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# Why Chinese Discount Future Financial and Environmental Gains but not Losses More Than Americans

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**Abstract:** Understanding cultural and economic country differences in temporal discounting is critical for extending incentive-based environmental policies successfully from developed countries to developing countries. We report the results of a study that examined differences between Chinese and Americans in discounting of future financial and environmental gains and losses. 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, 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 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.

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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" (2007). One way to do so 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 as 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 understanding better 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 environment 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 (1989) and Du et al. (2002). Tan and Johnson (1989) 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. 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 analyses 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):

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

where $\rho_t$ is the discount rate applied to consumption at time $t$, $\delta$ is the pure rate of time preference (PRTP), $\eta$ 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, $\eta$ 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 those 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.

**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 | |
| | Gain | Loss | Gain | Loss | Gain | Loss | Gain | Loss | Gain | Loss |
| **Decision** | Not Wait | Wait | Wait | Wait | Not Wait | Wait | Depends? | Depends? | Depends? | Depends? |
| **Discounting 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, until more recently when hyperbolic discounting was introduced (Laibson 1997; Fischer 1999; O'Donoghue and Rabin 1999; Frederic 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 of 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, decreases 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

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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 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 both notable similarities and differences between health and money discounting results. For example, various studies have found that the discount rate for health is higher than for money (Cairns 1992; Chapman et al. 2001). However, Moore and Viscusi (1990) estimated implicit discount rate for deferred health benefits by analyzing the workers' choices related to job risk and wage associated with the risk. They concluded that the estimated discount rate for health risk was 2%, which was consistent with financial market rates at the time. Similarly, conflicting results exist in research on discounting of environmental values. Bohm and Pfister (2005) suggested that people discount financial outcomes more than environmental ones. However, Hardisty and Weber (2009) found no significant difference between discounting environmental values and financial values when they noticed that financial outcomes had been gains in their study and environmental outcomes had been losses, and controlled for the difference in outcome sign.

In the current research, we further distinguish the environmental value into use value and existence value (Hanley et al. 2007), and the monetary value into self-earned money and luck money (Thaler and Johnson 1990). We expect people to focus on difference components when facing environmental use value vs. existence value, and self-earned money vs. luck money, and exhibit different discounting behaviors. Further more, these focus disparities may interact with the gain/loss domain. As will be discussed later, the data confirms our expectation.

# 2 Study Design

## 2.1 Participants

118 American participants and 87 Chinese participants were recruited online and completed a web-based survey. 11 American and 9 Chinese participants were excluded from analysis for completing the survey in less than 5 minutes (mean length was 20 minutes, and 5 minutes was the minimum time to complete the survey in an internal pilot). One Chinese participant was excluded for completing the survey multiple times. Analyses below are based on the remaining 107 Americans and 77 Chinese participants.

53% of the American participants were female. 52% of them were between 25 and 44 years old. The Chinese sample was similar to the American one in terms of age with 58% of the participants between 25 and 44 years old, but was more gender skewed with 65% being male.

## 2.2 Design

The study had a 2 (Chinese vs. American: between) 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. 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 increase/decrease in the future.[1] For the monetary values, participants chose between a smaller amount of monetary gain/loss now and 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, 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.

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

**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 pay check 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. There was no significant difference between Chinese and American participants on 4 out of 5 dimensions: the reality of limits to growth, anti-anthropocentrism, rejection of exceptionalism, and the possibility of an eco-crisis. However, Chinese participants displayed significantly stronger beliefs on the fragility of nature's balance ($p < 0.01$) than Americans, probably because Chinese have witnessed more environmental deterioration accompanying their country's economy growth, with sixteen of the world's twenty most polluted cities being in China (World Bank 2008).

## 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. 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?" Details on the range of values showing up in the titration are reported in Appendix A.

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.[2] 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."

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.

## 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[3].

# 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:

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

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[2] We dropped the outliers that were greater than 3 standard deviations. Out of the 736 values from all participants, 18 outliers were dropped and treated as missing values in the analyses.
[3] In most scenarios, we used the same number in US Dollar 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.

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" as good as "between 6 and 9 later." Using the middle value, 7.5, as $V_1$, and $V_0$=5, $T$ =1 year, we get delta = 50%.

## 3.2 Main Effects and Interactions

Figure 1 shows the mean discount rates for the commodities of all eight scenarios for both American and Chinese participants. To test for main effects of the independent variables in our design and their interactions, we used a random-effects regression model that also controlled for participant-level individual differences and the repeated-measure characteristic of the data. The results are reported in Table 2.

There was no main effect of outcome category (environmental vs. monetary), consistent with Hardisty and Weber (2009). Also in line with previous research, there was a main effect of the sign of outcomes (gains vs. losses): participants discounted more in the gain domain than in the loss domain ($p < 0.05$). No significant main effect for culture (Chinese vs. American) was found ($p > 0.05$), but the interaction between culture and outcome sign (gain/loss) was large and significant ($p < 0.01$): Chinese discounted more than Americans in the gain domain ($p < 0.01$), but had similar discount rates in the loss domain ($p > 0.05$). Finally, the three-way interaction in Table 2 was large and significant, showing that the interaction between Chinese/American and Gain/Loss depends on the value category the participant is discounting.

**Fig. 1** Mean Discount Rates in Eight Scenarios
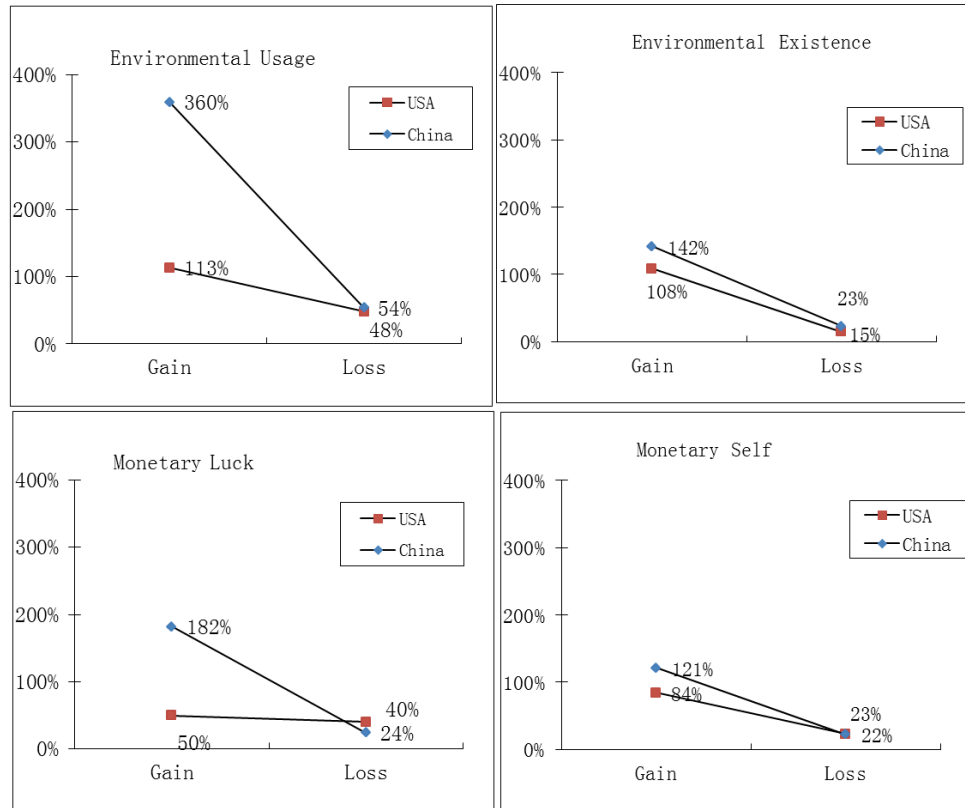


**Table 2** Random Effect Regression Model for the Discount Rates

| Variable | Coefficient | Standard Error | t value | Pr(>|t|) |
|---|---|---|---|---|
| **Dependent Variable** | | | | |
| Discount rate | | | | |
| **Independent Variables** | | | | |
| Constant | 0.45 | 0.28 | 1.61 | 0.10* |
| Outcome Category | -0.05 | 0.10 | -0.51 | 0.61 |
| Chinese | -0.00 | 0.45 | -0.00 | 0.99 |
| Gain | 0.80 | 0.39 | 2.02 | 0.04** |
| **Interaction Term** | | | | |
| Outcome Category*Chinese | -0.00 | 0.16 | -0.06 | 0.95 |
| Category*Gain | -0.09 | 0.14 | -0.64 | 0.52 |
| Chinese*Gain | 3.05 | 0.63 | 4.82 | 0.00*** |
| Category*Chinese*Gain | -0.76 | 0.23 | -3.31 | 0.00*** |
| **Log likelihood** | -1313 | | | |

## 3.3 Verbal Comments on Choices

The comments that most participants provided to explain many of their answers were analyzed to help understand why Chinese participants discounted some but not all future outcomes differently from American participants.

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 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 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 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 interaction in Table 2 was 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 Figure 1. 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 on 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 to extend 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. Chinese discounted gains, but not losses, 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 was 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 seem 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.

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, given the relationship between uncertainty and discounting, risk preference probably also plays a role in intertemporal decisions. Previous research has found that Chinese perceive the risk of financial options with known probabilities and outcomes to be smaller than Americans, and thus appear to be less risk averse in terms of pricing those financial options[4], although Chinese and Americans exhibit similar attitudes towards perceived risks (Weber and Hsee 1998). Since risk aversion is usually associated with a high discount rate, we would expect Chinese to have lower discount rates on monetary values for decisions where contexts has been removed from the intertemporal choices and the magnitude of the uncertainty is quantified as in Weber and Hsee (1998).

Third, 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.[5] 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 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

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[4] Note that this cultural difference in risk perception was true for outcome dimensions that were transferable, i.e., for money, but not for health or course grades.
[5] The current personal saving rate in the United States was 4.5% as of August 2011 (Bureau of Economic Analysis 2011)

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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**Appendix A:**
**Eight Scenarios and Their Titration Scales**

1.  How to read the titration scale

We will use the environmental existence value in the gain domain as an example.

There are three sets of values in each scenario. For example, in the environmental existence/gain example, we have the follows.

base: 5

var: [ 6, 9, 13, 18 ]

sub: [ 11,    16]

where 'base' has one number, 'var' has four numbers in it, 'sub' has four numbers, and both 'var' and 'sub' are in monotonically increasing order.

Each participant made a series of choices between immediate and one-year delayed outcomes. 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 ('base') 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 (the highest number in 'var') 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 ('var' set), 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 ('sub' value) is 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.

The middle value of the range measured above was used to calculate the participant's discount rate, unless she maxed out the titration scale, in which case we use the free response value that was measured by the last question at the end of the survey page: "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."

Figure 2 illustrates the decision flow of the procedure.

Figure 2: the Decision Flow in the Environmental Existence /Gain Scenario
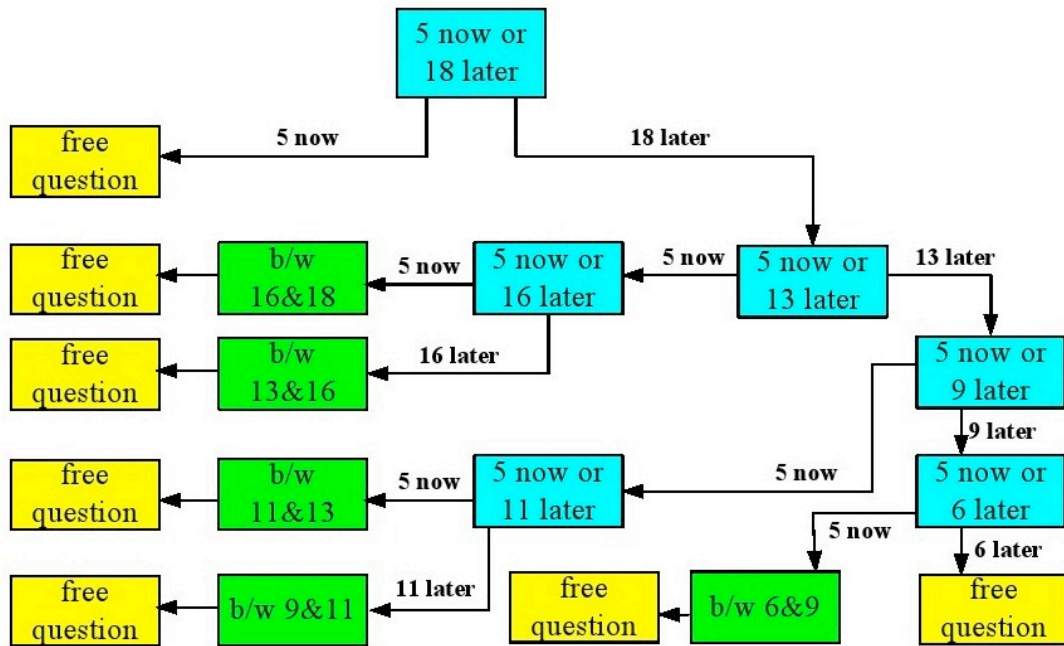


2. The Complete Design of 8 Scenarios

---
id: 1

#1.1.1Air quality (use value)– Gain and Loss
#Environmental: use x gain

tm-index: 2
base: 21
var: [ 22, 30,   44,   65 ]
sub: [ 37, 55 ]

desc:
　en:>

　　　　Imagine that you live in a region that has a fairly constant climate all year round, like San Diego. The current air quality (measured by number and size of particulates) in the area is moderate and the local county government is considering a temporary change to its emissions policy to study the effects of air quality on human health and the local wildlife. The particulate output of nearby factories will be reduced, but the factories will be compensated so that they do not incur any costs during the test period. The test will lead to an immediate improvement in air quality over a period of three weeks ($BASE_VALUE days), after which time the air quality will return to its former level. However, the government is also considering carrying out the test a year from now, for a different length of time. Which one would you prefer, improved air quality immediately for 21 days, or improved air quality a year from now for a longer duration?<br/><br/>

No matter when the test period begins, the government will start implementing the new policy two years from today's date, if the new policy is approved.

zh:>
请设想一下, 您住在一个气候比较稳定的地方, 比如昆明. 您那里的空气质量 (主要是空气中的浮尘) 属于中等. 当地政府准备试行一段时间一个新的排污政策, 用来测试空气质量对人们的身体健康以及对当地野生动物的影响. 试行期间,附近的工厂要减少大气排放. 因为减少排放而造成工厂的利润损失将由政府补贴. 如果现在马上开始试行的话, 试行会持续 3 个星期 ($BASE_VALUE 天).<br/><br/>

这 3 个星期的空气质量会有所提高. 3 个星期以后将恢复原有政策, 空气质量回落到现有水平. 当地政府也在考虑等到一年以后再做这个试行测试. 如果等到一年以后再试行, 试行持续的时间长短还没有确定. 您是愿意试行马上开始, 接下来$BASE_VALUE 天的空气质量都有提高, 还是愿意等一年再试行, 试行时间更长(空气质量比较好的时间更长)?<br/><br/>

无论试行何时开始, 如果该排污政策被批准, 政府都会在两年之后正式执行该政策.

ans:
    en:
        - Improved air quality immediately for $BASE_VALUE days.
        - Improved air quality a year from now for $VAR_VALUE days.
    zh:
        - 试行马上开始, 接下来$BASE_VALUE 天的空气质量都有提高.
        - 等一年再试行, 试行时间持续$VAR_VALUE 天 ($VAR_VALUE 天比较好的空气质量).
    # note, only for ctype = 0
    note:
        en: Note that we are not interested in how you feel about the government's decision on changing its policy. What we are interested in is your preference between the two options.
        zh: 请注意, 我们是想知道您觉得以上两个可能性中的哪一个比较好, 而不是您对以上政策的看法.

    ---
    id: 2

    #Loss
    #Environmental: use x loss

    tm-index:1
    base: 21
    var: [ 22, 30, 44, 65 ]

sub: [ 37,    55]

desc:
    en:>

    Imagine that you live in a region that has a fairly constant climate all year around, like San Diego. The current air quality (measured by number and size of particulates) in the area is moderate and the local county government is considering a temporary change to its emissions policy to study the effects of air quality on human health and the local wildlife. The pollution output of nearby factories and power plants will be increased, but they will be taxed so that they do not incur any extra profits during the test period. The test will lead to an immediate decrease in air quality over a period of three weeks ($BASE_VALUE days), after which time the air quality will return to its former level. However, the government is also considering carrying out the test a year from now, for a different length of time.Which one would you prefer, deterioration in air quality immediately for $BASE_VALUE days, or deterioration in air quality a year from now for a longer period?

    zh:>

    请设想一下, 您住在一个气候比较稳定的地方, 比如昆明. 您那里的空气质量 (主要是空气中的浮尘) 属于中等. 当地政府准备试行一段时间一个新的排污政策, 用来测试空气质量对人们的身体健康以及对当地野生动物的影响. 试行期间,附近的工厂会增加大气排放. 因为增加排放, 工厂要交额外的税, 所以增加排放不会给工厂带来额外的利润. 如果现在马上开始试行这个新政策的话, 试行会持续 3 个星期($BASE_VALUE 天). 这 3 个星期的空气质量会有所下降. 3 个星期以后将恢复原有政策, 空气质量回升到现有水平. 当地政府也在考虑等到一年以后再做这个试行测试. 如果等到一年以后再试行, 试行持续的时间长短还没有确定. 您是愿意试行马上开始, 接下来$BASE_VALUE 天的空气质量都有下降, 还是愿意等一年再试行, 试行时间更长     (比较好空气质量比较差的时间更长)?

    ans:
    en:
        - Deterioration in air quality immediately for $BASE_VALUE days.
        - Deterioration in air quality a year from now for $VAR_VALUE days.
    zh:
        - 试行马上开始, 接下来$BASE_VALUE 天的空气质量都有下降.
        - 等一年再试行, 试行时间持续$VAR_VALUE 天 ($VAR_VALUE 天比较差的空气质量).
    note:
        en: Note that we are not interested in how you feel about the government's decision on changing its policy. What we are interested in is your preference between the two options.
        zh: 请注意, 我们是想知道您觉得以上两个可能性中的哪一个比较好, 而不是您对以上政策的看法.

    ---
    id: 3

# 1.1.2. 100-year-old trees (existence value) -- Loss
# Environmental: existence x loss
tm-index: 1
base: 22

# Changed by Yi from
# var: [66,    45,    31, 23]
# sub:[ [ ], [56], [38] ]
# to

var: [23,    31,    45, 66]
sub:[ 38, 56 ]

desc:
  en:>
      Imagine that you live 2 hours (by car) away from a forest. You have never visited it and do not plan to do so. The local government is selling part of the forest to an estate developer to help cover the financial deficit. Two developers are interested in buying it. Developer A has informed the government that they will cut down $BASE_VALUE 100-year-old trees immediately to make space for their current project. Developer B intends to cut down even more 100-year-old trees a year from now for their project. The government is conducting a survey on the public's preference. Which would you prefer, Developer A cutting $BASE_VALUE trees immediately, or Developer B cutting more trees a year from now?
    zh:>
      请设想一下, 离您住的地方附近有一个森林. 坐车去那里要 2 个小时. 你从来没有去过那个森林, 也不打算去. 因为财政问题, 当地政府准备把森林的一部分卖给房产开发商. 现在有两个开发商想要买这块地. 开发商甲告诉政府说如果卖给他们, 他们会马上砍掉 $BASE_VALUE 棵百年老树, 因为他们马上就需要地皮. 开发商乙说如果卖给他们, 他们会在一年以后砍掉更多棵百年老树, 因为他们一年以后才有计划开发那里. 当地政府正在做一个调查, 想知道人们愿意选择卖给谁. 请问您会选择卖给甲, 马上砍掉$BASE_VALUE 棵老树, 还是乙, 一年以后砍掉更多棵老树?

  ans:
    en:
      - "Developer A: cutting $BASE_VALUE trees immediately"
      - "Developer B: cutting $VAR_VALUE trees a year from now"
    zh:
      - 卖给甲, 马上砍掉$BASE_VALUE 棵老树
      - 卖给乙, 一年以后砍掉$VAR_VALUE 棵老树
# note, only for ctype = 0
note:
  en:
  zh:

---
id: 4

#Endangered species (existence value) – Gain
#Environmental: existence x gain
tm-index: 2
base: 5
var: [ 6, 9, 13, 18 ]
sub: [ 11,   16]


desc:
   en:>

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 $BASE_VALUE dams immediately. Construction company B removes more dams a year from now. Would you prefer A to remove $BASE_VALUE dams immediately, or B to remove more dams a year from now?


   zh:>
       请设想一下, 您住的区域有 20 个很久以前建的水坝, 现在已经没有用了. 这些水坝隔断了水流, 阻隔了鱼群上游去一个国家公园去产卵的途径. 当地政府准备拆除一些水坝. 据估计, 每拆除一个水坝, 那个国家公园的鱼群数量就会增加 10%. 如果 20 个水坝都被拆除, 鱼群数量会翻倍.  因为经费问题, 现在政府只有两个选择: 同样的钱, 建筑公司甲可以马上拆除$BASE_VALUE 个水坝, 建筑公司乙可以拆除更多个水坝, 但是要等到一年以后才能拆除. 因为经费问题, 现在政府只有两个选择. 请问您愿意选择哪一个?
   ans:
     en:
       - Construction company A removes $BASE_VALUE dams immediately.
       - Construction company B removes $VAR_VALUE dams a year from now.
     zh:
       - 建筑公司甲马上拆除 $BASE_VALUE 个水坝.
       - 建筑公司乙一年以后拆除 $VAR_VALUE 个水坝.

   note:
     en: Note that we are not interested in how you feel about the government's decision on changing its policy. What we are interested in is your preference between the two options.
     zh: 请注意, 我们是想知道您觉得以上两个可能性中的哪一个比较好, 而不是您对以上政府行为的看法.

---
id: 5

#1.2.1 luck money (lottery) – gain
#Monetary: luck x gain
tm-index: 2
base: 250
var: [ 260, 350, 510, 750 ]
sub: [ 430,    630]

desc:
   en:>
      Imagine you just won a lottery, worth $250, which will be paid to you immediately. However, the lottery commission is giving you the option of receiving a different amount, paid to you a year from now. Which one would you prefer, $$BASE_VALUE immediately, or a bigger sum, a year from now?
   zh:>
      请设想一下, 您刚刚中了个 250 元的奖. 您可以马上去兑现, 或者一年以后再兑现更大的奖. 请问您愿意选择哪一个奖?

   ans:
      $: 1
      en:
         - $$BASE_VALUE immediately
         - $$VAR_VALUE a year from now
      zh:
         - 马上拿到$BASE_VALUE 元.
         - 一年以后拿到$VAR_VALUE 元.
   note:
      en: Note that we are not interested in how you feel about the government's decision on changing its policy. What we are interested in is your preference between the two options.
      zh: 请注意, 我们是想知道您觉得以上两个可能性中的哪一个比较好, 而不是您对以上政府行为的看法.
      ---
id: 6

#1.2.2 luck money (lost rent check) - loss
#Monetary: luck x loss
tm-index: 1
base: 250
var: [ 260, 350, 510, 750 ]
sub: [ 430,    630]

desc:

en:>

Imagine that you live in an apartment building and have to send a rent check in to your landlord by the first Monday of every month to avoid a late fee. Recently you received a letter from your local post office apologizing for the fact that your envelope containing the check for your landlord had been misplaced but has finally turned up. In spite of this postal error, your landlord is charging you the late fee of $$BASE_VALUE on top of what you owe for rent for this month. Your landlord gives you the option of paying a different amount instead, a year from now. Which one would you prefer, paying $$BASE_VALUE immediately, or paying more money a year from now?

zh:>

请设想一下, 您每个月的第一个星期一需要交房租, 不然就会罚款. 您每次都是通过银行转帐给房东. 最近您的银行给您发了一封信, 说因为系统出错, 您这个月的转帐被推迟了一个星期. 虽然这个不是您的过错, 您的房东还是决定罚钱. 您有两个选择:您现在马上交$BASE_VALUE 元的罚金, 或者您等到一年以后再交更多的罚金. 请问您愿意选择哪一个?

ans:

$: 1

en:

- paying $$BASE_VALUE immediately
- paying $$VAR_VALUE a year from now

zh:

- 现在马上交$BASE_VALUE 元的罚金
- 一年以后再交$VAR_VALUE 元的罚金

note:

en: Note that we are not interested in how you feel about the landlord's decision on charging you. What we are interested in is your preference between the two options.

zh: 请注意, 我们是想知道您觉得以上两个选择中的哪一个比较好, 而不是您对以房东罚钱决定的看法.

---
id: 7

#1.2.3 Self earned money (salary) - gain
#Monetary: self-earned/inflicted x gain
tm-index: 2
base: 750
var: [ 760, 1000, 1500, 2250 ]
sub: [ 1250,   1875]

desc:

en:>

Imagine that you work for a big company. Every Monday you get a $750 check as your salary. The company recently ran into a cash flow problem and proposed to its employees that anyone who puts off cashing this week's pay check for one year can cash it for a larger amount

than the face value. Which would you prefer?

    zh:>

        请设想一下, 您在一家大公司工作. 公司每个星期发一次工资. 每个星期一, 您都会拿到一张750元的工资条. 您可以拿这张工资条去公司的财务部兑现750元的现金. 这个星期您工作的这个公司现金流有点紧张, 所以公布了一个员工兑现工资的新政策. 根据这个新政策, 如果您今天去兑现您的工资条, 您跟平时一样, 可以拿到750元的现金. 但是如果您等一年到一年后的今天再去兑现, 您可以拿到更多的现金. 请问您愿意选择哪一个?

    ans:

      $: 1

    en:

      - Cash your check for $$BASE_VALUE today

      - Cash your check for $$VAR_VALUE a year from now

    zh:

      - 今天去兑现您的工资条, 拿到$BASE_VALUE 元的现金.

      - 一年后的今天再去兑现, 拿到$VAR_VALUE 元的现金

note:

    en:

    zh:

---

id: 8

#1.2.4 Self -inflicted money loss

#Monetary: self-earned/inflicted x loss

tm-index: 1

base: 100

var: [ 110, 134, 200, 300 ]

sub: [ 167,　250]

base-zh: 600

var-zh: [ 660, 804, 1200, 1800 ]

sub-zh: [ 1002, 1500 ]

desc:

    en:>

        Imagine that you accidentally trip onto your roommate's computer and break its hard drive. Replacing the old hard drive with a brand new one will cost $$BASE_VALUE .  Your roommate gives you two options: you can either pay her $$BASE_VALUE immediately for a new hard drive, or, she can use her friend's old hard drive for the time being, and you will pay her a larger amount a year from today when she buys a new computer. Your roommate does not have a preference on either option. Which would you prefer?

    zh:>

        请设想一下, 您和室友合租. 有一天, 您不小心绊倒您室友的电脑, 烧坏了电脑的硬盘. 换一个新硬盘需要$BASE_VALUE 元. 您室友给了您两个选择: 或者您现在花$BASE_VALUE 元给她这台电脑换一个新硬盘, 或者她先找一个旧硬盘先用着, 等一年以后

她换新电脑的时候您帮她出更多的现金. 您室友觉得这个两个办法都一样, 对她而言没有差别. 而您也愿意赔偿，请问您是愿意现在出$BASE_VALUE 元, 还是一年以后出更多的现金?

    ans:

      $: 1

    en:

      - Pay $$BASE_VALUE immediately

      - pay $$VAR_VALUE a year from now

    zh:

      - 现在出$BASE_VALUE 元.

      - 一年以后出$VAR_VALUE 元.

  note:

    en:

    zh: