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How Time Preferences Differ: Evidence from 45 Countries

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How Time Preferences Differ:
Evidence from 45 Countries

Abstract

We present results from the first large-scale international survey on time discounting, conducted in 45 countries. Cross-country variation cannot simply be explained by economic variables such as interest rates or inflation. In particular, we find strong evidence for cultural differences, as measured by the Hofstede cultural dimensions. For example, high levels of Uncertainty Avoidance or Individualism are both associated with strong hyperbolic discounting. Moreover, as application of our data, we find evidence for an impact of time preferences on the capability of technological innovations in a country and on environmental protection.

Keywords: Time preferences; Intertemporal decision; Endogenous preference; Cross-cultural comparison.

JEL classification: D90, F40

1 Introduction

The discount rate is one of the most fundamental concepts in finance and economics. It has been widely applied in asset pricing, project evaluation, decisions on investment and saving, among many others. In this article we measure discount rates empirically in a large sample across 45 countries and reveal several influencing factors for individual and cultural differences in time discounting.

1.1 Motivation for an international survey

There is abundant evidence that people differ in time preferences, see Frederick, Loewenstein & O'Donoghue (2002) for a survey. Many factors have been proposed in the literature that could influence time discounting. We will summarize some of these predictions in Sec. 3.2 and derive an economic model that justifies some of these predictions in a coherent framework in Sec. 2.1.

Given that many of these variables (economic, but also cultural) naturally vary between different countries, it seems very interesting to test some of the influencing factors in a cross-country sample. Most previous cross-cultural studies involve very few countries for comparison, and have inherent difficulties in distinguishing socio-economic and cultural factors. For example, the United States and China are different in many dimensions, including economic situation, political system, and cultural roots. It is hard to deduce what causes observed differences in risk preferences and time discounting. To study more systematically the impacts of country-level factors, it is helpful to include other countries. Including, e.g., Japan, with similar cultural roots as China, but similar economic development and political system as the

U.S., helps to disentangle these factors. Including countries in Eastern Europe with European cultural roots, but similar modern political experiences as China, is another example how a larger international sample can provide new insights.

In this article, we present results from an international survey of economics students from 45 countries on time preferences. The relatively large number of countries included in our survey allows us to link the measured time preferences with the background of the countries. We elicit time discounting for different time horizons (one month, one year, and ten years). Our main findings are:

- Time discounting for short time horizons exhibits much higher heterogeneity than for longer time horizons.
- The discount rate for one year is much higher than the discount rate for ten years, which is consistent with hyperbolic discounting.
- Participants from countries with higher GDP per capita and lower growth rate are more willing to wait for higher returns, whereas the inflation rate has surprisingly only an effect on the one-month waiting tendency, but not on discounting for one and ten years.
- Cultural factors as captured by the Hofstede dimensions (Hofstede 1991) contribute also significantly to time discounting. In particular, on an individual level Long-term Orientation (a concept measuring respect for tradition versus orientation towards the future) decreases hyperbolic discounting and increases the willingness to wait for higher returns. Similar effects can be found in countries with a low degree of Uncertainty Avoidance. The effects of Individualism are more complex, and do not seem to support the cushion hypothesis (Hsee &

Weber 1999, Mahajna, Benzion, Bogaire & Shavit 2008).

- We also find countries that with a higher pace of time (e.g., more punctuality and higher working speed) are more likely to choose the more "patient" option.[1]
- The measured time preferences, especially the tendency to wait, can predict fairly well country-level innovation and environmental sustainability measures.

There could be two major concerns about the survey method we adopted here. The first point is that we only used university students as subjects, not a representative sample of the total population. There are, however, several advantages of this sample selection: (1) First and second year economic students understand better the numeric formulations of lottery and time-preference questions than the general public, but can still answer the questions intuitively. (2) Students from economics can also be expected to play an important role in economics and financial markets in each country and in the global market. The time and risk preferences we study here are relevant for those finance-related activities. (3) Moreover, as Hofstede (1991), a leading researcher in cross-cultural comparisons, emphasized: to make a cross-national comparison, it is important to recruit homogeneous, comparable groups from each country in order to control the background variables as much as possible.

The second concern about our survey method might be that we only asked hypothetical questions without offering real monetary incentives, such that participants may not be motivated to give thoughtful answers. However,

[1]We use the term time discounting, time preference, and patience interchangeably for convenience, although strictly speaking, the three concepts are not identical.

researchers who compared directly the real and hypothetical rewards did not find systematic differences, e.g., Johnson & Bickel (2002).[2] Moreover, hypothetical questions have even some advantages in the domain of time preferences because they allow to ask questions involving a long time span and large payoffs (Frederick et al. 2002).

The collected data on time preferences offer many potential applications. As examples, we demonstrate that the average country-level time preference measured from our survey is related to some general phenomena such as a country's innovation capability and environmental sustainability, even after controlling for macro-economic variables. Although the collected data do not allow us to analyze the direct causal relationship, our results can be useful to form hypotheses for further empirical investigation and theoretical modeling.

The rest of this article is organized as follows: In the second section, we discuss a theoretical model for time discounting and derive its predictions. Moreover, we present the survey methodology. In the third section we summarize the key results. In the final section we discuss applications to explain the effects of time preferences on innovations and environmental protection and outline possible future research directions for which this survey data could be used.

[2]In a pilot study, we conducted the survey in different classes in the economic department at the University of Zurich. For the lottery questions, we also used monetary incentives following the BDM procedure (Becker, Degroot & Marschak 1964). No significant differences were found across different classes and between the monetary-incentive group versus the hypothetical-question group.

2 Methodology

2.1 Intertemporal decisions under constraints

Most standard economic models assume that time discounting or time preferences are exogenous. One can argue that in a perfect capital market where individuals can borrow and lend freely, the personal taste concerning time preference should not matter, because intertemporal choices can be made such that the discount rate corresponds with the interest rate in the market. If markets were perfect (and people perfectly rational) then we would measure in our survey discount rates that equal market interest.

Many studies, however, have shown that discount rates tend to be much larger (compare the survey of Frederick (2005)). One of the reasons why that might be the case is, that in reality markets are far from perfect: even in countries with well-developed financial systems there are many constraints, particular on borrowing money. They can be institutional or cultural in nature: in some countries, obtaining a loan might be impossible for many people (compare Beck, Demirgüç-Kunt & Peria (2008) for an international comparison study on this issue), in other countries taking a loan for consumption might be considered simply as foolish behavior that could reduce reputation substantially.

Depicting the decision problem in a diagram where x- and y-axis are the consumption in period t and $t+1$, respectively, we can display the possible consumption streams induced by a decision for obtaining A at time t or X at time $t+1$. Figure 1 shows the following cases:

(a) Complete market without restrictions: both options are only equally good if both lines coincide, i.e. if $X = RA$, where R is the market interest.

(b) No financial market access: both options are only equally good if they lie on the same indifference curve. We will discuss this problem below.

(c) The first intermediate case: differences in interest for borrowing and investing. If differences become large, this case resembles the case (b), if the differences are small, this case approaches case (a).

(d) The second intermediate case: borrowing is not possible, but investing is. In this case the problem will usually coincide with problem (a).

Whatever the reason, we have to consider the possibility that people do not have the possibility to arrange the money in a free way between the two time periods, but indeed have to stick to what is offered.

In this case, the choice between an amount A at time t and X at time $t+1$ is (applying the classical utility model for intertemporal decisions) the choice between the utilities

$$U_1 = u(w_t + A) + \delta u(w_{t+1}) \text{ and } U_2 = u(w_t) + \delta u(w_{t+1} + X),$$

where w_t denotes the wealth at time t, u is the utility function and δ is the endogenous time discounting that is in itself independent of the interest rate, but might depend, e.g., on the probability to live up to the time $t+1$.

Finding the value X for which a person is indifferent between both options, i.e. where $U_1 = U_2$, leads to a fairly simple numerical problem. We are, however, more interested in how X changes when exogenous conditions change, in particular when wealth level, wealth increase, risk aversion and market interest rate change.

To this purpose it is useful to linearize the problem. We can rewrite the equation $U_1 = U_2$ as

$$u(w_t + A) - u(w_t) = \delta u(w_{t+1} + X) - \delta u(w_{t+1}). \tag{1}$$

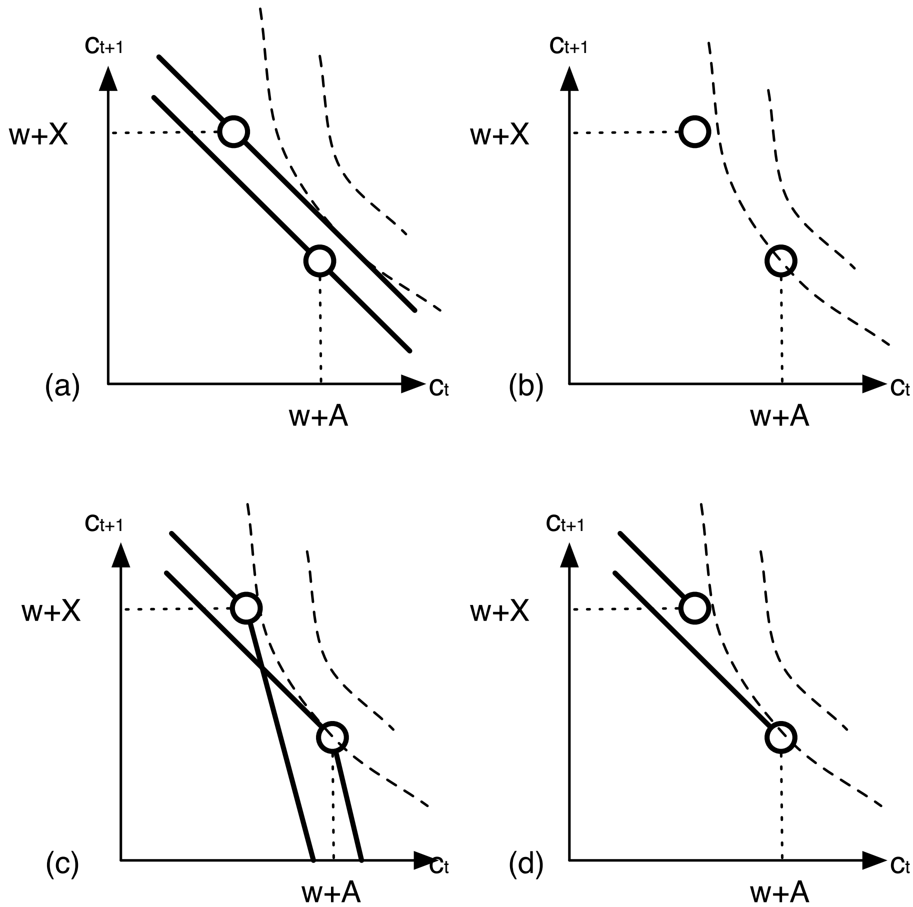

Figure 1: Choices between a gain at time t or a delayed, but larger gain at time $t+1$. The optimization problem differs depending on the accessibility of financial markets: (a) full access, (b) no access, (c) full access with borrowing costs, (d) investing, but no borrowing.

Using a Taylor expansion of u at w_t for $u(w_t+A)$ and at w_{t+1} for $u(w_{t+1}+X)$ gives

$$u'(w_t)A + \mathcal{O}(A^2) = \delta u'(w_{t+1})X + \mathcal{O}(X^2),$$

where $\mathcal{O}(f(x))$ denotes the Landau symbol, i.e. terms of order $f(x)$ or higher.

Assuming that A and X are small we get the approximation

$$\delta \frac{u'(w_{t+1})}{u'(w_t)} = \frac{A}{X}. \tag{2}$$

This equation is very similar to the standard intertemporal optimization problem where the time discounted marginal rate of substitution equals the market interest. In our case, however, the right hand side is not the market interest, but the ratio between the two payoffs that make the agent indifferent, i.e. his revealed time discounting (where smaller values of A/X correspond to a stronger time discounting).

The intuition behind this formula is that the utility gain given by X in the future (hence discounted by delta) is equal to the utility gain by A now. Thus their quotient is one. Both utility gains can then be approximated by the marginal utility times the wealth increase (A or X, respectively) which gives equation (2).

Based on this model, we can make the following observations about the influence of various parameters on the time discounting:

First, A/X depends on δ, the endogenous time discounting, but not on the market interest R. This is rather obvious in this setting, since the decision is made independently of the market. It implies particularly that uncertainty about the future directly affect time discounting, since they increase the probability that due to whatever reason the future payment will not be obtained.

Second, we have the following general results whose proofs can be found in the appendix:

Proposition 1. *Suppose that a strictly risk averse expected utility agent faces the decision between obtaining A at time t and X at time $t+1$ such that the general equation (1) holds. Then a higher wealth growth leads to a stronger time discounting, i.e. if $g := w_{t+1}/w_t$ increases, then A/X decreases.*

Proposition 2. *Assume that (1) holds. Then a higher level of risk aversion (e.g., if $u(x) = x^\alpha/\alpha$, a smaller α) leads to higher time discounting.*

Proposition 3. *Assume that (1) holds. If wealth growths with a fixed growth rate g, i.e. $w_{t+1} = gw_t$ with $g \geq 1$, then:*

(i) If u has constant absolute risk aversion (CARA), then time discounting is independent of the wealth level w_t.

(ii) If u has decreasing absolute risk aversion (DARA), and in particular if u is CRRA, then time discounting decreases when the wealth level w_t increases.

Proposition 4. *Assume that (2) holds and that $u(x) = x^\alpha/\alpha$ (CRRA). If there is inflation (i.e. all future wealth and payoffs are reduced by a factor $(1-i) < 1$), then the higher the inflation rate, the stronger the time discounting.*

These results are summarized in Table 1, where we assume that u is CRRA.

2.2 Measuring time preference

We have now derived a number of predictions about time discounting and describe in the following how we have measured it in our survey.

We have asked three hypothetical questions to measure time preferences.[3] The first question is a binary choice question taken from Frederick (2005),

[3] Some studies have reported differences between elicitation methods such as matching

Financial market access:	Variable:	Effect on time discounting:
Full	Market interest	Increasing
Limited	Growth rate	Increasing
	Risk aversion	Increasing
	Wealth level	Decreasing
	Inflation rate	Increasing

Table 1: Theoretical influence of various factors on time discounting depending on access to a financial market.

which we refer to as the "wait-or-not" question in the rest of the article. The question is presented as follows:

Which offer would you prefer?

A. a payment of $3400 this month

B. a payment of $3800 next month

To measure the implicit discount rate more directly, in the next two questions, we asked participants to give the amount of a delayed payment which makes them indifferent with an immediate payment. We refer to these two questions as the "one-year matching question" and the "ten-year matching question," respectively. These two questions are:

and choice, e.g., Read & Roelofsma (2003). Although we asked time preference questions in both decision modes (i.e., choice and matching), our survey design did not mean to draw any definite conclusions of these two elicitation methods, because we focus more on systematic cross-country variations instead of cross-question variations.

Please consider the following alternatives

A. a payment of \$100 now

B. a payment of \$ X in one year from now

X has to be at least \$ __, such that B is as attractive as A.

Please consider the following alternatives

A. a payment of \$100 now

B. a payment of \$ X in 10 years from now

X has to be at least \$ __, such that B is as attractive as A.

2.3 Measuring risk preferences

We also measured risk preferences in a different section of the questionnaire by asking the participants' willingness to pay for some hypothetical lotteries. In a separate paper, we will discuss how to use these responses to fit Prospect Theory parameters. In the present paper, we check the relationship of time preference with a measure on the revealed risk attitude in gains. It is computed as the Relative Risk Premium (RRP) for a lottery in the gain domain where one can win \$10000 with 60% probability (and otherwise nothing):
The RRP is calculated as $(WTP - EV)/EV$. (This definition has been used in a similar context, e.g. by Fehr-Duda, Epper, Bruhin & Schubert (2011)). We refer the mean RRP of the two lottery questions as Risk Premium in our regression analysis later.

2.4 Measuring cultural dimensions

Culture is typically defined as something stable over time that distinguishes different groups. One of the most influential measurements for culture has been developed by the Dutch sociologist Geert Hofstede during his long-term research on cross-national organizational culture. Five persistent cultural dimensions were found across different nations and different times (Hofstede 2001). In the second part of our questionnaire, we used the Values Survey Module (VSM94) developed by Hofstede and his colleagues to measure the cultural dimensions (Hofstede 2001). In particular, we will report the results that involve the following three cultural dimensions:

- Individualism (IDV): IDV measures the degree to which the society reinforces individual or collective achievement, and the extent to which people are expected to stand up as an individual as compared to loyal affiliation to a life-long in-group (e.g., extended family, friends, etc.). The opposite of individualism is collectivism. For example, the U.S. has an individualistic culture, whereas Japan has a collectivistic culture. The index is calculated from four questions in our questionnaire where the participants were asked to rate the importance of the described feature for an ideal job (1=of utmost importance; 5=of very little or no importance) : (1) sufficient time for your personal or family life; (2) good physical working conditions (good ventilation and lighting, adequate work space, etc.) (3) security of employment; (4) an element of variety and adventure in the job.

- Uncertainty Avoidance (UAI): A high score of UAI indicates that a society is afraid of uncertain, unknown and unstructured situations. It is derived from four questions. The first question is "How often do you feel nervous or tense at work (1=never; 5=always)?" The rest of the questions asked the participants to what extent they agree with each of the following statements (1=strongly agree; 5=strongly disagree): (1) One can be a good manager without having precise answers to most questions that subordinates may raise about their work; (2) Competition between employees usually does more harm than good; (3) A company's or organization's rules should not be broken – not even when the employee thinks it is in the company's best interest.

- Long Term Orientation (LTO): When using a Chinese Value Survey in East Asia, Hofstede (1991) identified a fifth dimension "long-term-orientation," or Confucian Dynamism, which captures the society's time horizon. It reflects to what extent a society has "a dynamic, future-oriented mentality." A higher score implies that the past is valued less than the future, and people may look more forward. We measure this by asking participants to rate the importance of the following questions: (1) "In your private life, how important is 'respect to tradition' for you (1=of utmost importance; 5=of no importance)?" (2) "How important is 'thrift' for you (1=of utmost importance; 5=of no importance)?"

There are alternative measures for culture, most notably the Schwartz dimensions (Schwartz 2004), but they are least frequently used than the Hofstede dimensions and it was not possible for us to include more than one scale into our questionnaire. Therefore we discuss only the effect of the Hofstede cultural dimensions which we measured in our sample directly.

2.5 The survey instrument

A total of 5912 university students in 45 countries/regions participated in our survey. Most participants were first or second year students from departments of economics, finance and business administration. The average age of participants was 21.5 years (SD=3.82). Fifty-two percent of the participants were males. The survey yielded 5903 responses for the first time discounting question, 5632 for the second questions, and 5546 for the third questions.

Each participant was asked to fill in a questionnaire that included 14 decision making questions (three time preference questions, one ambiguity aversion question, and 10 lottery questions), 19 questions from the Hofstede VSM94 questionnaire, a happiness question and some information about their personal background, nationality and cultural origin. The questionnaire was translated into local languages for each country by professional translators or translators with economic background. The amount of monetary payoffs in the questions were adjusted according to each country's Purchasing Power Parity and the monthly income/expenses of the local students. The participants were instructed that there are no wrong or correct answers to these questions, and that the researchers are only interested in their personal preferences and attitudes. In most cases, the survey was conducted during the first fifteen to twenty minutes of a regular lecture under the monitoring of the local lecturers and experimenters. The response rate was therefore very high (nearly 100%).

3 Results

3.1 Measured level of time discounting

3.1.1 To wait or not

In this section, we evaluate the results from the "wait-or-not" question ($3400 this month or $3800 next month). Figure 2 shows the percentage of the participants in each country who chose to wait for $3800 next month. We observe a wide range of variation on the country level – the percentage of students who chose to wait ranged from only 8% in Nigeria to 89% of Germany. Note that the implicit interest rate in this question is as high as 11.8% per month (i.e., an annual discount rate of 280%), which is far higher than the market interest rate and inflation rates in any of these countries at the time of the survey. Therefore, the large variation across countries is hard to be justified purely by the differences in market interest rates or inflation rates.

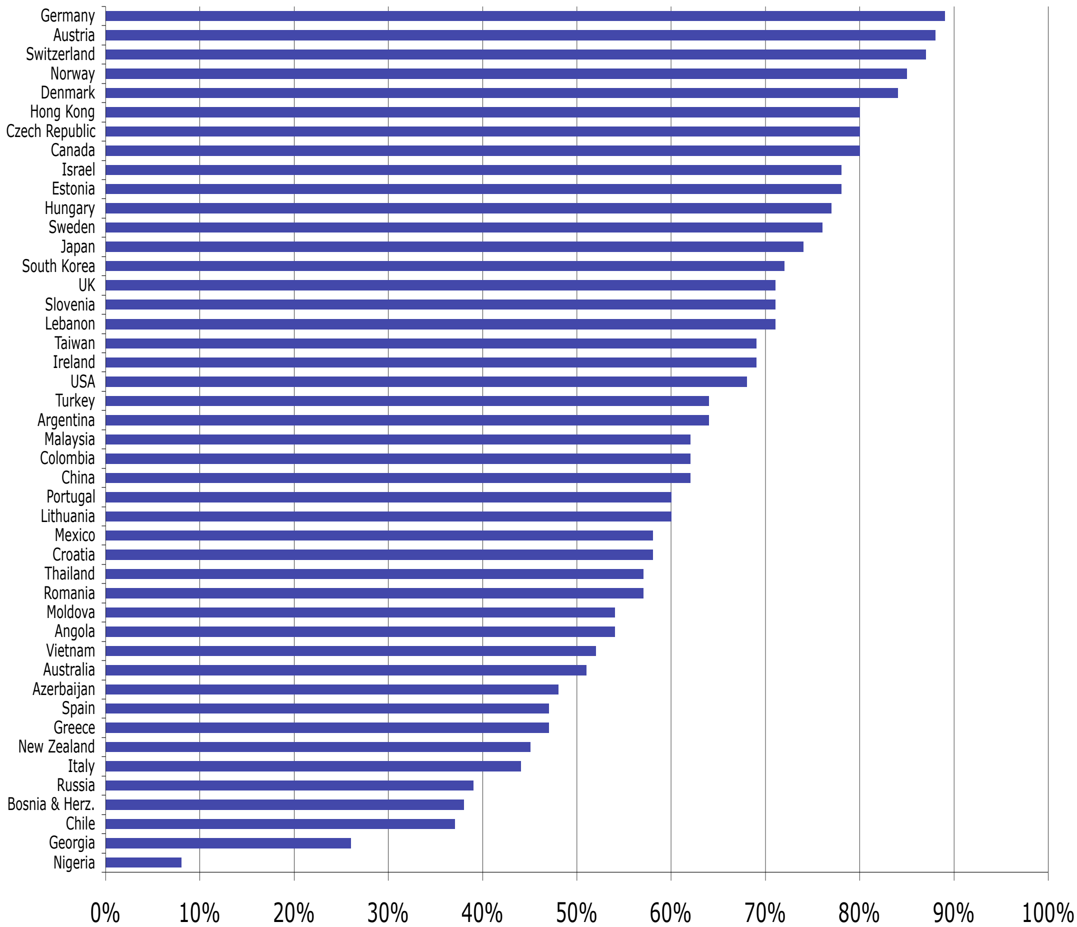

Figure 2: Percentage of Participants Who Choose to Wait

In particular, 68% of our U.S. sample chose to wait (N=72). For comparison, in the survey by Frederick (2005) where he used the same question with a relatively large sample (N=807) of U.S. undergraduate students from several universities, only around 41% students chose to wait. Among those students who scored high in a separate Cognitive Reflection Test (CRT), there were 60% choosing the waiting option, which is closer to our result. The potential reason is that our participants were studying economics, and thus more likely to take the market interest rate into account. On the other hand, even 68% for the U.S. sample is still significantly lower than the percentage in Germanic/Nordic countries like Germany (89%), Austria (88%), Switzerland (87%), and Norway (85%). This difference is hard to explain only by wealth, education and the macro-economic situations.[4]

Each participant has stated not only their nationality, but also the culture they feel they belong to. We classified each participant into one of seven cultural clusters, mostly following the classification scheme suggested by Chhokar et al. (2007). Figure 3 shows the percentage of choosing the wait option within each cultural cluster. In general, the Germanic/Nordic group are far more likely to wait (88% chose to wait) than other cultural clusters. Anglo, Middle East, and East Asia are similar (around 66% to 70%), then followed by East Europe, Latin America and Latin Europe (around 52% to 59%). Africa has the lowest percentage of participants choosing to wait (34%). These discrepancies might be of cultural or of economic origin. We will discuss later the relative importance of both reasons.

[4]Even for the students from Princeton University, the percentage choosing the patient option is lower than the percentage of German students (80% vs. 89%). Actually some students from our Norway survey even complained that the question was ridiculous because *everybody* would choose to wait for one month given the high implicit interest rate.

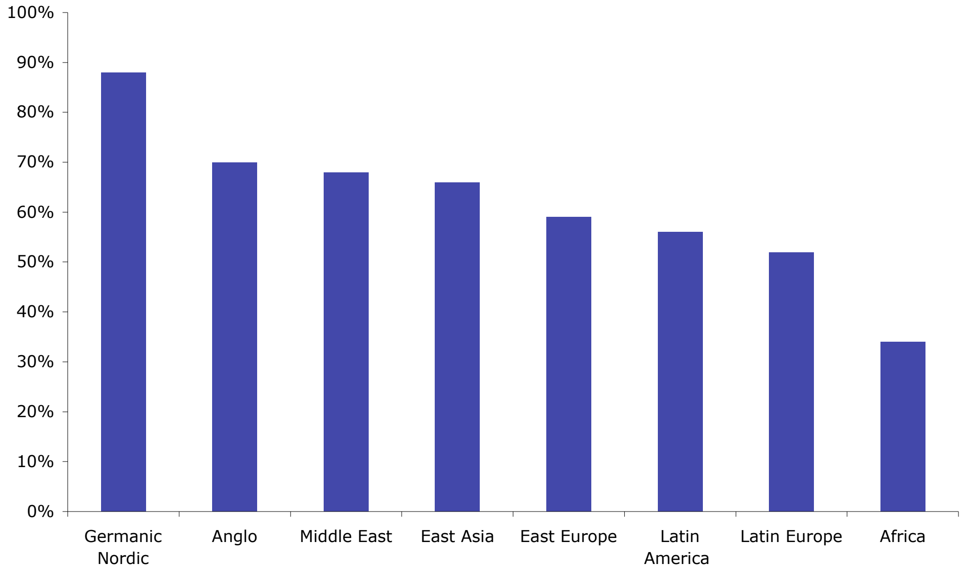

Figure 3: The percentage of choosing to wait grouped by cultural origin

Note: The column shows the percentage of participants who chose to the $3800 option when they were asked to choose between $3400 this month or $3800 next month. The respondents were asked about which culture they thought they belong to. We exclude those participants who do not live in their own countries. We group the countries into seven cultural clusters based on the classification from Chhokar, Brodbeck & House (2007).

3.1.2 Measured subjective discount rate

Inferred Discount Rate: The Classical Approach

To infer discount rates from intertemporal decisions, we use the relationship between the present value of a cashflow, denoted by P, and its future value, denoted by F. Formally,

$$F = P(1 + R)^t,$$

where R is the discount rate and t is the time to be waited. Since both P and t are given in our questions, the inferred discount rate can be obtained easily from

$$R = (F/P)^{(1/t)} - 1.$$

We have two questions to infer the subjective discount rate, where t equals to 1 year and 10 years, respectively.

The classical approach states that there is only one "market riskless discount rate", which is supposed to be the same for all individuals. Our results indicate that this is not the case. Figure 4 shows the implicit annual interest rate for one-year and 10-year matching questions. We observe substantial variations of the implicit interest rate across individuals and across countries. The median R_{1year} is 100%, ranging from 14% in Australia to 1358% in Bosnia & Herzegovina, whereas median R_{10year} is 29%, ranging from 7% in Thailand and Spain to 71% in Bosnia & Herzegovina.[5] For all countries except for Australia, the median R_{1year} is higher than R_{10year}, which is consistent with

[5]Georgia has an extremely high implicit interest rate, especially for the one-year-matching question (14900% for the one-year question, and 86% for the ten-year question). The potential reason is that the survey was conducted two months before the outbreak of the Russian-Georgian war. The feeling of uncertainty induced by the tensions preluding the war may have induced high discounts for the near future.

the typical empirical findings that discount rates decrease with longer time horizons. This is also true at the individual level. In total, 87% participants had an implicit interest rate R_{1year} higher than R_{10year}.

The Classical Discounted Utility Model assumes consistent time preferences by using an exponential discounting model. It implies that the time preference between any adjacent periods should hold constant. Our results, consistent with previous empirical findings, show that most people discount the near future more than the far future, e.g., Thaler (1981) and Benzion, Rapoport & Yagil (1989). This pattern can be elegantly modeled by the implicit risk approach and the (quasi-)hyperbolic discounting function, which we will discuss in more details in the following sections.

The Implicit Risk Approach

The above results indicate that even for a single person, the subjective discount rate varies for different time intervals. In particular, most people appear to be more impatient for the one-year interval than for the ten-year interval. Hence we apply alternative models, namely, the implicit risk approach and the hyperbolic discounting model, which describe better the empirical results. According to the implicit risk approach (Mischel & Grusec 1967, Stevenson 1986), risk and time are conceptually separated. It is assumed that the individual believes that there is a chance that the delayed outcome will not happen, which is associated with an implicit risk premium. People try to avoid delayed positive consequences and prefer delayed negative consequences, because both are less certain. Therefore, the subjective discount rate has two components: a pure, riskless discount rate, and a risk-related discount rate.

Two extreme hypotheses concerning the effects of risk can be formulated

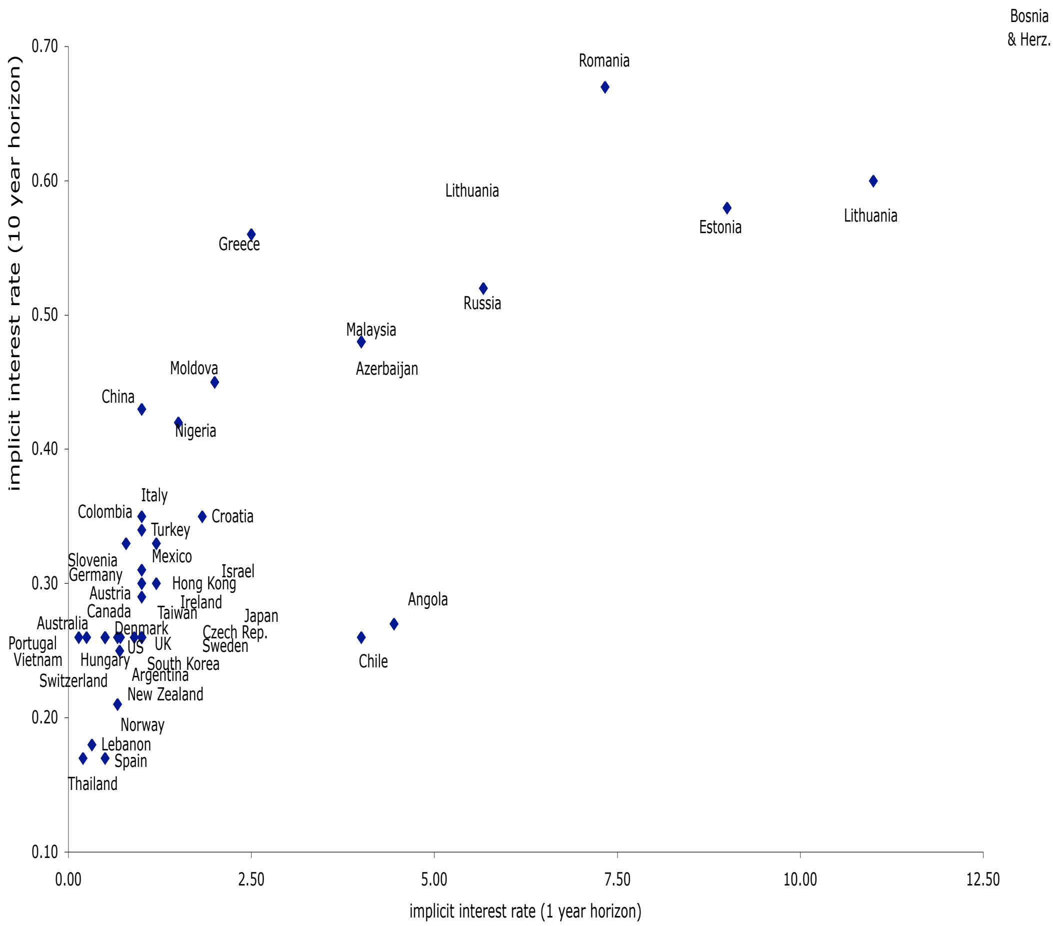

Figure 4: Implicit annual interest rate for 1-year and 10-year horizon

within the implicit risk approach (Benzion et al. 1989, Robicheck & Myers 1966). In the *one-period-realization of risk* hypothesis, risk depends on the time of the receipt or payment but not on the length of the time period. Therefore, in addition to the riskless discount rate, denoted by i, there is a one-time discount rate factor for the implicit risk, denoted by d. Formally,

$$F = P(1 + d)(1 + i)^t.$$

In contrast, the *multiple-period-realization of risk* hypothesis assumes that risk increases proportionally in time, and the standard equation takes the form:

$$F = P[(1+d)(1+i)]^t = P(1+d)^t(1+i)^t.$$

Note that in this formulation, the effective implicit discount rate is $(1+d)(1+i)$, which is the same for the one-year and the ten-year period. It is inconsistent with our observation. Therefore the *one-period-realization* model is more plausible.

We had two questions to elicit the future value for one and ten years:

$$F_{1year} = 100(1+d)(1+i),$$
$$F_{10year} = 100(1+d)(1+i)^{10}.$$

It follows that

$$i = (\frac{F_{10year}}{F_{1year}})^{1/9} - 1,$$
$$d = \frac{F_{1year}}{100(1+i)} - 1.$$

For all participants, the median value of the riskless interest rate i is 0.23 (Mean=0.25, SD=0.20). The median value of the risk-related discount rate d is 0.67 (Mean=8.62, SD=77.91).

Quasi-hyperbolic Discounting Model

The Quasi-hyperbolic Discounting model is mathematically equivalent to the above one-period-realization implicit risk approach, but conceptually different. It is usually defined in discrete time periods as follows:

$$u(x_0, x_1, ..., x_T) = u(x_0) + \sum_{t=1}^{T} \beta\delta^t u(x_t).$$

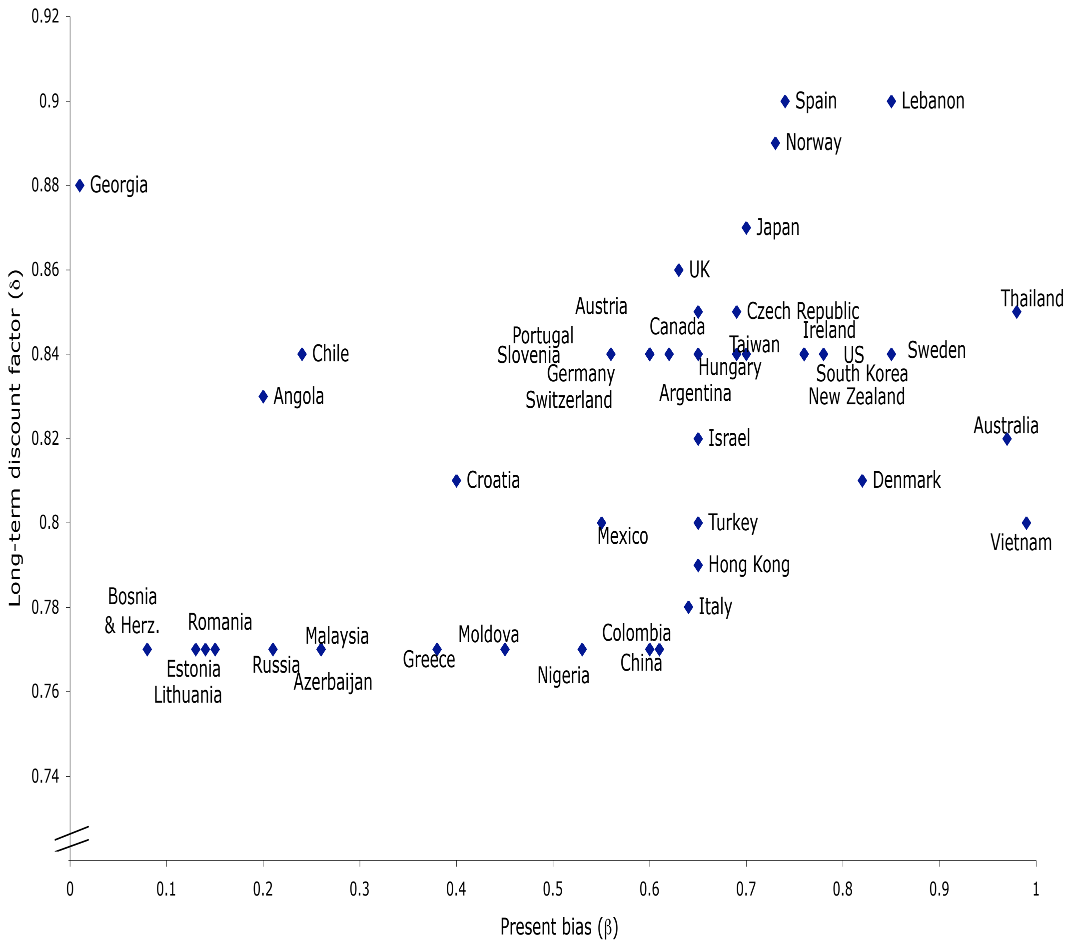

Figure 5: Median values of Parameters in Hyperbolic Discounting Model for All Countries

This discount function has been used by Phelps & Pollak (1968) to study intergenerational discounting and by Laibson (1997) to intra-personal decision problems. When $0 < \beta < 1$ and $0 < \delta < 1$, people appear to be more patient in the long run and less patient for the immediate future. The per-period discount rate between now and the next period is $(1-\beta\delta)/\beta\delta$ and the per-period discount rate between any two future periods is $(1-\delta)/\delta$, which is less than $(1-\beta\delta)/\beta\delta$. Same as in the one-period realization implicit-risk approach, the quasi-hyperbolic discounting model assumes a declining discount rate between this period and the next, but a constant discount rate thereafter. In fact, $\delta = 1/(1+i)$ and $\beta = 1/(1+d)$. However, unlike the implicit risk approach which rationalizes the time inconsistent preferences, the quasi-hyperbolic discounting model has often been discussed in the context of irrationality, such as lack of control, and thus used to justify the need for commitment devices. In particular, β refers to the degree of "present bias". Larger β implies less present bias. When β=1, the quasi-hyperbolic discounting model coincides with the standard exponential discounting model. We call the other parameter δ the long-term discount factor.

When we assume a linear utility function, the two matching questions about time discounting can be represented as:

$$100 = \beta\delta F_{1year},$$
$$100 = \beta\delta^{10} F_{10year}.$$

Thus δ and β can be inferred from the responses F_{1year} and F_{10year}:

$$\delta = (\frac{F_{1year}}{F_{10year}})^{1/9},$$
$$\beta = \frac{100}{\delta F_{1year}}.$$

For all participants, the median value of β is 0.60 (Mean=0.56, SD=0.41), and the median value of δ is 0.81 (Mean=0.82, SD=0.12). See Figure 5 for a plot of parameter estimates of β and δ for each country. Note that the variation in present bias β is much higher than the variation in long-term discount factor δ. The responses of the two matching questions are highly correlated (Spearman's ρ=0.78, p<0.001). However, the present bias parameter β and the long-term discount factor δ are only moderately correlated (Spearman's ρ=0.250, $p < 0.001$), indicating that the two components from the quasi-hyperbolic model may correspond to different psychological constructs or risk perceptions.

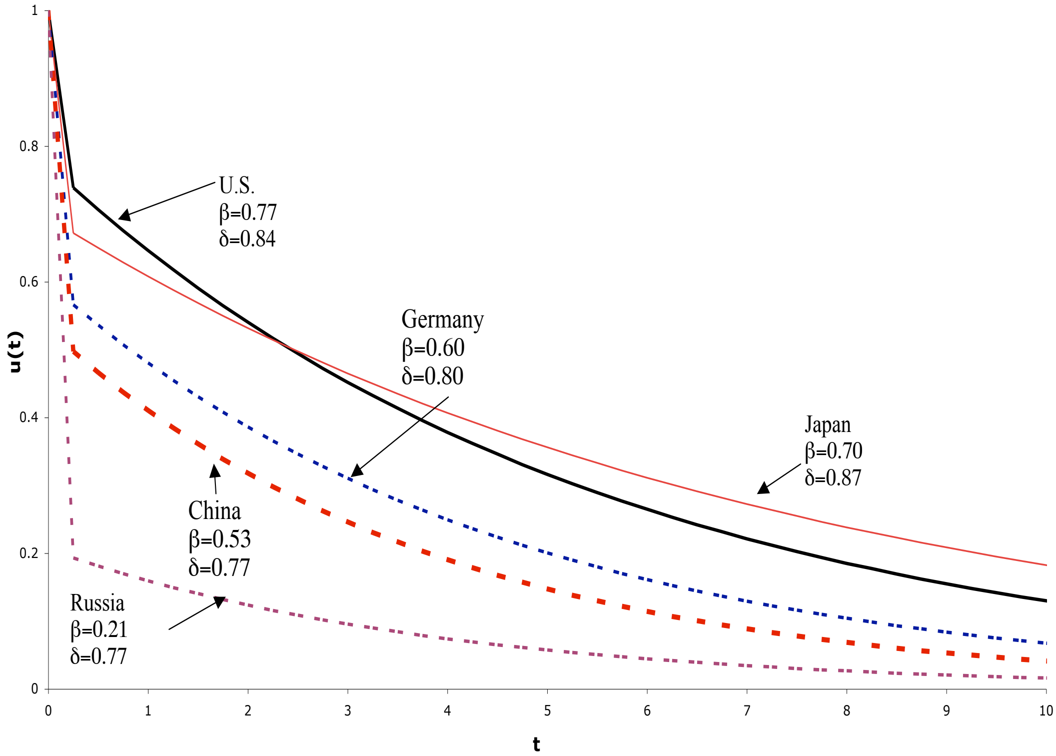

Figure 6: Median hyperbolic discounting functions for U.S., Germany, China, Japan, Russia (β: present bias; δ: long term discount factor)

As an example, Figure 6 exhibits the discounting function for a median participant in the U.S., China, Germany, Russia, and Japan. Among these countries, the U.S. has the highest value of β (=0.78), i.e., the lowest present bias, followed by Japan (β=0.71). Germany and China have the same β value (=0.60). Russia has by far the lowest value of β (=0.21), implying a very impatient attitude for one-year horizon.

Regarding the long-term discounting, the U.S., Germany and Japan have similar values of δ (around 0.85). Russia and China have the same value of

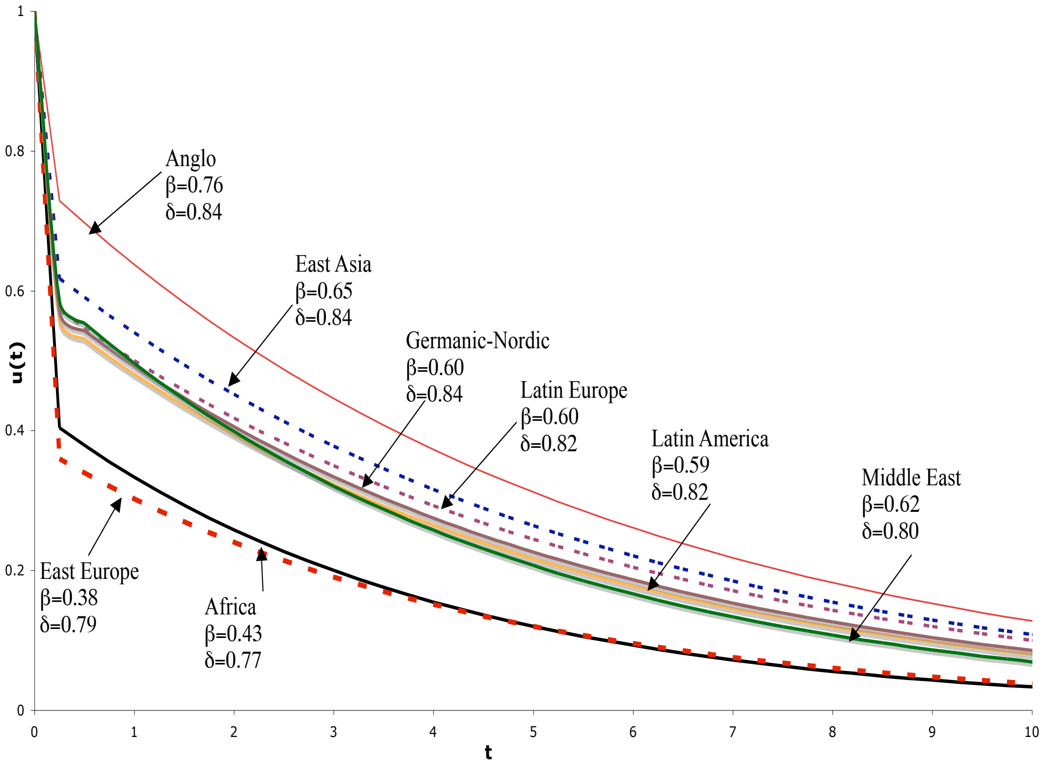

Figure 7: Median hyperbolic discounting functions for different cultural clusters (β: present bias; δ: long term discount factor)

δ (=0.77), which is lower than the other three developed countries, implying a slight less patient attitude in the long term, but the difference is not as dramatic as that of the present-bias parameter.

Figure 7 plots the median values of β and δ for each cultural cluster. Here we use the self-reported cultural origins[6], but if we use the nationalities as the culture origin, the results are similar. East Europe and Africa has the strongest degree of present bias with β around 0.40, whereas Anglo cultures have the least degree of present bias (β=0.76). The rest cultures have similar

[6]It corresponds to the question: "I consider myself to belong to the following culture: [ ](Country in which test is performed) [ ] others (please specify)."

degree of present bias with β around 0.60. On the other hand, all cultural groups are very similar regarding the median value of their long-term discount factor δ (around 0.80).

3.2 Time preferences, culture and economics

3.2.1 Independent variables

We have demonstrated that our measured time preference is very heterogeneous across countries. Now we would like to explore macroeconomic and cultural factors that correlate with the measured time preference. To this aim we study a number of individual and country-level parameters:

Age and gender

A number of experimental and survey studies find that time preferences are correlated with personal characteristics such as gender (Silverman 2003), age (Green, Fry & Myerson 1994), anxiety (Hesketh, Watson-Brown & Whiteley 1998), and even intelligence and working memory (Frederick 2005, Shamosh, DeYoung, Green, Reis, Johnson, Conway, Engle, Braver & Gray 2008).

Culture

Perception of time is a part of culture. According to Graham (1981), the concept of time value of money is rooted in "linear-separable" views of Anglo-American cultures, who view time as a continuum stretching from past to present to future. In these cultures, time is considered to be an essential component of money (e.g., via discount rate/interest rate), a notion that we know from modern economic and finance textbooks. Other cultures, however, may have dramatically different views of time. In particular, Graham (1981) explains that Latin American cultures perceive time as a circular concept that repeats itself with a cyclical pattern. This "circular-traditional" view of time is the root of the *mañana* attitudes in Mexico and other parts of Latin America, where people's activities orient much more to the present than to the future. Therefore, immediate rewards are preferred. This may explain the low percentage of subjects who chose to wait in our Latin Europe and Latin American sample (Figure 3), even though Latin Europe is closer to Western Europe regarding the economic conditions.

There are other cultural differences that may affect time discounting. Financial discounting, for instance, is found to be related to a range of psychological variables, such as conscientiousness (Daly, Delaney & Harmon 2009). As Terracciano et al. (2005) reported, that in their sample German Switzerland, Sweden, Germany, Burkina Faso, and Estonia have the highest scores on Conscientiousness, whereas Spain, Turkey, Croatia, Chile, and Indonesia have the lowest scores on Conscientiousness. This again seems to be consistent with our findings: those countries with higher Conscientiousness score are more likely to wait for the delayed larger reward in our one-month question.

We should be cautious, however, to simply equate this unwillingness to wait for the larger payoff to a degree of impatience. As Graham (1981) points out, due to the large difference in the perception of time, in some cultures, when a person is forced to choose between immediate and future rewards, he may view this not as evaluating alternatives: "He was essentially asked if he wanted something or nothing"– because future rewards were perceived as of no real value, thus "what one person views as a choice situation, another views as mandated action." (Graham 1981, p.341) In the one-year and ten-year matching questions, when students were asked to state the amount of money that makes them indifferent, Latin European exhibited similar preferences as Germanic/Nordic cultures, whereas Latin Americans were slightly "less" patient. It somehow hints that the one-month waiting question reflects more about a general attitude, whereas the one-year and ten-year matching questions may be more treated as evaluative questions.

Another measure for culture are the cultural dimensions by Hofstede (1991). Here we study three of them: Individualism, Uncertainty avoidance and Long Term Orientation. (See Sec. 2.4 for more details on the measurement.)

A high score of Individualism implies that individuals are loosely connected to the society, and are expected to take care of themselves. In comparison, in a society with collectivistic culture, people can be protected by some strong cohesive groups throughout lifetime as a reward to their unshakeable loyalty. Therefore, the social connection in a collectivist culture may provide its citizen a "cushion" or safety net for potential losses (Hsee & Weber 1999), with which people can afford to be more risk-seeking and more patient. To test the impacts of a collectivistic culture, Mahajna et al. (2008) compared the subjective discount rates and risk preferences for Israeli Jews and Arabs with bank customers as participants. They examined two competing hypothesis: If the "cushion" hypothesis were right, then in a collectivist society (Israeli Arabs), a person would exhibit lower subjective discount rate (more patience) and lower risk-aversion. In contrast, the "trust" hypothesis states that Israeli Arabs, who tend to show low levels of trust, probably due to a difficult political situation and a feeling of being discriminated, would exhibit higher subjective discount rates (less patience) and higher risk aversion. Their results show that Israeli Arabs have higher subjective discount rates, and higher risk-aversion, which is inconsistent with the "cushion" hypothesis.

Uncertainty Avoidance is another culture dimension relevant to time preferences. A society with higher Uncertainty Avoidance score tends to be less tolerant to uncertain situations. Presumably, people from such cultures should prefer immediate rewards because of the uncertainty about the future rewards. To our knowledge, no empirical studies have investigated this relationship yet.

Hofstede (1991) finds that the Long Term Orientation Score is typically high in East Asian, especially Confucian cultures, implying that people there value future more than present, and they are likely to be more patient. Moreover, the concept of "rebirth" in the dominant religions (e.g., Buddhism and Hinduism) in Southeast Asia reflects the belief that the current life is only a small portion of the whole existence. In an interesting experiment, Chen, Ng & Rao (2005) tested whether the influence of an Eastern culture makes people more patient than the influence of Western culture. By studying the bicultural Singaporean participants, they find U.S.-primed participants valued immediate consumption more than did Singaporean-primed participants, hence supported indirectly the hypothesis that high Long Term Orientation leads to patience.

Risk preference

Frederick (2005) and Dohmen, Falk, Huffman & Sunde (2008) find that people with higher cognitive ability tend to be more patient and less risk-averse. We have already seen in Proposition 2 that a higher risk aversion can lead to higher time discounting. To control for this effect we include the relative risk premium (RRP, as defined in Sec. 2.3) into our regression.

Wealth

Becker & Mulligan (1997) proposed a model to capture endogenous time preferences. It states that the more resources we use to imagine the future, the more patient we are. It follows that wealth and education leads to patience. Most studies find wealthier people are more patient (Hausman 1979, Lawrance 1991, Harrison, Lau & Williams 2002, Yesuf & Bluffstone 2008). Poor farm households, for example, tend to have shorter planning horizons and hence are reluctant to invest in conservation for natural resources (Mink 1993). But there are also several studies that find no relation between wealth and discount rates (Kirby, Godoy, Reyes-Garcia, Byron, Apaza, Leonard, Perez, Vadez & Wilkie 2002, Anderson, Dietz, Gordon & Klawitter 2004).

Proposition 3 showed that for DARA investors (which is the standard assumption in the literature) the theoretical prediction coincides with these empirical results.

Since we do not have individual wealth or income information, we use GDP per capita as the proxy for the national wealth.

Economic growth, inflation and interest rate

We have seen in Proposition 4 implies that a higher inflation rate should lead to higher time discounting. According to Proposition 1 this is also the case when growth rates are higher.

We include the logarithm of the economic growth rate and the annually inflation rate of the year before our survey (2007) into the regression analysis. Since previous times of higher inflation might lead to uncertainty about the future inflation rate, we repeated all regressions with the log of the maximum annually inflation rate of the previous ten years. As their was no significant difference in the results, we refrain from reporting this robustness test.

Finally, for subjects that perceive to have full (or at least substantial) financial market access when making their decision, the market interest rate should play an important role. To test for this effect, we use the interest rates of the country (one month or one year) and two proxies for access of private persons to financial markets and – in particular – to loans: First, the "easiness to obtain a loan" scale from the Global Competitiveness Report 2008-2009 by Porter & Schwab (2008). The variable was computed based on responses from the business community to the question: How easy is it from a bank to obtain a loan in your country with only a good business plan and no collateral? (1=impossible, 7=very easy). Second, the ratio of private debt to GDP (Beck et al. 2008). Both variables were included into the regressions.

3.2.2 Regression results

To test the hypotheses derived for the variables in the last section, we use a regression analysis. The main results are presented in Table 1–3, where the dependent variable is the answer to the waiting question (logit regression, Table 1) and the hyperbolic time discounting variables β and δ for Table 2 and 3, respectively.[7]

The results show that there are certain differences between the results for the three measurements for time discounting. This has to be expected due to the different elicitation methods for the waiting choice question and due to the fact that β reflects the "non-rational" part of the time preferences, while δ corresponds (to some extent) to the rational discounting.

When looking on the impact of demographic information, it is interesting to notice that gender differences play mostly an insignificant role, but it seems that female subjects were more prone to the present time bias, i.e. the discount factor β was smaller (Table 3). Given the on average very young participants, we refrain from discussing the results for the variable *age*.

The influence of individual risk preferences are mostly in line with the theory: higher risk aversion (as captured by a higher RRP) leads to seemingly

[7]When taking out non-economic majors or students with cultural background different than their place of study, we did not find significant deviations from the presented results.

more "impatient" behavior. Only for the binary question we did not obtain this result.

On the macroeconomic side, the effects were as predicted by Propositions 1–4: higher wealth (as measured by log(GDP/capita)) increased the tendency to wait, while a higher inflation rate for most measurements decreased the waiting tendency. We also obtained a clear result for the relation between growth rate and time discounting: in all three settings a higher growth rate induced higher discounting. These results confirmed the effects of limited market access as predicted in our model under limited access to financial markets well.

When testing the influence of factors with respect to free market access, we found mixed results: while easiness to obtain loans and a large ratio of private debt to GDP (as another proxy for a good market access) decrease time discounting as expected, the influence of the interest rate itself was inconsistent. This might be due to the fact that even in the countries with highly developed financial markets the majority of subjects had time discounting way above the market rate. Even in these countries, the option to take a loan now and pay back later with the prospective gain on offer, was not taken into account by most. Moreover, the difference in interest rates between these countries was quite small during the period of our study.

Summing up, the empirical results support fully our model of time preferences without (or with limited) access to financial markets. Market interest rates do not seem to play such an important role as classical financial theory would predict.

Whether controlling for macroeconomic conditions or not, we find in any case strong evidence for a cultural influence on time discounting. This holds in particular true for the two "behavioral" measurements (waiting tendency

Table 2: Linear Regression of Waiting Tendency

Independent variables	Model 1	Model 2	Model 3	Model 4
age	-0.038***	-0.031**	-0.045***	-0.06***
	(-2.967)	(-2.416)	(-3.538)	(-4.499)
gender	-0.006	-0.015	-0.012	-0.019
	(-0.464)	(-1.21)	(-0.96)	(-1.472)
Interest rate 1 month	-0.008			
	(-0.563)			
Private debt/GDP	0.146***			
	(8.263)			
easyness to obtain loan	0.102***			
	(6.38)			
inflation rate		-0.1***	-0.091***	-0.086***
		(-5.899)	(-5.279)	(-4.46)
Log(growth rate)		-0.058***	-0.049***	-0.068***
		(-3.949)	(-3.356)	(-4.578)
log(GDP/capita)		0.156***	0.137***	0.073***
		(8.492)	(7.361)	(3.26)
RRP		-0.021*	-0.013	-0.016
		(-1.645)	(-1.057)	(-1.295)
IDV (country)			0.084***	0.04**
			(5.868)	(2.514)
IDV ind. diff.			0.029**	0.03**
			(2.348)	(2.41)
UAI (country)			-0.046***	-0.008
			(-3.187)	(-0.503)
UAI ind. dif.			-0.012	-0.013
			(-0.949)	(-1.085)
LTO (country)			0.026**	0.078***
			(2.016)	(4.764)
LTO ind. diff.			0.049***	0.048***
			(3.971)	(3.933)
Africa				0.006
				(0.429)
Anglo/American				0.058***
				(3.029)
Germ./Nordic				0.2***
				(8.713)
East Asia				0.092***
				(4.7)
L.America				-0.007
				(-0.418)
L.Europe				-0.046***
				(-2.98)
E.Europe				0.046**
				(2.156)
Middle East				0.091***
				(5.547)
R^2 (%)	4.9	7.2	8.6	10.9
Delta F^2	100.2	11.7	15.4	18.9

* =significant on 10% level, **significant on 5% level,
***significant on 1% level

* significant at 5% level; **significant at 1% level; t-values in brackets

Further controls: native dummy and economist dummy. Missing values were replaced by average values.

Table 3: Linear Regression of Present Bias

Independent variables	Model 1	Model 2	Model 3	Model 4
age	0.106***	0.13***	0.133***	0.128***
	(8.351)	(10.37)	(10.59)	(9.736)
gender	0.069***	0.042***	0.031**	0.029**
	(5.414)	(3.324)	(2.485)	(2.291)
Interest rate 1 year	0.087***			
	(5.722)			
Private debt/GDP	0.179***			
	(9.567)			
easyness to obtain loan	0.047***			
	(2.897)			
inflation rate		0.009	0.025	0.044**
		(0.521)	(1.489)	(2.293)
Log(growth rate)		-0.164***	-0.164***	-0.182***
		(-11.232)	(-11.26)	(-12.278)
log(GDP/capita)		0.089***	0.104***	0.115***
		(4.885)	(5.617)	(5.172)
RRP		-0.155***	-0.147***	-0.14***
		(-12.296)	(-11.71)	(-11.204)
IDV (country)			-0.076***	-0.028*
			(-5.38)	(-1.763)
IDV ind. diff.			-0.013	-0.013
			(-1.028)	(-1.09)
UAI (country)			-0.08***	-0.044***
			(-5.641)	(-2.805)
UAI ind. diff.			-0.015	-0.015
			(-1.19)	(-1.238)
LTO (country)			-0.098***	-0.089***
			(-7.689)	(-5.466)
LTO ind. diff.			0.029**	0.029**
			(2.359)	(2.385)
Africa				0.025*
				(1.722)
Anglo/American				0.064***
				(3.413)
Germ./Nordic				-0.034
				(-1.508)
East Asia				0.071***
				(3.679)
L.America				0.062***
				(3.665)
L.Europe				-0.005
				(-0.345)
E.Europe				-0.048**
				(-2.265)
Middle East				0.012
				(0.71)
R^2 (%)	5.9	9.2	10.6	12.2
Delta F^2	108.2***	6.7***	15.4***	13.3***

* =significant on 10% level, **significant on 5% level,
***significant on 1% level

* significant at 5% level; **significant at 1% level; t-values in brackets
Further controls: native dummy and economist dummy. Missing values were replaced by average values.

Table 4: Linear Regression of Long-term Discount Factor

Independent variables	Model 1	Model 2	Model 3	Model 4
age	0.034***	0.05***	0.059***	0.065***
	(2.647)	(3.872)	(4.533)	(4.721)
gender	0.019	0.008	0.007	0.004
	(1.498)	(0.583)	(0.512)	(0.268)
Interest rate 1 year	0.043***			
	(2.756)			
Private debt/GDP	0.123***			
	(6.477)			
easyness to obtain loan	0.054***			
	(3.219)			
inflation rate		0.006	0	0.01
		(0.347)	(-0.028)	(0.526)
Log(growth rate)		-0.092***	-0.099***	-0.098***
		(-6.135)	(-6.53)	(-6.341)
log(GDP/capita)		0.106***	0.115***	0.153***
		(5.667)	(6.039)	(6.613)
RRP		-0.052***	-0.057***	-0.057***
		(-4.04)	(-4.368)	(-4.355)
IDV (country)			-0.044***	-0.01
			(-3.006)	(-0.609)
IDV ind. diff.			0.01	0.01
			(0.789)	(0.756)
UAI (country)			0.029**	0.03*
			(1.991)	(1.85)
UAI ind. diff.			0.028**	0.028**
			(2.202)	(2.167)
LTO (country)			-0.03**	-0.072***
			(-2.307)	(-4.285)
LTO ind. diff.			-0.001	0
			(-0.04)	(0.02)
Africa				0.023
				(1.553)
Anglo/American				-0.007
				(-0.35)
Germ./Nordic				-0.032
				(-1.368)
East Asia				0.023
				(1.126)
L.America				0.087***
				(4.897)
L.Europe				0.011
				(0.704)
E.Europe				0.004
				(0.172)
Middle East				-0.017
				(-1.024)
R^2 (%)	2.6	3.5	4	4.6
Delta F^2	49.4***	-5.8***	5.0***	4.5***

* =significant on 10% level, **significant on 5% level,
***significant on 1% level

* significant at 5% level; **significant at 1% level; t-values in brackets
Further controls: native dummy and economist dummy. Missing values were replaced by average values.

and β). The effects, however, differ: for the waiting tendency, individualism and long-term orientation played an important role, on the country level, as well as on the individual level. The influence of long-term orientation was as predicted, but the effect of individualism was puzzling: it seemed that individualism induced more “patience” in the “wait-or-not” question. This seems to contradict the “cushion” hypothesis that would predict the opposite pattern. When looking, however, on β, the effect of individualism is as predicted by the cushion hypothesis: there is a negative effect of the mean individualism on the “patience” of a person, but no significant effect of its own individualism (as the “cushion” would be made of the people surrounding the subject, not by the subject itself). The discrepancy might therefore be due to some specific effect induced by the elicitation of the waiting tendency question that might call for further investigation.

Given that the evidence for the cushion hypothesis was mixed, we also tested for a competing hypothesis by Mahajna et al. (2008) who conjecture that lower income and low trust may have stronger influence than a collectivist culture on time and risk preferences. Since income data were not collected and there were no measurements for trust, this hypothesis could not be tested directly. In our questionnaire, we have included a “trust” question which asked participants to what extent they agree that “Most people can be trusted.” Therefore, we could test at the individual level, whether the degree of trust is related with the time discounting measurement, but we found no significant relationship.

Besides the cultural differences captured by the three aforementioned Hofstede dimensions, there are of course countless differences that cannot be captured that easily within a simple survey. We find strong evidence that these differences also affect time discounting in a significant way: including dummy variables with cultural clusters into the regression lead to significant coefficients, particular for the two "behavioral" time discounting questions. In general, East Asian and Anglo-American subjects showed *ceteris paribus* more "patience". For β, this also holds true for Latin Americans, whereas for the waiting tendency question Germanic/Nordic countries showed a significant amount of more "patience" than would be expected based on cultural dimensions, macroeconomic data and the other control variables.

These results suggest that beyond the cultural dimensions by Hofstede, further cultural differences are key to the understanding of the heterogeneity in time discounting.

3.2.3 Causal relation between culture and time preferences

We have seen that there are significant relations between culture, as measured by the Hofstede dimensions, and time preferences. Besides the obvious interpretation that culture forms preferences, it would be as conceivable that both are formed independently by underlying factors (besides economic conditions) or that culture is indeed influenced by time preferences.

To find support for a causal influence of culture on time preferences, we apply an instrumental variable approach. We use two variables that have already been used as instrumental variables for cultural dimensions: the distribution of blood types as a proxy for genetic and hence cultural distance, and the distribution of the main religions as a proxy for different cultural development in the past (Huang 2007, Spolaore & Wacziarg 2009, Guiso, Sapienza & Zingales 2009, Gorodnichenko & Roland 2010).

The distribution of blood types has been measured based on the percentage of the population in a country having the blood types A, B, AB and O.[8]

[8] Values for Croatia, Slovenia, Taiwan and Chile were not available and replaced with

Table 5: Results from the two-stage least-square regression for IDV on the waiting tendency for one month with instrumental variables based on the distributions of blood types and religions. The results are robust and suggest a causal influence of IDV on this time preference.

	Waiting tendency for the one month question					
	1	2	3	4	5	6
Instruments:						
Blood, l^1-distance	Yes	Yes	Yes	No	No	Yes
Blood, Mahalanobis	No	No	No	No	Yes	No
Religion, Euclidean	Yes	Yes	No	Yes	No	Yes
Religion, Mahalanobis	No	No	No	No	Yes	No
Controls:						
Age	-0.049*	-0.056**	-0.073**	-0.082**	-0.078*	-0.062**
Gender	0.018	0.015	0.019	0.022	0.019	0.015
log(GDP/capita)	0.196**	0.108**	0.087**	0.076	0.079	0.097**
log(growth rate)		-0.046	-0.04	-0.037	-0.02	-0.052*
Inflation		-0.099**	-0.087**	-0.081*	-0.07	-0.106**
RRP						-0.016
UAI						0.017
LTO						0.041*
IDV	0.558*	0.607**	1.072**	1.310**	1.401**	0.630**
(t-value)	(2.27)	(2.52)	(3.22)	(3.15)	(2.96)	(2.54)
F-statistics	40.8	31.1	20.6	16.5	12.1	19.9

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

A good instrumental variable is given by the l^1-distance between the blood type vectors, which is the sum of the absolute differences for each of the four types.

The difference of two countries with respect to the distribution of the main religions has been measured as the Euclidean distance between the vectors reflecting the percentage of protestants, catholics, orthodoxes, muslims, buddhists, jews and others in the countries, where the category "others" was normalized such that the sum of all categories added to one.

In both cases, "difference" has to be measured with respect to a base country. Since in both IDV and UAI Sweden showed in our sample the most extreme values (highest individuality and lowest uncertainty avoidance), we chose this country as benchmark.

As controls in our two-stage least-square regression we used first age, gender and log(GDP/capita) and then added inflation and log(growth rate). As robustness checks we applied both instrumental variables together and separately and applied the Mahalanobis distance as alternative metric for both blood types and religions.

We found one highly significant and robust regression result that suggests a causal relationship between IDV and the tendency to wait in the one-month question (see Tab. 5). This supports the influence of cultural differences at least on short-term time preferences.

3.2.4 Pace of time

We are, as pointed out before, not the first to study interactions between culture and time. We would like to point out another interesting connection to

the linguistically closest neighbors. Colombia and Mexico were excluded due to lack of data.

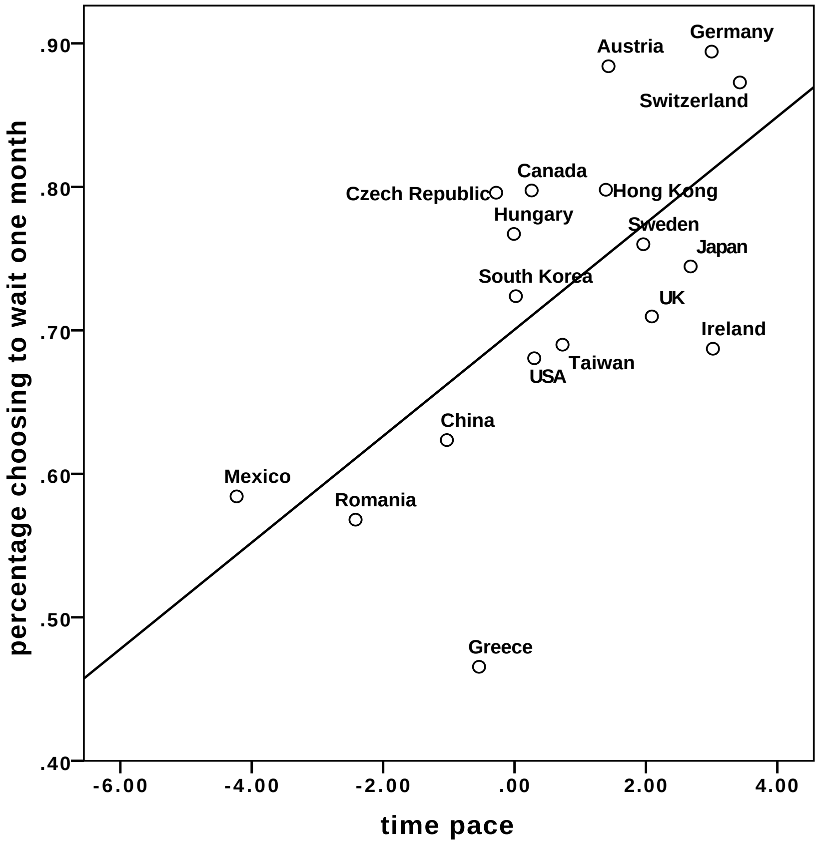

Figure 8: Correlation between Pace of Time and Waiting Tendency

previous work in social psychology. Robert Levine has defined and measured a concept which he called "pace of time" in a field study across 31 countries. This overall-pace measure is calculated out of three measures that could be obtained in most countries: walking speed, postal speed, and clock accuracy (Levine 1997). Interestingly, we find this measurement is highly correlated with our measured time preference ($r = 0.647$, $p = 0.002$) (see Figure 8). Furthermore, regression analysis shows that the time pace measure is significant even when we control for GDP per capita (see Table 6). This can be most likely understood by considering the discounting effect for disutilities:

Table 6: Logit regression of Time Pace on Waiting Tendency

	Percentage choosing to wait
GDP per cap	0.015
time pace	0.034*
Constant	0.654
N	18
R^2	42.1%

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

Note:

1. The independent variables "GDP per cap" is the natural logarithm of GDP (PPP) per capita in 2007.
2. The independent variable "time pace" is measured by Levine (1997) in his field study to capture the tempo and punctuality in a country. The higher score implies higher speed and more punctuality.

an "impatient" person would be very "patiently" procrastinating some dull or annoying tasks. This attitude would then manifest itself in slow walking speed, slow and inaccurate service and the tendency to postpone tedious tasks like adjusting a watch. We did not have such disutility questions in our survey, but other surveys found a strong correlation between impatience for rewards and procrastinating behavior for disutilities (Benzion et al. 1989).

4 Applications and Discussion

4.1 Examples for possible applications

In the following, we want to demonstrate the validity and potential usefulness of our data on two simple examples. Each of them could be taken as a starting point for further research, based on our survey data.

4.1.1 Innovation

In this section, as an example for possible applications of our data, we investigate whether we can predict a country's innovation capability by the measured patience. Technological change and innovation are often treated as exogenous variable in economic modeling. However, Romer (1990) argues that it can be endogenously determined. He points out that an increase in patience will increase research and thus economic growth, which is consistent with the intuition that one must forego some immediate benefits to invest in research and innovation, in order to get larger rewards in the future.

We test the relationship of patience with the "innovation factor" from the Global Competitive Report 2008-2009 (Porter & Schwab 2008). It measures the technological innovation of a country, in particular investment in research and development (R & D) in the private sector, the presence of high-quality scientific research institutions, collaboration in research between universities and industry, and the protection of intellectual property. We find a positive correlation between the response of our "wait-or-not" question with the innovation factor at the country level. Table 7 shows that after controlling the wealth level of the country, the response to the waiting question is still highly significant in predicting the innovation factor, so is the present bias parameter, but the long-term discount factor is not significant. This result suggests that although the wealth level (and hence a general level of a country's economy) is crucial to stimulate innovation, the attitude towards future also plays an important role. For example, while 69% of Taiwanese participants prefer to wait in the one-month question, only 44% of our Italian students prefer to wait. The two countries have the same GDP per capita in 2007, but Taiwan scored much higher in the innovation factor than Italy (5.26 vs. 4.19). It is worthwhile to investigate further to what extent and under what mechanism a general attitude towards future is related to the innovation activity.

Table 7: Country-level OLS Regression for Innovation Factor

	Dependent Variable Innovation Factor		
	(1)	(2)	(3)
Constant	2.362**	2.254**	2.235**
Choosing to wait	1.099**		
Present bias β		0.887**	
Long term discount δ			0.388
Log(GDP per cap)	0.483**	0.557**	0.651**
N	43	43	43
R^2	65.1%	61.8%	56.1%

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

Notes:

1.The dependent variable "innovation factor" is from Global Competitive Report 2008-2009 (Porter & Schwab 2008). It measures the technological innovation of a country, in particular investment in research and development (R&D) in private sectors, the presence of high-quality scientific research institutions, collaboration in research between universities and industry, and the protection of intellectual property.

2.Angola and Lebanon are excluded because of the lack of data for "Innovation factor."

3.The independent variable "choosing to wait," "present bias β," and "long-term discount" are transformed to Blom's proportion estimate to reduce the impacts of outliers.

4.1.2 Environmental sustainability

Studies have revealed that time preference is related to the practice of environmental preservation. For example, farmers who discount the future more strongly were less likely to use soil conservation measures (Yesuf & Bluffstone 2008). Since the wealth level is one important determinant of time preference, one may argue that we should focus on poverty reduction to make people discount the future less. However, it is not clear to what extent time preference per se is a driving factor for a lack of environmental concern. We illustrate a regression analysis to examine the relative impacts of a country's wealth level (as measured by GDP per capita) and the average patience level (as measured by our first survey question). The dependent variable is the "percentage of total land area under protected status" from the report of Environmental Sustainability Index by Esty, Levy, Srebotnjak & de Sherbinin (2005). This measure represents an investment by the country in biodiversity conservation, which is important for a sustainable environment. Column one in Table 8 demonstrates an interesting result in that our measured time preference has an significant impact on protected area at the country level, whereas GDP per capita is not significant in this model. Columns (3) and (4) show that the estimated parameter values from the hyperbolic discounting model, however, are not significant when GDP is controlled. Column (4) substitutes subjective time-preference measures with the objective inflation rate, which turns out to be insignificant. The relatively low R^2 can be attributed to measurement errors, as well as other important variables that are not included in the model. On the other hand, it is clear that our measured waiting tendency improves the model substantially (R^2 increases from 15% to 25%). We also used an alternative measure from the report of Environmental Sustainability Index by Esty et al. (2005), namely "the ratio of gasoline price to world average" as dependent variable, and obtained similar results, although at less significant level.[9] Our finding is in line with the experimental study by Hardisty & Weber (2009), where they find that people discount environmental outcomes in a similar way to monetary outcomes. This would help policy makers to understand societal discount rates across countries.

4.2 Future directions

Our survey is a first attempt to collect large-scale empirical data on country-level variations of time preferences. It is to our knowledge the largest international survey of this kind. We have documented the systematic variation in time preferences, as compared to the situational and cultural factors of the countries. Several independent variables in our regression models were endogenous. Ideally, the parameters should have been estimated by using a simultaneous equation system. With our cross-section data, it is difficult to identify instrumental or lagged variables for such analysis. If time series data could be collected in the future, then one might gain more insights about the causal relationships. To compare our findings with parallel studies on the cross-country comparisons on market-level behavior (e.g., equity premium, price kernel, volatility) would be extremely helpful for cross-validation and generalization of what has been found.

We have illustrated two applications that use time preference to predict more general phenomena at the country level, such as innovation and environmental preservation. Although the analysis illustrated above is simple in

[9] The logic behind this index is that unsubsidized gasoline prices are an indicator that appropriate price signals are being sent and that environmental externalities have been internalized. High taxes on gasoline act as an incentive for public transportation use and development of alternative fuels.

Table 8: Country-level OLS Regression for Environmental Sustainability

	Dependent Variable Percentage of Protected Area			
	(1)	(2)	(3)	(4)
Constant	-0.001	-1.303	-1.022	5.176
Choosing to wait	12.530*			
Present bias β		-1.784		
Long term discount δ			-4.811	
Inflation Rate				-0.510
Log(GDP per cap)	1.557	4.478*	4.932*	2.667
N	43	43	43	43
R^2	24.6%	14.4%	15.9%	15.9%

* significant at 5% level

Notes:

1. The dependent variable "Protected area" is taken from the report of 2005 Environmental Sustainability Index by Esty et al. (2005). It measures the percentage of total land area under protected status. The logic is that the percentage of land area dedicated to protected areas represents an investment by country in biodiversity conservation .

2. Hong Kong is excluded because of the lack of data for "Protected area." Colombia is excluded because of its extremely high value which distorts the model.

3. The independent variable "choosing to wait," "present bias β," and "long-term discount" are transformed to Blom's proportion estimate to reduce the impacts of outliers.

its kind, we hope that it can stimulate more in-depth cross-sectional studies in this direction. Further applications are conceivable. For example, Buiter (1981) presents a theoretical model using country-level time preference to explain the capital movement between countries. The model has not been tested empirically. Shiller (1999) suggests intergenerational and international risk sharing in pension system, and emphasizes that the international risk sharing is rarely discussed. Empirical evidence of the degree of time discounting across countries can be an important input for such discussions. We believe that systematic investigations and documentations of time preference across countries will deepen our understanding of the discrepancies across countries, and provide policy makers with useful advice for development at the global level.

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A Proofs of mathematical results

Proof of Proposition 1:

Consider two different growth rates g and g' with $g' > g$. If X and X' are the payoffs at time $t+1$ that make the agent indifferent in the respective situations then we obtain the following two equations from (1):

$$u(w_t) + \delta u(w_t g + X) - u(w_t + A) - \delta u(w_t g) = 0,$$
$$u(w_t) + \delta u(w_t g' + X') - u(w_t + A) - \delta u(w_t g') = 0.$$

Combining these two equations and dividing by δ we obtain

$$u(w_t g + X) - u(w_t g) = u(w_t g' + X') - u(w_t g').$$

Due to the strict concavity of u we have

$$u(w_t g + X) - u(w_t g) > u(w_t g' + X) - u(w_t g').$$

Taking both together we conclude that $X' > X$. □

Proof of Proposition 2:

We start from equation (1) and divide by $1 + \delta$. This gives

$$\frac{1}{1+\delta}u(w + A) + \frac{\delta}{1+\delta}u(wg) = \frac{1}{1+\delta}u(w) + \frac{\delta}{1+\delta}u(wg + X).$$

We can reinterpret this equation as an indifference of an expected utility maximizer between the following two lotteries:

$\frac{1}{1+\delta}$	$w+A$
$\frac{\delta}{1+\delta}$	wg

$\frac{1}{1+\delta}$	w
$\frac{\delta}{1+\delta}$	$wg+X$

If risk aversion increases (e.g. if in $u(x) = x^\alpha/\alpha$ and α decreases) then the more risky lottery (which is the second one since $w < w+A$, $wg+X > wg$ and $wg > w$) becomes less attractive, thus X needs to be higher to compensate that: we see more time discounting. □

Proof of Proposition 3:

We start from equation (1) and divide by $1+\delta$. This gives

$$\frac{1}{1+\delta}u(w+A) + \frac{\delta}{1+\delta}u(wg) = \frac{1}{1+\delta}u(w) + \frac{\delta}{1+\delta}u(wg+X).$$

As in the proof of Proposition 2 we can reinterpret this equation as an indifference of an expected utility maximizer between two lotteries.

The payoffs and probabilities in these lotteries do not depend on w. Therefore, when we increase w, the preference between them will be constant if and only if the utility function u has constant absolute risk aversion (CARA). If u has constant relative risk aversion (CRRA), then it has in particular decreasing absolute risk aversion (DARA) and therefore the more risky lottery will be become more attractive when w increases. Hence, to keep indifference, we have to lower X. This implies that increasing w leads to less time discounting. □