1957). A behavioral model of rational choice. In *Models of man, social and rational: Mathematical essays on rational human behavior in a social setting*. New York: Wiley.
- Stern, N. (2006). *Stern review on the economics of climate change* (pre-publication edition). Executive Summary. London: HM Treasury.
- Tan, C. T., & Johnson, R. D. (1996). To wait or not to wait: The influence of culture on discounting behavior. In W. H. Loke (Ed.), *Perspectives on judgment and decision making* (pp. 97–106). Lanham: Scarecrow.
- Thaler, R. H. (1981). Some empirical evidence on dynamic inconsistency. *Economics Letters*, 8, 201–207.

- Thaler, R., & Johnson, E. (1990). Gambling with the house money and trying to break even: the effects of prior outcomes on risky choice. *Management Science*, *36*, 643–660.
- Trading Economics. (2011). <http://www.tradingeconomics.com>. Accessed February 2011.
- U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business. (2011). <http://www.bea.gov/newsreleases/relsarchivespi.htm>.
- Viscusi, W. K., & Aldy, J. E. (2003). The value of a statistical life: a critical review of market estimates throughout the world. *Journal of Risk and Uncertainty*, *27*(1), 5–76.
- Viscusi, W. K., Huber, J., & Bell, J. (2008). Estimating discount rates for environmental quality from utility-based choice experiments. *Journal of Risk and Uncertainty*, *37*, 199–220.
- Weber, B. J., & Chapman, G. B. (2005). The combined effects of risk and time on choice: Does uncertainty eliminate the immediacy effect? Does delay eliminate the certainty effect? *Organizational Behavior and Human Decision Processes*, *96*(2), 104–118.
- Weber, E. U., & Hsee, C. K. (1998). Cross-cultural differences in risk perception but cross-cultural similarities in attitudes towards risk. *Management Science*, *44*, 1205–1217.
- Weber, E. U., Blais, A. R., & Betz, N. E. (2002). A domain-specific risk-attitude scale: measuring risk perceptions and risk behaviors. *Journal of Behavioral Decision Making*, *15*, 263–290. doi:10.1002/bdm.414.
- Weber, E. U., Johnson, E. J., Milch, K., Chang, H., Brodscholl, J., & Goldstein, D. (2007). Asymmetric discounting in intertemporal choice: a query theory account. *Psychological Science*, *18*, 516–523.
- Weber, E. U., & Johnson, E. J. (2009). Mindful judgment and decision making. *Annual Review of Psychology*, *60*, 53–85.
- Weitzman, M. L. (2007). A review of the Stern Review on the economics of climate change. *Journal of Economic Literature*, *45*(3), 703–724.
- Zauberman, G., & Lynch, J. G. (2005). Resource slack and propensity to discount delayed investments of time versus money. *Journal of Experimental Psychology: General*, *134*(1), 23–37.