

Term structure of psychological interest rate: A behavioural test

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05/06/09

First version, do not quote, comments welcome

Abstract

The subjective value given to time, also known as the psychological interest rate, or the subjective price of time, is a core concept of the microeconomic choices. Individual decisions using a unique and constant subjective interest rate will refer to an exponential discounting function. However, many empirical and behavioural studies underline the idea of a non-flat term structure of subjective interest rates with a decreasing slope.

Using an empirical test this paper aims at identifying in individual behaviours if agents see their psychological value of time decreasing or not. A sample of 243 individuals was questioned with regard to their time preference attitudes. We show that the subjective interest rates follow a negatively sloped term structure. It can be parameterized using two variables, one specifying the instantaneous time preference, the other characterizing the slope of the term structure. A trade-off law called “balancing pressure law” is identified between these two parameters. We show that the term structure of psychological rates depends strongly on gender, but appears not linked with life expectancy. In that sense, individual subjective time preference is not exposed to a *tempus fugit* effect. We also question the cross relation between risk aversion and time preference. On the theoretical ground, they stand as two different and independent dimensions of choices. However, empirically, both time preference attitude and slope seem directly influenced by the risk attitude.

Keywords: subjective interest rate, time preference, behavioural economics, psychological time value.

JEL classification: C9, D03, D91

Introduction

If risk aversion is an important feature of economic and financial behaviours, the attitude of an agent with regard to time is also fundamental. The subjective value given to time, also known as the subjective interest rate or the subjective price of time, is identified as a core concept of the microeconomic literature. It is a fundamental parameter which enters into economic or financial choices. We know that choices are comparisons between pleasures and pains (Bentham, *Introduction to the Principles of Morals and Legislation*, 1789) which are estimated at different time, now and in the future. The weighting factor of choices that makes preferences is subjective utility. The time dimension is rooted in the economic process of choice because different periods are considered. This is why we need to consider not only a subjective interest rate to discount the future utility, but several subjective interest rates allowing to define a subjective or psychological discount function. There is a difference between the subjective interest rate, which is a variable used by an agent to discount his future utility, and the time preference hypothesis. The latter refers to the idea that an agent has a « *preference for immediate utility compared with a future utility* » (Frederick et al., 2002, p. 351). We suppose here that the economically rational agent has a positive subjective interest rate. He discounts future utility¹. As a consequence, the time preference hypothesis implies that the rational agent (i) needs to subjectively evaluate time, (ii) discounts future utility and (iii) develops a set of multitemporal choices. Moreover, the subjective interest rate is often submitted to an additional hypothesis: it is assumed to be constant whatever the age of the individual or the time horizon considered in the choice. This is the standard micro-economic setting of individual choices. Combined with the hypothesis of time invariance of preferences (involving time separable utility function), it leads to the classical model of maximisation of the sum of discounted future utilities, as introduced by Samuelson (1937). Individual decisions using a unique and constant subjective interest rate will refer to an exponential discounting function. In equilibrium models of consumptions-investment choices are specified with regard to a representative agent, what allows to consider available aggregated variables.

¹ The opposite idea of a negative subjective interest rate would be rather strange. In such a framework, between food now and food tomorrow, the individual will systematically prefer food tomorrow. The agent will not accept any pleasure today and his utility improves if he abstains consuming and abstract from the real world today. It will be difficult for a simple human being, except if he anticipates a resurrection program.

The hypothesis of a unique and constant subjective interest rate is very useful for further modelling and empirical test. Using market equilibrium variables or the aggregate values of investment of a representative agent is easy. However, it deserves a very poor view of intertemporal choice setting by individuals. Many empirical and behavioural studies underline the idea of a non-flat term structure of subjective interest rates with a decreasing slope. This hypothesis has to be crossed with individual behaviours.

This paper aims at identifying if agents see their psychological value of time decreasing or not. We questioned a sample of 243 individuals to analyse their attitude with regard to time². They should give to time different psychological values at different moment in the future. The difficulty here is to stay at the psychological value level and not to question a monetary value of time. Public interest rates are social prices of time in a market and appear as alternative saving or investment goods. Here, we want to question, not the utility of saving goods or financial assets, but the intertemporal comparison of personal utilities (whatever they come from). The psychological value of time derives from the individual perception of choices between the current “self” of the individual at time t and his futures “selves” at time $t+1, t+2\dots$. We show that the subjective interest rates are specific to each individual. They have a decreasing form coherent with a negatively sloped term structure. They can be parameterized using two individual parameters, one specifying the immediate term preference, the other characterizing the slope. A trade-off law is documented between the two parameters, which appear to follow a log-log relationship common to any individuals. The term structure of psychological interest rates does not appear linked with life expectancy, but strongly depends on gender. Individual subjective time preference does not show a tempus fugit effect.

The individual preferences are conditioned by few variables. Cross relation between risk aversion and time preference, is often questioned, at least on the theoretical ground..They stand as two different and independent dimensions. Empirically, time preference attitude and slope seem directly influenced by the attitude with regard to risk.

The following paper is divided into 5 Sections. The first one presents a review of literature. Section 2 introduces the concept of free time and the questionnaire. Section 3 gives

² I thank Florent Pralong for his help in designing the questionnaire.

the results and tests some assumptions. Section 4 estimates the term structure of subjective interest rates. The determinant variables explaining the subjective interest rates are analyzed in Section 5.

1- Literature

Samuelson (1937) developed a normative model of intertemporal choice using the discounted value of expected future utility. The idea is that an individual maximise a set of utilities at different current and future periods. Referring to a “time separation” hypothesis, each periodic and specific future utility can be discounted. Individual choice will result from the combination of the utility dimension (which is itself influenced by the attitude toward risk) and the time dimension. The individual psychological price of time, also referred as the rate of impatience, is an economic variable *per se* needed to build economic choices. Discounting the consequence of future decision is at the heart of individual behaviours according the standard micro-economic theory. The agent considers globally current and future expected utility, the later forecasted using available information. Samuelson introduces an identical subjective rate of interest that results in a simple exponential discounting function in the standard microeconomic model.

$$Max \quad E_0 \left[\sum_{t=0}^{\infty} \delta^t U(C_t) \right] \quad (1)$$

δ : annual constant psychological discount factor

C_t : consumption at period t

$U(C_t)$: consumption utility

The Consumption Capital Asset Pricing Model (CCAPM) develops the model of intertemporal choices between consumption and investment seen as future delayed consumption. Financial assets are tools to transfer wealth in the future. Their expected return allows evaluating the individual’s future wealth. Hansen and Singleton (1983) and Breeden (1986) used a constant and unique psychological interest rate. If we focus on pure one period risk free assets, future wealth invested in this asset can be devoted with certainty to future

consumption. Hansen and Singleton show that the risk free interest rate in the market should verify³:

$$r_1 = -\log \delta + \alpha \cdot E_0(\Delta c_1) - \frac{1}{2} \alpha^2 \sigma_c^2 \quad (2)$$

The CCAPM model draws important conclusions. The one period risk free interest rate is linear in the forecasted consumption growth Δc . The slope coefficient is equal to the risk aversion coefficient. Equation (2) can be inverted to derive the expected growth of consumption of the time horizon as a linear function of the equilibrium risk free rate in the market. The slope is then $\psi = 1/\alpha$. The relation between consumption growth and moves in risk free interest rates in the market defines the elasticity of intertemporal substitution (EIS). This measures the influence of a move in interest rate on the dynamics of the consumption path. The standard "exponential EIS" derived from (2) is :

$$EIS_{\text{exp}} = \frac{\partial \log\left(\frac{C_1}{C_0}\right)}{\partial \log(R_1)} = \frac{1}{\alpha} \quad (3)$$

It follows that, in the standard exponential setting of the time discount function, risk aversion coefficient and EIS are pure inverse. The exponential setting implies a confusion between these two concepts. This is very questionable since EIS captures the attitude with regard to time (i.e. the relative willingness to accept a delay in consumption). This is different from the attitude with regard to a risky future stochastic consumption. Epstein et Zin (1989) underline the necessity to introduce a difference between the two concepts: « *An important feature of these general preference is that they permit risk attitudes to be disentangled from the degree of intertemporal substitutability* ». Following their approach, Epstein and Zin (1991) and Weil (1989) developed models with no conceptual link between the coefficient of risk aversion and EIS.

Looking back to neoclassical economists, the Von Mises (1949) analysis of time rationality appears at the same time very promising and largely ignored. He states that « *It is*

³ Equation (2) was evidenced by Hansen and Singleton (1983) and Breeden (1986). A power utility function is used. This relation obtains assuming that consumption and returns are jointly and lognormally distributed. Lower case are logarithms. The consumption volatility is supposed non conditional.

no less impermissible to differentiate between rational and allegedly irrational acting on the basis of a comparison of real acting with earlier drafts and plans for future actions. It may be very interesting that yesterday goals were set for today's acting other than those really aimed at today. But yesterday's plans do not provide us with any more objective and non arbitrary standard for the appraisal of today's real acting than any other ideas and norms”⁴. Past choices have been decided using given information at that time, a rational agent will use a different one to decide now. Between the two, there are new facts and information which are the ex post consequences of yesterday's choices. He adds « Constancy and rationality are entirely different notions. If one's valuations have changed, unremitting faithfulness to the once espoused principles of action merely for the sake of constancy would not be rational but simply stubborn” »⁵. The idea of time constancy is here new.

Time is a specific dimension in the process of decision. *« In any case action can influence only the future, never the present that with every infinitesimal fraction of a second sinks down into the past. Man becomes conscious of time when he plans to convert a less satisfactory present state into a more satisfactory future state »⁶. Time is an economic valuable dimension. Von Mises recognizes the time preference hypothesis⁷. He consequently mentions that individuals give a psychological value to time and their impatience rate should not be assimilated with the interest rates in the financial markets. These last are social price of time and are used to compare alternative consumption and investment opportunities. The psychological interest rate is used to discount subjective evaluation by individuals in their calculus, what he calls « economization ». For him, « The economization of time is independent of the economization of economic goods and services. Even in the land of Cockaigne man would be forced to economize time, provided he were not immortal and not endowed with eternal youth and indestructible health and vigor. Although all his appetites could be satisfied immediately without any expenditure of labor, he would have to arrange his time schedule, as there are states of satisfaction which are incompatible and cannot be consummated at the same time. For this man, too, time would be scarce and subject to the aspect of sooner and later »⁸. The analysis of the variables which may explain the individual time preference is very rich: remaining duration of life, health, youth will condition the level*

⁴ Ouvr. cit., chap 5, p.102-103.

⁵ Ouvr. cit., chap. 5, p.103..

⁶ Ouvr. cit., chap. 5 p. 100.

⁷ Ouvr. cit. chap 18, p. 481. “Time preference is a categorial requisite of human action”.

⁸ Ouvr. cit chap 5, p. 102.

of the subjective interest rates. This approach opens the way to subjective interest rates, which are variable through time for the same individual according his expected duration of life or his health. This is the first mention of a possible terms structure in the psychological value of time. Later and independently, this theoretical hypothesis was reinforced by empirical research questioning the exponential discount function.

Empirical tests were developed to see if the individual subjective interest rates are constant whatever the time horizon of the choice. These tests will generally invalidate the idea of flat impatience rates and lead to the conclusion of a decreasing term structure. Thaler (1981), was among the first to sustain that hypothesis by questioning individuals : “Which amount in respectively 1 month, 1 year or 10 years will you judge equivalent to 15 dollars now?” The median answers were 20\$ in 1 month, 50\$ in 1 year, and 100\$ in 10 years. Thaler deduced a decreasing term structure of impatience rate with values of 345% for the one month horizon, 220% for the one year and 15% for the 10 years.

Experimental tests of the psychological discount function have been made on human individuals or animals by psychologists or psychiatrists. Chung and Herrnstein (1961) draw the conclusion that a decreasing hyperbola fits well the time preference function of animals. Considering human individuals, Ainslie (1992) and Loewenstein and Prelec (1992) propose to model discount functions as hyperbolic curve $\delta(t)=(1+\alpha.t)^{-\gamma/\alpha}$, with t the time horizon. These functions will involve psychological interest rate curves following the equation:

$$-\frac{\frac{\partial}{\partial t}((1+\alpha.t)^{-\gamma/\alpha})}{(1+\alpha.t)^{-\gamma/\alpha}} = \frac{\gamma}{(1+\alpha.t)} \quad (4)$$

These curves are decreasing. The immediate subjective interest rate is equal to the parameter γ . Long-term psychological rates converge toward zero.

The decreasing term structure as suggested by a hyperbolic model, will entail overdiscounting the immediate future vis-à-vis with the far distant future. On the other hand a flat term structure will ceteris paribus results in overdiscounting the far future. The characteristics of hyperbolic (or any decreasing) subjective term structure is that the long term future accounts *relatively* more in solving the dynamic choice problems than the short term

future. At the limit, a myopic individual who considers only the current period and the following next one will need only a short-term discount rate for the next period and is not concerned by the time inconsistency problem for onward periods (Loewenstein et Prelec, 1992). Laibson (1996) suggests to use a « quasi-hyperbolic » discount function which refers to two parameters: the standard discount coefficient δ and a second parameter $\beta < 1$. At period $t=1$, the discount coefficient is $\beta \cdot \delta$. The following coefficients are multiplied by the unique β coefficients. It results in a discrete discount function $\{1, \beta \cdot \delta, \beta \delta^2, \beta \cdot \delta^3 \dots\}$. Laibson (1996) shows that the EIS in a hyperbolic world is effectively lower than the inverted value of the risk aversion coefficient α . He was one of the first to mention that economic agents are more impatient when they do short-term arbitrage than when they make economic choices in long-term horizon.

The behavioural dimension of the subjective interest rates

The theoretical problem with a non-flat term structure of psychological interest rates is their time inconsistency. The sequences of economic choices are ex ante incoherent, which is not rational in the homo economicus setting. The optimal choices which are calculated for period t using a discount factor $\delta(t)$ are not the same that will be preferred one period later using a factor $\delta(t-1)$ and discounted. Strotz (1956) underlined that ex ante the two sequences of the consumption plans are dynamically incoherent. Time consistent setting of present and future consumptions using the available information implies that individuals cannot be irrational. Then the (only) simple solution is that psychological interest rates should be constant. However, in a situation of dynamic time inconsistent plans, intertemporal choices can also be analyzed as a conflict between different economically calculating agents, living in the same individual. As Laibson (1996) points out the « self » who decides at time t , enters in a strategic game with the optimising « self » at time $t+1$. Multiples « selves » model is a way to cope with the « time inconsistency » consequence involved by non-flat psychological interest rates. Multiples “selves” is a psychological concept that allows characterizing the peculiar nature of intertemporal choices (Frederick et al., 2002). On another hand, time inconsistency may also derive from evolving preference functions as “changing taste” preferences”.

Thaler and Shefrin (1981) introduces multiple selves in a non-formalised way, which do not lead to testable hypothesis. They analyzed the consistency of temporal choices in a

theory of « self-control ». The agent has two “selves” in a conflict. The same individual is supposed to be at the same time a « planner » who organises his consumption-investment choices looking at the long-term and a myopic agent doing choices on the very short-term horizon (“doer”). The “doer” optimises looking only at the next period. A conflict arises between the two different series of preferences. Thaler and Shefrin (1981) sets an analogy with the agency conflict between the manager and shareholders in a firm. The agent’s « self control » is a way to reduce the conflict between the planner’s self and the doer’s self. The only way for the planner to modify the myopic doer’s behaviour is to control his behaviour. This can be done either by modifying his preferences, or by imposing constraints or commitment rules to curb his choices. The devices to curb the behaviour are classically incentives or rules. For instance, looking at trade-off between consumption and investment, incentives may influence the behaviour of the myopic agent by giving a strong moral and ethical value to saving. Self-limitation rules may be set to limit consumption and favour abstinence (equivalent to “hungry-cuts” for people who wants to follow a diet regime). Other rules can be commitments to save, following for instance rules to save a given percentage of one’s income, or to forbid borrowing, or to subscribe mandatory pension plans...Laibson (1996) referring to his « quasi-hyperbolic » discount function shows under restrictive conditions that the time consistency condition can be met between economics choices made by one’s « self » at period t and one’s « self » at period $t+1$ in the future. The economic rule they should follow is compatible and is the same: at any period, the individual should respect a saving rule and invest a given deterministic percentage of his wealth. This result needs to assume that the rate of return of investment is identical and constant whatever the time horizon.

Kahneman (1994) introduces a distinction between the “decision utility” which results from choices consciously made by an individual, more precisely the consequences of his choices, and the « experienced utility ». The latter stands at the global level of an individual’s well being. The difference between the two refers to “basic” needs and psychological concerns of human beings (Frederick et al., 2002). In a behavioural approach, there are indirect utility elements that are exogenously given, received or inherited from the context of the individual, or can also be indirect consequence of his choices. These elements will depend on the context of the individual, from previous choices, from pure random externalities and from tensions between the different “selves” that make a personality and a character. The individual context links past to future choices. In the economic dimension, the difference

between “decision utility” and “experienced utility” is a difference in linkage with a decision made at time t ; it suggests that the instantaneous utility function is not constant.

In a behavioural approach, “time separability” exists and means that the individual can identify the instantaneous utilities from which he can build his global utility: the latter is “the temporal integral of some transformation of instant utility”⁹. The temporal aggregation means that the individual can compare two instantaneous utilities at different time periods by evaluating which one have the most important hedonic value. We still are in a psychological economic rational of preferences. Kahneman et al. (1997) use the concept of value or preference and not the one of discount coefficient or subjective time preference. This “transformation” of the instantaneous utility seems close to the idea of present value (art. cit., p. 391) ; but Kahneman et al. do not question the aggregation function which leads to a cardinal global utility. The axiom 3 of Kahneman et al. (1997) recognizes the time separability of these instantaneous utilities: for them, it is fundamental that these instantaneous utilities are “sufficient statistic”, “in that sense that all the information needed to evaluate the goodness of an episode may be incorporated in its utility profile”¹⁰. On another hand, Kahneman et Riis (2005, p. 8) add that “time is the last human resource of his life and find a way to use it at best is an important goal both for the individual involved in his well-being and at the level of social choices aiming at human well-being”. This leads to the idea of time preference or positive psychological time value. This also entails questions on the upper limit in aggregating future instantaneous utilities. The end of human life imposes a limit in the definition of his time personality. The successors of the agent (heirs, global society...) are not his economic “selves”. His identity at the end will die and be replaced by other actors and other preferences. It does not imply that the agent is indifferent to what can happen after his death. He can derive utility in transmitting wealth or economic goods. His successors (if any and ex ante identified) have different personalities and preferences.

The idea of identity is the one of consciousness of the structure of one’s preference: Is the agent conscious of the stability/unstability of his tastes? Am I now the same as I was yesterday? Will I be the same tomorrow? There are as much strengths of differentiation and of continuity between the « selves » of the same individual within time than between different agents close each other and living at the same time in the same social group. In analysing

⁹ Cf. Kahneman *et al.* (1997), p. 388.

¹⁰ Cf. Kahneman *et al.* (1997), p. 390.

economic behaviour, discounting temporal preferences is as rational as socially aggregating individual preferences. According to Frederick (2006): “*It may be just as rational to discount one’s (self) future utility, as to discount the utility of another distinct individual, because the distinction between the stage of one’s life may be as deep as the distinction between individuals*”¹¹.

Experimental studies have privileged individual choices and answers. In that sense, they convey more information than looking at aggregated market data. Feather and Shaw (1999) try to evaluate the leisure opportunity cost of beach sports. The latter is traditionally estimated as a fraction of the wage rate. A problem rises for individuals who are not employed and have no observables wages. The demand for leisure will depend jointly on the pure time preference and on the wage rate. The time devoted to work is not a discretionary continuous variable that an agent may easily optimize. Feather and Shaw underline that the “value of time” is not only given by a trade-off with the wage rate. It depends also on other hedonic variables. An estimate of the “shadow price of leisure time” is proposed by Lew et Larson (2005) in their evaluation of the discretionary wage. This concept assumes that the agent stands at his equilibrium between work and leisure and can trade-off. The evaluation of the leisure consumption is stochastic and is empirically estimated with regard to the consumption of leisure on Californian beaches. The implicit prices of leisure time are very different. They are high for employed or over-employed individuals, and lower for retired, unemployed and students individuals. Warner and Pleeter (2001) analyzed the choices made by 60,000 American army members who were proposed to leave the army receiving life annuity or an immediate indemnity. The actuarial rate used to define the annual cash flow was 17.5%, at a time where the interest rate offered in the financial market was 7%. The annual cash flow choice appeared financially better than the spot down payment. The empirical study showed that half of officers and around 10% of soldiers and civil employees chose the annual instalments. This result evidences a very strong individual preference for the present time. The estimates of psychological interest rate of army members by Warner and Pleeter were between 24% and 42%.

Shapiro (2005) made an empirical study of American individuals who benefited from a free allocation of « food stamps ». These subsidies are monthly granted. It is shown that the

¹¹ Cf. art cit. p.674.

caloric consumption of beneficiary people decreased between 10 and 15% during the month. This implies a strong short-term preference. Calibrating a time preference function of a logarithmic agent, Shapiro gets a daily subjective time discount coefficient of 0.996. Under the hypothesis of an exponential discount function, it is equivalent to an annual discount coefficient of 0.23 on a one-year horizon, i.e. a subjective interest rate of 320% per year. This estimate is viewed as too strong, so Shapiro questions the exponential subjective impatience hypothesis and uses the Laibson (1996)'s quasi-hyperbolic function to calibrate the data. With an estimated β of 0.96, he concludes that a hyperbolic function is a better suit with high interest rates on the short-term end of the time preference curve. Kurz et al. (1973) using a simple questionnaire concludes that the annual subjective interest rate belong to the 36% to 76% range. Thaler and Shefrin (1981) also asked a very simple question: « Which money bonus do you want now instead of a 100 dollars bonus in one year period? ». They highlight the influence of conditioning variables such as age, le income level, the marital status. They insist on the relation between age and maturity: Young people have to learn and internalize the technique of behavioural self-control. Social categories are also important to explain the subjective interest rate. Thaler and Shefrin evoke a decreasing structure of subjective interest rates. In the long-term agents are relatively more patient: for instance, I prefer two apples within 101 days from now than one apple within 100 days. However, in a short-term view, the rate of impatience is different: I prefer one apple now than two apples tomorrow. Frederick et al. (2002) collected the estimates of subjective discount factor resulting from thirty experimental studies. They cross these subjective values of time with the time horizon of choices ranging from the very short-term (10 dollars now versus X dollars tomorrow) to the very long-term (10 dollars now versus Y dollars in 10 years). The average discount factors (average subjective interest rate) shows an increasing (decreasing) structure with the time horizon term structure. Frederick et al. point out that questions based on money comparisons may be polluted with the idea of interest rate, which is a social and marketable price of time and not a subjective time preference used by individuals to set their personal choices.

A lot of experiments and studies tried to identify the conditioning variable explaining the individual time preference attitudes. The influencing variables are:

- *Smoking attitude* : smokers have a psychological price of time which appear higher as compared with non smokers (Backer *et al.*, 2003, Kirby and Perty, 2004, Ohmura *et al.*, 2005).

- *Alcohol dependancy* : alcoholics have a larger psychological price of time. Serious alcoholics discount more the future gains than former alcoholics (Petry, 2001a, Bjork *et al.*, 2004). The same is true for drug addicted people (Bretteville-Jensen, 1999, Kirby and Petry, 2004)
- *Age* : Young people are moderately patient (i.e. have a low psychological price of time). Patience increases with age and senior people have a larger psychological price of time (i.e a lower discount factor) (Green *et al.*, 1994). Life expectancy appears to influence and attenuate the relation with age.
- *Cognitive ability* : Frederick (2005) shows the influence of cognitive abilities. In his test he uses an index of “cognitive refection” (CRT, “*Cognitive reflection test*”) which spans the difference of behaviour between individuals who behaves intuitively without taking the time for reflection and those who acts taking the time for analysing and evaluating the choices. The CRT index is crossed with both dimensions of time preference and risk aversion using a sample of 3,428 respondents. A positive relation between the CRT index and patience is highlighted: high cognitive reflection people are also more patient. A link is identified with risk attitude: people with a high CRT index are more prone to risk.
- *Gender* is a fundamental characteristic in psychological valuation of time. For instance, Frederick (2005) shows that women have a lower CRT index (correlated with impatience and a higher time preference) than men.
- *Risk aversion* seems to play a role. According to Frederick (2005), there is a common factor behind time preference and risk aversion. This hypothesis is important because it would mean that the two dimensions of risk aversion and time preference may be linked in human choices.

2-The concept of free time and questionnaire

One important issue when dealing with individual time preference is to know if question and choices have to be set in monetary units or not. Using money equivalent places the individual in a framework of consumption power and lead to underestimate the answer. People are systematically exposed to confusion with saving decision and interest rates. Comparing money amounts now and later in the future is a saving choice and that decision is polluted by the existing possibility to defer power consumption using exiting market interest

rates. The pure time preference is independent of the content of current and future choices between consumption and saving. We should compare the utility of consuming a good now and the utility of consuming the same good in the future. Cairns and Van Der Poole (2000, 2002) first used questionnaires with questions comparing of money amounts. Later they privileged studies without any reference to money and comparing the possibility to defer further in the future a disease.

The psychological value of time is the discounted factor applied to choice involving the future. This element is crucial in the dimension of intertemporal comparison at different time. The valuation ratio of two (utility) choices has not a value in itself; it has a value relatively to individual choices. It is not a general and shared price; it is a subjective ratio that should not be expressed in monetary unit. Time is an open window for present and future choices and maybe future utility. Deferring or accelerating these choices expresses the personal value given to time. The idea of “free time” is used to identify an extra opportunity opened to individual to make new choices now or in the future. It does not say anything on the content of these choices. When comparing two apples in the future and one apple now, comparison develops within the framework of the utility of a given choice, i.e to eat an apple. This involves the specific utility of an apple for someone who is found of apple or the one of another individual who hates apples. The idea of marginal free time opens the space for new choices and additional utility independently of the contents of choice and the utility of the decision made within this new deferred opportunity to act economically. This free time is a window to enter into new economical and behavioural choices. It is not *per se* a set of substantial choices. It may have no value; it is not automatically linked to consumption of goods, additional time to work or salary. The unit is one hour of free time, not its value in euro.

An additional hour of free time at period t is compared with an additional hours of free time later. The hypothesis of time preference means that an hour of free time now is more valuable than one hour of free time later in the future. The relative ratio between the two gives an implicit price that is the individual’s subjective interest rate.

The questionnaire

The form (see annex) is structured in four blocks of questions. It has been anonymously submitted to individuals. The first block of questions (block S) are questions about the characteristics of the respondent. Characteristics are unambiguous: date of birth, gender, place of birth, native language... Questions related to attitude and behaviour covers the perception of the time, the importance to give something to heirs; three questions are devoted to the attitude versus risk and risk aversion (S21, S22, S23). Two questions propose a traditional choice between an uncertain lottery and a certain income. Personal attitude vis-à-vis the risk is asked through a scale between risk-lovers and absolute risk averters.

The A block of questions introduce the idea of “free time”. What we want to analyse is the attitude vis-à-vis a pure space of time open to any economical or behavioural choice. When giving the form to respondents, we introduced orally the questionnaire by saying: “imagine that a day is now 25 hours instead of 24, what is the importance of that extra new hour for you?” We want to identify individual preference for an extra space of choices before these choices are effectively made. In that sense we do not need to rely on rational assumption linked to choices. We stand before choices and valuation of their utility. We want to compare the preferences of this extra window of space for new choices between for instance now and X years in the future. Respondents were asked to compare a set of free time now and a set of free time in a given period of the future.

- A1.-Will you prefer 1 extra hour of free time now or 2 hours of free time in 1 year?
- A2. -Will you prefer 1 extra hour of free time now or 5 hours of free time in 5 year?
- A3. -Will you prefer 1 extra hour of free time in 1 year or 5 hours of free time in 6 year?
- A4. -Will you prefer 2 extra hours of free time in 10 years or a set of 1 hours of free time now and 1 hour of free time in 20 years?
- A5. -Will you prefer 4 extra hours of free time in 10 years or a set of 1 hours of free time now and 1 hour of free time in 20 years?
- A6. -Will you prefer 2 extra hours of free time in 5 years or a set of 1 hours of free time now and 1 hour of free time in 20 years?
- A7. -Will you prefer a set of 1 extra hour of free time now and 1 hour of free time in 20 years or 2 hours of free time in 10 years?

A8 -Will you prefer to have in 10 years 2 hours of extra free time for you or to get in 10 years a set of one hour of free time for you and 1 hour of free time for one of your relatives?

Table 1 –Block A questions

(Answers with 3 alternate choices: choice of the first alternative, choice of the second alternative and indifference between the two. Indifferent choices will not be considered in the analysis)

The B block is a series of six questions on the relative value of one hour of free time in the future compared with one hour of free time now. Nine ordinal choices are proposed linked with range of values expressed in number of hours. For instance, item 3 refers to a range of [2 to 6] hours. Respondents were asked to compare one hour of free time now and X hours in the future. By checking the item 3, it means that one hour of free time now is considered by the respondent as equivalent to 2 to 6 hours in the future. Different time horizons are questioned: 1 year ahead, 5 years, 10 years, 20 years, 30 years and 50 years corresponding respectively to questions B1 to B6. Questions B7 and B8 are dealing with curvature comparing a package of 15 hours of free time at two time horizons and 15 hours awarded at a medium term horizon.

The B1-B6 questions are the followings: One extra hour of free time now is equivalent to how many hours of free time in 1 year (respectively 5 years, 10 years, 20 years, 30 years and 50 years)? The answer should be one of the 9 ordered choices:

- 1- Less than 1h in 1 y
- 2- Between 1h and 2h in 1y
- 3- Between 2h and 6h in 1y
- 4- Between 6h and 12h in 1y
- 5- Between 12h and 22h in 1y
- 6- Between 22h and 36h in 1y
- 7- Between 36h and 52h in 1y
- 8- Between 52h and 78h in 1y
- 9- More than 78h in 1y

The same questions are submitted again after the respondent was asked to read a mortality table. In Block C questions, people had to compute their life expectancy taking into account their date of birth and their gender. Each respondent has to calculate the probable year of his death and his expected remaining duration of life from now. Then, after been

informed with his true average life expectancy, questions identical to B1-B8 were asked again (questions C6-C13).

Data

The sample is made from answers from 243 individuals. Two different categories of people have been questioned using the questionnaire form. Most of the respondents are students from the Paris Sorbonne University. They follow management and business economics studies and are in the graduation year for the bachelor's degree or for the master's degree. A sub sample of 58 old and retired people have been interviewed in the French city of Reims (26 people) and by sending the questionnaires by mail to retired countrymen and women in France (32 respondents)¹². They are members of a non-profit organizations of retired people¹³. Their average age is 67.1 years. The student sub-sample (185 people) was on average 22.1 years old. The two sub-samples are very distinct since we do not have any people born in the 1958-1976 period.

The questionnaire was answered in the academic year 2007-2008. The global average age of the whole sample is 32.8 years. Considering the total sample, 58% were women. Only 56 respondents (23%) have children (average number of children is 2.03); 47 are grand-fathers (mothers).. 88 of the respondents (36,5%) have thought to transmit something to heirs. Among the others, 106 (44%) will think about it. However, a minority of 19% claims that they are not motivated by giving anything to any heirs. Globally, 49% of the individuals are considering that they have something valuable (i.e. capital or knowledge) to transmit to heirs.

	average	standard dev	min	max	N
Date of birth	1974.18	19.64	1920	1988	243
Gender (0:men/1 women)	0.59	0.49	0	1	243
Number of children	2.03	1.06	0	5	56
Speaking fluently another foreign language(0:yes/1:no)	0.55	0.49	0	1	240
Currently smoking (0:yes/1:no)	0.85	0.35	0	1	240
Education level	4.16	1.14	1	6	242

¹² A total of 250 questionnaires was diffused by the Fédération des Aînés Ruraux and sent to theirs members.

¹³ I want to thank for their support Mrs Renate Gossart, Président of the association "Les panthères grises" located in Reims and Mrs Delphine Guillaume in charge of internal communication at the Fédération Nationale des Aînés Ruraux, www.ainesruraux.org..

Financial monthly expenses category (1 to 6)	2.29	1.42	1	6	240
Perception of the free time importance (ordered from 1 no to 6 utmost importance)	4.12	1.22	1	6	241
Financial planning horizon (1 to 4)	1.73	0.88	1	4	243
Transmission of capital and knowledge to nears or relatives (0:yes/1:no)	0.63	0.48	0	1	241
Importance of capital and knowledge to transmit (from 1 to 6)	2.60	1.21	1	6	242
Perception of risk attitude	3.40	1.34	1	6	243

Table 2 - Descriptive statistics of the sample

(Education level: answers from 1 (autodidact) to 6 (master's degree); Financial monthly expenses by ordered categories: 1: below 300€ up to 6: more than ; Financial planning horizon ordered from 1 to 4: 1 next coming months, 4 over the next 10 years; Importance of capital and knowledge to transmit: 1, null, to 6, huge; Risk attitude: from 1, risk lover, to 6, absolute risk rejection.)

3-Results

Qualitative time preference

Questions A1 to A8 aim at testing qualitatively the time preference hypothesis by proposing two propositions. The respondent can prefer one, the other or can say that the two are equivalent. If the answer is indifference, it is withdrawn from the data. We only consider choices expressed as preferences. The A1 question tests the time preference hypothesis by asking the preference of individuals between 1 hour of free time now (0) and 2 hours of free time 1 year ahead (1). The average answer (indifference excluded) is 0.33. It is significantly above zero. The idea of a trade-off between the present and the future can be accepted if a price exists, i.e. a preference of 1 hour now vs. 2 hours tomorrow. The test of equality of the A1 answer compared to a random average answer of 0.5 is rejected. However, the t-test assumes a normal distribution. This assumption is weak. We also consider a sign test (proportion below 0.5=0.64, p-val:0.00). It confirms the previous one.

A2 is the same question with a further forwarded trade-off (1 hour now vs. 5 hours in 5 years). The average answer is 0.34. It is significantly different and lower than a random 0.5 answer.

The test A1 vs. A2 will allow checking a difference in pricing the future. The null is that the two means are not different. A p-value above the usual significance levels does not reject the null. The difference is not significant (p-value of the t-test: 0.00). This test is reliable because the difference A1-A2 is normal (Jarque-Bera statistic=64.90; p:0.00). It means that 2 hours in 1 year forward are equivalent (not different to) 5 hours in 5 years forward. The sign test gives 82% of zero differences. The implicit discount factor ($5/2=2.5$) is 26% a year (for horizon 1-5y).

	A1 corr.	A2 corr.	A1 vs. A2	A3 corr.	A2 vs.A3
N	209	217	209	191	187
average	0.33	0.34	0.00	0.45	0.08
std dev	0.47	0.47	0.42	0.55	0.41
t-test	-5.39	-4.94	0.48	-1.38	2.65
p-val	0.00	0.00	0.63	0.17	0.01
Sign test					
Proportion below 0.5	0.67	0.66	0.82	0.55	0.82
p-val	0.00	0.00	0.00	0.07	0.00

Table 3 Results of the Block A questions (I)

(corr.: corrected to eliminate indifferent answers)

The A3 question is the same as A2 but put forward in 1 year. The average answer is 0.45. The t-test and the sign test shows that it is not different compared with a random answer of 0.50. It means indifference between the two terms of choices suggested in the A3 question. When compared to A2, we checked if the results are the same. A3 is significantly different from A2. According to the t-test but the hypothesis of difference is accepted, but is rejected looking at the sign test. These results are contradictory. The statistic A3 minus A2 is normally distributed (JB=60.16, p:0.00); we privileged the t-test. It means that when the choice is put forward 1 year, the preference for the time closer to the present date decreases. If the time preference would have been the same, i.e. if exponential discounting were true, delaying the same choice 1 year should have given the same result in questions A2 and A3. Here, the trade-off price is not the same. That result suggests a non-flat subjective interest rate. A decreasing curb will give less attraction to the short-term side of the trade-off and a larger

weight on the long-term proposition. This is why we get an average answer of 0.45 for the A2 question above 0.37 for the A3 question. However the two set of choices are still coherent. The Spearman correlation between A2 and A3 is significant and positive (+0.65, p-val:0.00).

The A4 question tests the curvature of the time preference function. It asks if individuals prefer 2 hours of free time within 10 years or a package of 1 hour now and 1 hour within 20 years. If linearity prevails, under a flat curve, the two terms are equivalent so the answer should be the average of 0 and 1, i.e. 0.5. We get an average answer of 0.66. The t-test against 0.5 and the sign test confirm this result to be significantly above a 50% probability. By preferring the package, individuals have a decreasing time curve preference, i.e. a decreasing subjective price of time.

The A5 question modifies the term of the curvature. It gives a larger weight to the medium term choice (doubling it to 4 hours against 2 hours in the A4 question). The terms of the package remains the same. The preference for the medium-term time horizon choice (choice 0) increases logically with an average answer of 0.34. Referring both to the t-test and the sign test, it is significantly lower than 0.5. The A5 question is not meaningful in analysing curvature because the relative terms are not comparable and not linear in time horizon. However, it confirms individual are time rational. The choice (0) in A5 is logically better than the one proposed in A4. Using linear approximation and the results from A4 and A5, it means that to get indifference between X hours 10 year forward and a package of 2 hours (one now and one in 20 year), we should give $(0.66-0.5) \times (4-2) / (0.66-0.34) = 1,00$ hour more. It means 3.00 hours in 10 years compare with a set of 2 hours now and in 20 years.

The A6 question is another way to test the curvature. The choice is similar to A5. The package is the same, but the medium term proposal is now 2 hours within 5 years (instead 10 years in question A4). We expect that individuals with preference for the present will choose the first answer compared with question A4. The average value is 0.39 compared with 0.66 in question A4. It is significantly below the random average answer of 0.50.

	A4 corr.	A5 corr.	A6 corr.	A4 vs. A6	A5 vs. A6
N	173	173	175	157	163
average	0.66	0.34	0.39	0.25	0.05
std dev	0.47	0.47	0.49	0.48	0.40

t-test	4.41	-4.59	-2.86	6.66	1.58
p-val	0.00	0.00	0.00	0.00	0.12
Sign test					
Proportion below 0.5	0.34	0.66	0.61	0.71	0.85
p-val	0.00	0.00	0.00	0.00	0.00

Table 4 Results of the Block A questions (II)

(corr.: corrected to eliminate indifferent answers)

We now consider the difference A4 vs. A6; it is normally distributed (JB=10.14, p:0.01). The difference of A6 with A4 is significant. The result are not the same when comparing A6 answers to those of the A5 question. When testing the hypothesis of different means between A6 and A5, we reject it. Using a sign test, we have a different conclusion with an average probability of identical median of 85%. We will accept the conclusion of the t-test on the basis that data are normally distributed (JB=78.82, p:0.00) and that the sign test is less robust. It means that 4 hours in 10 years are equivalent to 2 hours within 5 years. The psychological (annual) interest rate for the 5-10 year horizon that emerges is then 14.9%. It is lower than the 26% average subjective rate for the 1-5 year horizon.

We can mix the A4 and A6 results and use a linear approximation to find indifference between 2 hours forward and the package (1h now + 1h in 20 years). We have: $(0.66-0.5) \times (10-5)/(0.66-0.39) = 2.96$ years. It means that 2 hours in 7.96 years are equivalent to the package and the package is equivalent to 3.00 hours in 10 years (see above). The variation between 7.96 and 10 years is 2.04 years for an increase of 1.00 hours of free time.

The A7 question is identical to A4 but presented in reverse order. The answer should be strictly opposite. We inverted the A7 answers to get an average value of 0.54. It is not significantly different from 0.5 (contrarily to the A4 question). The test of difference between A4 and inverted A7 shows a significant and unexpected difference according the t-test (and not significant according the sign test). However the t-test should be disregarded as far as the A4 vs. inverted A7 variable is not normally distributed (Jarque-Bera=1.53, p:0.46). The sign test shows no difference. The Spearman rank correlation coefficient between A4 and inverted A7 is 0.43. It is positive significantly positive (p=0.00). The same ones are hopefully answering the same thing to similar questions of the questionnaire.

The A8 question is a test for altruism. After correction of indifference, the average value is 0.72, closer to 1 (altruist attitude) than to 0 (personal individualism). The test vs. a random 0.5 value is significant. The Spearman coefficient was calculated to cross with curvature (question A4). The coefficient is 0.01. It is non significant (p=0.30). Altruism does not seem to be linked with curvature, i.e. temporality in the subjective price of time. These are two separate dimensions of human behaviour.

	A7 inv.	A7inv. vs. A4	A8 corr.
N	177	157	183
average	0.54	0.14	0.72
std dev	0.50	0.52	0.45
t-test	1.28	-3.34	6.47
p-val	0.20	0.00	0.00
Sign test			
Proportion below			
0.5 (or equal to 0)	0.55	0.71	0.28
p-val	0.11	0.00	1.00

Table 5 Results of the Block A questions (III)

(inv.: answers are corrected to eliminate indifferent answers and inverted; corr.: corrected to eliminate indifferent answers)

Quantitative time preference evaluation

The direct price of time is tested through B1 to B6 questions considering the “price” of one hour of “free time” at different time horizon 1y, 5y, 10y, 20y, 30y and 50y. A measure of the subjective price of time is built considering the increase in the relative value of one hour of free time now and one hour later. If the subjective price of that hour increases, it means that the time has a cost. We compared the individual answer to question B1 (C1) and the average answer to questions B2 to B6. If an individual answers for instance 2 at the B1 question, it means he gives a value of 1 to 2 h of free time in 1 year forward compared with for one hour of free time now. If the average answers to the same question, but deferred forward in time (question B2) is 4, it means than the relative ratio of his personal time value is 6 to 9 hours compared to one hour now. We calculated the (possibly) negative slope of the subjective interest rate as the difference between the B1 answer and the average relative ratio resulting

from questions B2 to B6. For instance, the previous respondent will yield a value -2 (i.e. 2 at question B1 minus 4 at question B2); it shows a time preference attitude with deferred free time having less value than near current free time opportunity. If the average difference is negative, it globally indicates a positive price for time (or a preference for immediacy). Looking at the answers, the average value of the subjective price for time indicator is effectively negative (-1.49) and significantly different from null. The answer is the same with the “informed” set of respondent. The C6 to C11 questions are exact correspondent to the B1-B6 questions. The answer to question C6 has been compared in the same way to the average answers considering deferred horizon from 5 to 50 years (i.e. C7 to C11 questions). The average value of the informed price of time indicator is significantly negative (-1.48).

Questions	B1	Average time value B2 to B6	C6	Average time value C6-C11
N		228	207	225
average		2.24	-1.49	2.23
std dev		1.65	1.65	1.70
t-test			-13.04	-12.14
p-val			0.00	0.00

Table 6 Results of the Block B and C questions

When informed of his true average life expectancy, the individual does not seem to modify his answer regarding his subjective price of time. The score declines from 2.24 (question B1) to 2.23 (question C6). The difference between questions B1 and C6 is not significant (t-test=-0.15, p:0.88). The same is true for the subjective price of time before and after (t-test=-0.13, p:0.89). The two scores of subjective price of time shows a strong correlation (Pearson correlation of +0.75, p:0.00).

4-The term structure of subjective time preference

We calculate the average answer to the subjective price of time. Each question can be answered from checking ordinal values from 1 (a future free hour has a lower price than the current free time hour) up to 9 (i.e. one free time hour in the future has less value than 45 seconds today). Answer 1 is economically irrational in term of time preference. It means a

preference for the future compared to the present. It can also mean than the respondent did not understand the question.

The integer answer from 1 to 9 are trade-off relative values. The average ordinal answer to each question have been converted into subjective interest rate using the mid-range value. For instance, if a given individual answers 4 to the question B2, he says that he will ask between 6 to 12 hours of future free time 5 years ahead to be equivalent for one hour just now. Taking the mid-point of 9 hours in 5 years forward, we derive an implicit subjective price of time of 55.18% per year¹⁴.

Taking the average value of the choices of the individuals, we get a collective time value preference. Table 7 shows the average answers with regard to the 6 time horizons. The structure of the average psychological interest rates is clearly decreasing with the time horizon. The short-term rate is 135.31% (1 year ahead); it declines to 5.80% (50 years horizon). The data collected after delivering objective information on the life expectancy are similar. The term structure of psychological interest rates declines from 117.53% to 5.97%.

Horizon (years)	1	5	10	20	30	50
Panel A Before information						
Av. ordinal answer	2.3904	2.9248	3.4509	4.0045	4.3756	4.9074
Av. number of future hours for one free time hour now	2.4759	3.8119	6.2545	9.0360	12.0045	16.2593
Implicit subjective interest rate	1.4759	0.3069	0.2012	0.1163	0.0864	0.0574
Panel B After information						
Av. ordinal answer	2.4044	2.9381	3.4395	3.9452	4.3052	4.9761
Av. number of future hours for one free time hour now	2.5111	3.8451	6.1973	8.7260	11.4413	16.8086
Implicit subjective interest rate	1.5111	0.3091	0.2001	0.1144	0.0846	0.0581

Table 7 – Estimate of average subjective interest rates

(Average ordinal: average of answers from 1 to 9 without corrections of outliers; Average number of future hours: number of future hours equivalent to one hour now calculated from the average answer by interpolating the mid-range of the ordinal answer see table in annex; implicit subjective rate: annual equivalent rate calculated using the maturity and the ratio of

¹⁴ Solving the equation $(1 + x)^5 = 9$.

number of future hours compared to one hour now; before information are B block questions; after information are C block questions; information delivered between the two is the statistical mortality table and the average life expectancy of the respondent)

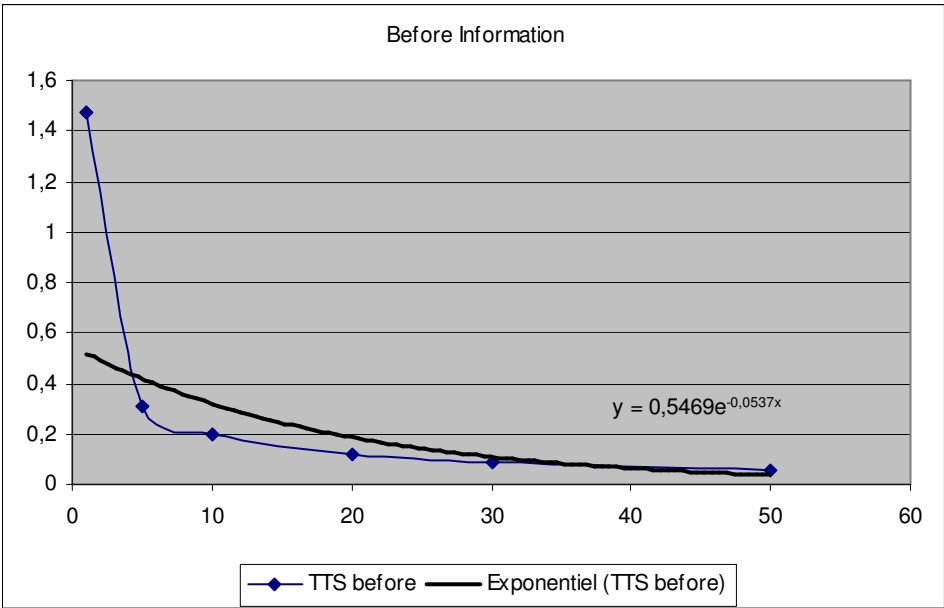


Figure 1 - Average estimate of subjective interest rates (Before information)
(Source: Table 3; fit using an exponential model)

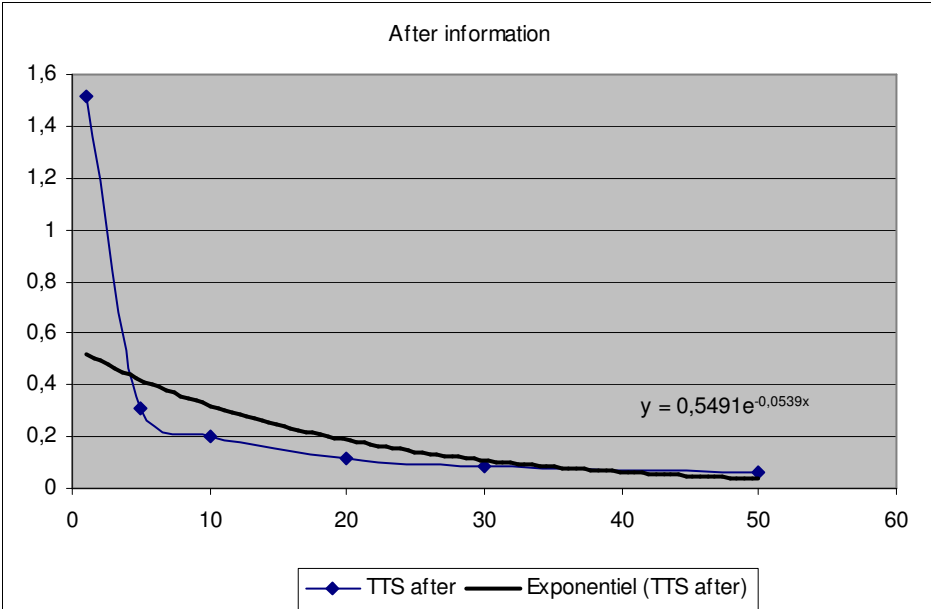


Figure 2 - Average estimate of subjective interest rates (After information)
(Source: Table 3; fit using an exponential model)

The fitted term structure of subjective interest rates is calculated using an exponential model: $r(t) = b.a^t$. The estimation is performed on average data of table 7. The b coefficient is the instantaneous subjective interest rate to forward free time one second in the future. The fitted values are 55% (before and after information). The subjective price of time is characterized by a negative slope in the term structure curve. The log of the slope is a yearly -5.37% (before information) and -5.39% (after).

Looking at each individual, we transform his ordinal answer to annual implicit subjective rates using a correspondence table (see annex). We corrected outliers particularly for wrong answers at question 1 about the relative ratio of one hour in one year. Wrong answers above 4 at the B1 (C6) question will bias upward the implicit rates and result in abnormally high implicit rates. This may be due to a bad understanding of the question. We decide not to remove these answers but to limit the maximum subjective rate to 500%. Descriptive statistics of the term structure of subjective interest rates of each respondent are given in table 8.

Variable	N	average	std. dev.	Minimum	Maximum
AV1	228	1.397184	1.713725	0.001000	5.000000
AV5	226	0.320404	0.339724	0.001000	1.390116
AV10	224	0.184333	0.167918	0.001000	0.546000
AV20	222	0.103912	0.084450	0.001000	0.243382
AV30	221	0.074331	0.057571	0.001000	0.156298
AV50	216	0.048872	0.035622	0.001000	0.091043

Table 8 - Descriptive statistics of individual subjective interest rates (Time horizon 1y, 5y, 10y, 20y, 30y, 50y; source: relative price ratios from question B1 to B6, converted into annual interest rates using the correspondence table in Annex)

Looking at average values, the term structure seems clearly negative. It starts from an average 140% for the psychological interest rate for the 1 year horizon. This high figure explains partly by possible errors in understanding the question and by outlier answers that have not been removed. At the end of the term structure, the rate is 4.9% for a 50 years horizon.

For each individual, we have a six point estimates of his psychological time preference structure. We fitted each individual term structure using an exponential two variables model. Each individual's characteristic time preference structure can be defined using a couple of parameters, which are the intercept instantaneous interest rate and the slope. Over the whole sample, the average estimated parameter for the slope is 0.96 (which corresponds to a log of the slope of -3.60% yearly). The average estimates intercept of the exponential model is 0.53 (i.e. a 53% instantaneous forward interest rate).

	Average a coefficients (before)	Average b coefficients (before)	Average a coefficients (after)	Average b coefficients (after)
Value	0.96446	0.5301	0.9650	0.5016
Correlation individual a_i and b_i	-0.57 (p=0.00)		-0.54 (=0.00)	
Correlation individual a_i and life expectancy	0.09 (p=0.18)		0.07 (p=0.33)	
Correlation individual b_i and life expectancy	0.04 (p=0.54)		0.07 (p=0.36)	

Table 9 - Individual fit of each individual term structure of subjective interest rates (Fit using a $r(t)=b.a^t$ exponential model; Before: without information; after: after true and average information of statistical life expectancy;)

When we regress the individual estimates b_i of the intercepts and the individuals slopes a_i , we get a -0.567 coefficient of correlation. Among individuals, if someone has a strong immediate time preference, his long-term time trade-off is smoother with a lower negative slope with time horizon. This relationship is confirmed even if we add new information about the "true and average" life expectancy. This raw correlation indicates the existence of a relationship between the two parameters instantaneous forward subjective rate and slope of the term structure of time value; however it does not tell anything on the form of the relationship. The linear form is not the best one. We also tested a log-log form. It gives a better fit with a R^2 value of 0.573 (correlation of -0.76) .

	β	α
Estimated coefficient	-0.01322	-0.0663
p-value	0.00	0.00
R^2	0.5727	

Table 10 - Relation $\text{Log}(\text{term structure slope}) = \alpha + \beta \text{Log}(\text{instantaneous forward subjective rate})$

(term structure slope: a_i estimates ; instantaneous forward rate : b_i estimates ; N=216)

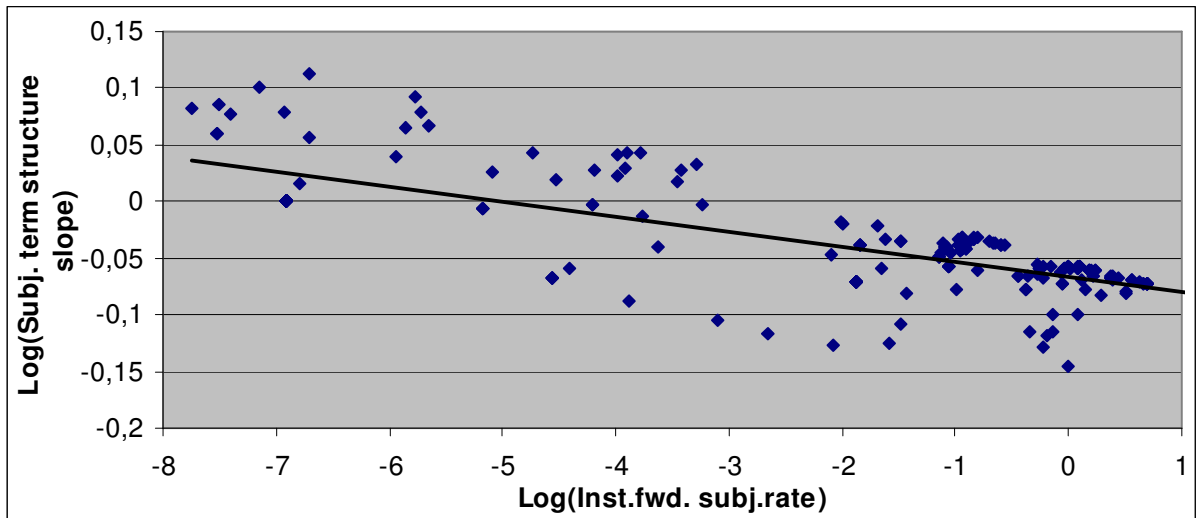


Figure 3 Log-log relation between individual intercepts and slopes

We derive some propositions.

Proposition 1: The individual's term structures of subjective price of time are decreasing. They are characterized by a couple of parameters setting the instantaneous forward interest rate and the decreasing slope of his personal term structure of interest rate.

Proposition2: A negative relation exists between the two parameters that characterises the term structure of subjective rates: an individual with a strong short-term time preference balances it with a relatively smaller negative slope. He penalizes relatively less the deferred future compared with an individual whose instantaneous short-term interest rate is small.

As a result a behavioural “law” may be formulated: those with a high immediate time preference have a relatively less demanding time preference in the deferred future. The original time preference hypothesis should be conceptualized deeper: the strength of that preference does not result in an equal pressure directed to the future. Time has a psychological price, but a term structure exists that unifies the relative prices. This defines a “balancing pressure law”: A balancing mechanism spread over the horizon the pressure for a time preference. Regarding the subjective price of time, when someone asks a lot in the very near future, he asks relatively less in the forward future.

Influence of information on the subjective interest rates

Introducing information refers to the C5-C11 questions, which are similar to B1-B6. Between the two sets of questions, the respondent is informed with his average statistical life expectancy as calculated from official mortality table.

We form the differences in the subjective interest rates for each horizon 1 year, 5 years, 10 years, 20 years, 30 years and 50 years. These differences are subjective interest rates calculated before and after new information on the true average life expectancy. We cross these differences with individual characteristics. We first used a simple univariate regression and then a system of joint estimate to see if individual features may explain global moves in attitude towards time preference. The results are negative. None of the individual characteristics appeared to explain changes in attitude toward time. A large model with 16 explaining variables was firstly tested through 6 simple OLS regression. These variables are individual's characteristics. A restricted model with 5 explaining variable in OLS estimates gave the same result. A multivariate SUR model of the difference of subjective rates before and after information for horizons of 1, 5, 10, 20, 30 and 50 years was estimated with 5 endogeneous variables. It gives the same inconclusive results that no individual characteristics will influence changes in subjective interest rates. The effect of new information on the shape of the term structure of subjective interest rates seems to be random and on average null.

We analyzed directly the influence of information on the value of the two parameters designing the individual term structure data. After information, the average of individual intercepts decreases (50% vs. 53%) and the log of the slope remains on average the same (-3.60% after vs. -3.60% before). A t-test of difference between the intercepts before and after rejects the hypothesis of different individual values (t-test=1.26, p-val: 0.21). We crossed the difference in intercepts $b_i^{before} - b_i^{after}$ and the life expectancy. We wanted to check if the level of new information modifies the instantaneous forward psychological interest rate. The correlation coefficient is close to zero and non significant (see table 11).

Correlation with	$b_i^{before} - b_i^{after}$	$a_i^{before} - a_i^{after}$
life expectancy	-0.04	-0.18
N	207	205
p-value	0.58	0.01

Table 11 -Correlation between the variations in intercept $b_i^{before} - b_i^{after}$ and the expected duration of life

A test of difference between the slopes a_i after and before has been performed. It rejects the hypothesis of different means (t-test=1.46, p-value:0.51). We also crossed the difference in slope $a_i^{before} - a_i^{after}$ and the expected duration of life. We wanted to check if new information modifies the shape of the term structure of psychological interest rate. The correlation coefficient is negative and weakly significant.

Modelling the term structure of subjective interest rates

We characterized the subjective term structure by an intercept (immediate time preference) and a slope. We tested if a relationship between the intercept interest rate or the slope, on the one hand, and life expectancy, on the other, may exist. No strong and significant relationship appears. A linear regression with life expectancy confirms these results as the parameters seem to share a common constant value.

Panel A - Before information- Dependant: Life expectancy				
Independent variable	Exp. slope	Constant	Exp. Intercept	Constant
Est. Coef	0,0003	0.9494	0.0021	0.4142
p-value	0.16	0.00	0.44	0.00
R ²	0.01		0.00	
Panel B – After information- Dependant: Life expectancy				
Independent variable	Exp. slope	Constant	Exp. Intercept	Constant
Est. Coef	0.0003	0.9508	0.0027	0.3519
p-value	0.32	0.00	0.34	0.03
R ²	0.00		0.00	

Table 12 - Relation between individual parameters of the term structure of subjective interest rates and life expectancy

(Before information: source questions B1-B6 After information source: questions C5-C11 after information an the true average life expectancy; N=198 Before sample, N=192 After sample; dependants are exponential individual estimates of the slope b_i and intercept a_i)

We used a restricted model with 3 explicatives (a larger regression with 16 explicatives is inconclusive). Results are given in table 13.

Dependant	Constant	Gender	Risk aversion	Life expectancy	F
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variable					
Individual slope	0.94	0.01	-0.00	0.00	1.76
p-val	0.00	0.09	0.22	0.26	0.16
Individual intercept	0.50	-0,29	0.09	0.00	4,44
p-val	0.01	0.00	0.01	0.20	0.00

Table 13 – Determinants of the term structure parameters
(OLS regression, 3 explicative variables plus a constant)

The slope of the individual subjective price of time does not seem to depend on individual characteristics. The regression on exogenous variables is non-significant. On the other hand, the level of the intercept is a psychological data with interacts with risk aversion and gender. It suggests further analysis but does not depend on life expectancy. Another test comparing the individual term structure characteristics of slopes and intercepts was performed comparing the two sub-samples or students and retired people. A test a difference was also significantly rejected.

	Retired people	Students
N	33	183
Term structure slope		
Average value	0.9573	0.9659
t-test (p-val)	-1.06	(0.29)
Instantaneous forward time preference		
Average	0.4033	0.5530
t-test of difference (p-val)	-1.57	(0.12)

Table 14 Difference of subjective term structure parameters between two sub-samples

Proposition 3 The term structure of personal price of time is an invariant psychological feature with no tempus fugit effect.

The B7 and B8 questions are implemented to test the curvature of the time preference. The average value for B7 is 0.29 and is significantly below 0.5. The value of the barbell package (1 year/10 years) is larger than the value of the medium term choice (5 years). It confirms above results showing that time preference is larger for short-term time horizon. However, the average answer between the 10y/50y package (0) and the medium 20 years term (1) is 0.52 and is not different from 0.5. Here, the two alternatives are statistically equivalent.

The C12 and C13 questions are identical and are answered after the delivery of information on life expectancy. The results are similar to the B7 and B8 questions answered before new information. The latter does not seem to influence the shape of the curvature curve of time structure preferences. We confirm that the decreasing curvature seems important at the short end of the personal term structure and is not at the long end.

Analysis of risk aversion

Risk aversion is tested through 3 questions. The first two are comparing package resulting from a lottery and a certain value. Question S21 tests if the expected uncertain value above the certain one is preferred. Question S22 is the same but the expected value is equal to the certain value. Risk averse people should choose the first answer (i.e. 0 compared to 1) for this late question. The average answer of S21 is 0.36. It is significantly different from a random 0.5 answer. Looking at question S22, the average answer is 0.14. It is also significantly different from 0.5. This later choice is closer to 0 than to 1; i.e. it means that the certain value is preferred compared with the lottery. It is coherent with the risk aversion hypothesis, which asserts that the certain value is definitely preferred when the expected value of the lottery is equal to the certain value. The difference between the two answers S21-S22 is positive (+0.21) and significant.

	S21corr.	S22 corr.	S21 vs. S22
N	229	236	224
average	0.36	0.14	0.21
std dev	0.48	0.35	0.54
t-test	-4.33	-15.95	5.91
p-val	0.00	0.00	0.00
Sign test			
Proportion below			
0.5 (above 0)	0.64	0.86	0.28
p-val	0.00	0.00	0.00

Table 15 Risk aversion
(corr.: corrected to eliminate indifferent answers)

We crossed the perception of risk as declared by individuals (S23 question) with the answers to the lottery questions S21 and S22. We expect that the self-perception of risk

attitude is coherent with the risk aversion as measured by lottery. The answers to the S23 question ranges from 1 to 6, with an ordinal value increasing with risk aversion starting from risk lover's attitude (1) to risk avoiders (6). Rational individuals when choosing the lottery will be conscious to take a risky position compared with a no-risk choice. S23 measure is increasing with risk aversion. A logit regression of S21 and S22 shows a strongly negative coefficient linked to the risk attitude S23. The coefficients are negative: an increase in risk aversion decreases the choice of the lottery and increases the probability to choose the certain value. Lottery games are coherently linked with the perception of risk aversion (see table 16). Individuals are rational and coherent when answering with regard to risk.

	Estimated coef	p-val	Pseudo R ²
Lottery S21			
S23 variable	-0.24	0.00	0.09
Lottery S22			
S23 variable	-0.56	0.00	0.03

Table 16 - Logit estimation of lottery games

Individual's risk attitudes are crossed with individual's characteristics to explain risk aversion. As explanatory variables, we introduce cultural and educational elements. A binary dummy sets if the mother language of the respondent is French or not. The same question is asked on the native language of his father and his mother. A dummy variable sets if the location of his/her birthplace is France or not. We also introduced a similar binary variable to know if the birthplace of his father (and his mother) is France.

Variables	S21 risky lottery	p-value	S22 risky lottery	p-value	S23 risk perception	p-value
S2-Gender	-0.74	0.00**	-0.05	0.86	0.74	0.00***
S12 – Smoking	-0.33	0.14	-0.68	0.01**	0.11	0.60
S14 – Education	0.13	0.16	-0.31	0.02**	-0.05	0.46
S15 – Worker/not	-0.84	0.29	-0.63	0.54	-0,08	0.88
S16 -Financial Expenses	0.09	0.36	-0.01	0.92	-0.03	0.70
S18- Financial planning horizon	-0.09	0.40	-0.26	0.11	-0.11	0.19
S19 - Transmission to heirs	0.48	0.04**	0.48	0.09*	-0.22	0.21
S20 - Size of personal capital	-0.04	0.61	0.05	0.64	-0.12	0.11
French native	0.03	0.91	0.27	0.50	0.15	0.60

language/not						
Father's French native language	0.21	0.69	-0.04	0.95	-0.74	0.06*
Mother's French native language	-0.32	0.51	0.21	0.74	0.79	0.03**
Birthplace (France/not)	-0.01	0.98	0.14	0.71	-0.26	0.34
Father's birthplace (France/not)	0.07	0.85	0.74	0.20	0.24	0.44
Mother's birthplace (France/not)	-0.16	0.66	-1,16	0.02**	-0.21	0.43
Life expectancy	-0.02	0.29	0.00	0.86	-0.01	0.42
LR	18.98	0.16	11,46	0.65	57.81	0.00

Table 17 - Determinants of risk attitude
(Dependant variables lotteries S21 and S22, probit model; dependant variable S23 risk perception, ordered logit model)

Looking at lottery S21, only two variables seem to explain the risk attitude: gender and the wish to transmit something to heirs. Women will choose the certainty choice; the lower the wish to transmit something, the larger the probability to choose the lottery. The other variables are not significant, especially the life expectancy.

Looking at S22 lottery, the probability to choose the lottery is negatively influenced by the not smoker status, by education, and by the fact that the mother was born in France. Life expectancy is not significant. These two logit regressions are globally very poor considering the whole set of explanatory variables.

The S23 self-perceived risk attitude is explained by gender (women are prone to reject risky choices), and by the fact that the mother's language is French: if yes the risk is rejected. Conversely, if the father's native language is French, individuals feels more risk lovers. Globally the risk attitude is a personal psychological feature and appears to have no economical or social determinants such as wealth employment status, education level. Particularly it does not seem to depend on life expectancy. However, it is linked with gender and cultural variable such as the fact that the native language of the father and the mother is not the same.

5-Determinants of time preference

We now try to explain the determinants variable of the individual time preference curve.

Determinants of binary qualitative choices

In a first step, we see if some determinants may explain the binary choice with regard to alternative time horizon. We first tested a set of 16 explicative variables.

Dependant variable	A1dum	p-value	A2dum	p-value	A3dum	p-value
Constant	-0,70	0.71	-0,59	0.78	-2,65	0.25
S2-Gender	-1,02	0.01***	-1.18	0.01***	-1,10	0.01**
S12 – Smoking	-0.32	0.49	-0.54	0.27	-0.59	0.29
S14 – Education	-0.14	0.41	-0.44	0.03**	-0.29	0.20
S15 - Worker/Not status	0.91	0.49	0,65	0.69	2,33	0.14
S16 Financial Expenses	0.02	0.88	0.36	0.08	0.33	0.18
S18- financial planning horizon	0.29	0.14	-0.06	0.78	0.11	0.66
S19 - transmission, to heirs	0.07	0.87	-0.54	0.19	0.38	0.41
S20 - Size of personal Capital	0.08	0.91	-0.12	0.42	-0.01	0.93
S23 - Risk attitude	0.08	0.56	-0.02	0.91	-0.12	0.41
French native language/not	-0.80	0.19	-0.49	0.41	0.13	0.82
Father's French native language	0.10	0.90	-0.38	0.67	-0.89	0.36
Mother's French native language	-0.32	0.67	-0.24	0.77	-0.73	0.41
Birthplace (France/not)	0.87	0.13	1,06	0.06*	1,29	0.03**
Father's birthplace (France/not)	0.08	0.91	0.59	0.39	1,02	0.17
Mother's birthplace (France/not)	0.02	0.97	0.02	0.97	0.43	0.56
Life expectancy	0.02	0.58	0.08	0.03**	0.05	0.20
LR	14.72	0.54	35,20	0.00***	58,08	0.00***

Table 18- Determinants of A1, A2, and A3 binary choices

(Logit model on A1, A2 A3 variables corrected from indifference)

Results are significant only to explain the A2 and A3 choices. The A1 logit model is not significant. Only the gender variable plays a role. A2 and A3 question share the same explicative variables: gender and birthplace. People born in France have a lower preference for the short-term. They are more open to the future¹⁵. We notice that life expectancy and risk attitude are not relevant to explain pure choices with regard to the time preference.

If we use a system of simultaneous equations to explain jointly A1, A2 and A3, we get the same explicative variables. A 2LS system of SUR estimates shows that gender, birthplace and the native language are significant. Neither the risk variable, nor the life expectancy are significant when comparing binary time choices.

Dependant	Gender	French native language	Birthplace	R ²
A1dum	-0.28	-0,25	0.24	0.16
p-value	0.00***	0,06*	0.05*	
A2dum	-0.26		0,19	0.26
p-value	0.00***		0,09*	
A3dum	-0.19		0.23	0.35
p-value	0.01***		0.04*	

Table 19 - SUR estimate of A1, A2 and A3 binary choices (only significant variables at the 10% level are mentioned)

Determinants of relative prices of time

We analyze here the individual relative prices of time resulting from a direct estimate by individual. The statistical method is an ordered logit regression to explain each of the variables B1 to B6. The regressions are estimated without constants, which are useless. Order is needed because answers are ranked from 1 to 9 (from a high price of future free time to a low price of future free time).

Dependant variable	Gender	Risk aversion	LR
B1 1y	-0,93		42,81
	0.00**		0.00***
B2 5y	-0.76		29,62

¹⁵ A probit model yields similar results.

	0.02**		0.01**
B3 10y	-0.88	0.20	42,74
	0.00***	0.07*	0.00***
B4 20y	-0.89		35,76
	0.00***		0.00***
B5 30y	-0.81		38,35
	0.01**		0.00***
B6 50y	-0.58	0.19	31,60
	0.04**	0.07*	0.00***

Table 20 – Determinants of the relative subjective price of time

(Individual ordered logit regressions, only significant variables at the 10% level are mentioned 15 variables; dependant variables are ordinal answer from 1 to 9, explicative variables are S2 gender man(0) woman(1), S23 risk aversion attitude from 1 to 6, life expectancy in number of years as of 2007, S12: smoking(0) non smoking(1), S14: Education From 1 self-made to 6 master' degree, S16: income level, S18: planning horizon from 1 to 4, S19: transmission to heirs, S20: personal capital importance from 1(no) to 6(huge), Native language French(1) no(0), Father's native language French(1) no(0), Mother's language French(1) no(0), Birthplace France(1) no (0), Father's birthplace France(1) no(0), Mother's birthplace French(1) no(0))

Gender plays systematically a significant role. Risk aversion is significant 2 times above 6. This result is new compared with the analysis of binary choice. It is important on the theoretical ground. It means that the risk attitude and the time preference dimensions are not orthogonal. A mild relationship exists. Individuals who have a strong time preference (high B values) also show a strong risk aversion. However these results are not strong and conclusive, except for gender.

We used a conversion factor that eliminates outliers to convert the B1-B6 and the C6-C11 answers to explicit the trade-off between extra hours of free time in forward periods. We get different values of the implicit subjective interest rate for each individual. Reference to implicit interest rates allows limiting the effect of outliers particularly for answers to the B1 question. We performed a joint parametric estimate of a multivariate system of 6 equations using the SUR method.

	Gender	Risk aversion	Life expectancy	S14	S18	Birth place	Father's Birth place	R ²
AV1 1y	-0,70	0.26	0.01	-0.02	0.02	0.39	-0.06	0.06
p-val	0.00***	0.00***	0.18	0.86	0.87	0.22	0.81	
AV5 5y	-0.12	0.04	0.00	0.01	-0.00	0.02	0.02	0.04
p-val	0.01***	0.04*	0.12	0.58	0.92	0.75	0.70	

AV10 10y	-0.07	0.02	0.00	0.01	-0.00	0.03	0.01	0.07
p-val	0.00***	0.02**	0.07*	0.33	0.92	0.38	0.63	
AV20 20y	-0.04	0.01	0.00	0.00	0.00	0.01	0.00	0.07
p-val	0.00***	0.08*	0.13	0.15	0.92	0.43	0.92	
AV30 30y	-0.03	0.00	0.00	0.01	0.00	0.01	-0.00	0.07
p-val	0.00**	0.14	0.07*	0.13	0.93	0.27	0.94	
AV50 50y	-0.01	0.00	0.00	0.00	-0.00	0.01	-0.01	0.08
p-val	0.01***	0.07*	0.08*	0.06*	0.54	0.07**	0.27	

Table 21 - Determinants of the relative subjective price of time (SUR estimate)

(Dependant are subjective interest rates after transformation, joint estimation of 6 equations, results of the constant are not displayed, parsimonious model with 7 explicatives)

We obtain the same mix of explicatives: gender risk, risk aversion and, at a lower level, life expectancy. Risk aversion is positively significant five times out of six. However, risk aversion seems to weight more on the short interest rates. Life expectancy is moderately significant and weights on the long-term part of the term structure. So the question of the level and the slope of the subjective rates appears important.

Panel analysis

We used a panel analysis by stacking for each individual, his 6 observations. The F-test signals a strong individual effect. The means of time relative values are different among individuals.

	Pooled B1-B6 ordinal answers	Pooled subjective interest rates 1y-50y
F-stat	1,76	3.50
degrees	242	242
p-value	0.00***	0.00***

Table 22 - Test individual effect individual

(1458 pooled observations)

We used a panel test with a random method to take into account the individual average answer. The random method will give individual a random effect around a mean value. Fixed method would imply 243 fixed constant coefficient to take into account the individual effect. Dependant variable sets are pooled B1-B6 and pooled AV1-AV50. The later eliminates outliers. Explicatives are the horizon maturity, gender, risk aversion, life expectancy, planning horizon (S14) and importance of capital (S20). The first explicative variable refers to the time horizon of the relative subjective price of time, i.e. 1, 5, 10, 20, 30 and 50 years. The others explicatives are individual characteristics and are deterministic. A Hausman test to separate

between a fixed and a random effect is performed. It does not show any difference in the estimated coefficients. The hypothesis of a dependant effect with regard to the explicative variables is rejected (at the p-value 0.50 and 0.70). A fixed effect is not necessary per se and we used a random effect model.

	Dep. B1-B6		Dep. AV1-AV50	
<u>Explicatives</u>	<u>Coef.</u>	<u>p-value</u>	<u>Coef.</u>	<u>p-value</u>
<u>Constant</u>	2,90	0,00***	0,88	0,00***
<u>Horizon maturity</u>	0,05	0,00***	-0,02	0,00***
Gender	-0.83	0.00***	-0.15	0.00***
Risk aversion	0.23	0.00***	0.05	0.00***
Life expectancy	-0.01	0.50	-0.00	0.40
Planning horizon	0,04	0.61	-0.01	0.82
Capital	-0.01	0.80	-0.01	0.73

Table 23 Panel estimates

We will focus on panel using subjective interest rates factors. Direct B1-B6 answers are ordinal variables. If we look at significant independent variables, they are the same across the six questions for a given individual. Horizon maturity explains significantly the personal value of time. The estimated coefficient is positive in the direct B1-B6 answers. We recall that the choices are ordered from 1 to 9 from a low time preference (1) to a strong one (9). The coefficient is negative in the AV1-AV50 dependant variable, which is expressed in term of subjective interest rates. Both results indicate a term structure of subjective interest rates decreasing with the time horizon. Gender is the first characteristic to influence the individual time preference. Women have a lower time preference and a lower subjective value of time. Men are more impatient. Risk aversion is the second psychological attitude that influences the time preference. Risk averse people will show at the same time a stronger time preference. They prefer certainty and, other thing being equal, immediacy. This conclusion is important on the theoretical ground because it suggests that the two dimensions of time preference and risk aversion are not isolated. This result is in line with Frederick (2005) who suggests the idea of a common factor behind the time and the risk attitude of individuals. Gender may be that common factor as far as we saw that it is linked with risk aversion.

Conclusion

This empirical study confirms the decreasing slope of the subjective interest rates. Individuals use a term structure to discount deferred choice preferences. The psychological value of time can be modeled and parametrized using the intercept which is the immediate time preference value and the slope of the decreasing subjective interest rates. An exponential modeling fits successfully the data. A “balanced pressure law” between these two parameters is suggested.

The individual subjective term structure of interest rates seems weakly influenced by social or economic characteristics of the individual. The life expectancy does not seem to influence the level and the shape of the psychological value of time. We concluded to the absence of tempus fugit effect in the term structure of subjective interest rates. Gender is a variable that strongly influences the level of subjective interest rates. The attitude toward risk also appeared as a determinant of the time preference attitude. These two dimensions seem to interact. The influence of risk aversion on the structure of time preference weights more on long-term choices than of short-term. This result contradicts the pure intertemporal microeconomic model, which separates the two dimensions. It suggests developing further tests to analyse the disentangling hypothesis.

Annex

Horizons	1y	5y	10y	20y	30y	50y
1	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%
2	50,0%	8,4%	4,1%	2,0%	1,4%	0,8%
3	300,0%	32,0%	14,9%	7,2%	4,7%	2,8%
4	500,0%	55,2%	24,6%	11,6%	7,6%	4,5%
5	500,0%	76,2%	32,8%	15,2%	9,9%	5,8%
6	500,0%	96,1%	40,0%	18,3%	11,9%	7,0%
7	500,0%	113,2%	46,0%	20,8%	13,4%	7,9%
8	500,0%	130,5%	51,8%	23,2%	14,9%	8,7%
9	500,0%	139,0%	54,6%	24,3%	15,6%	9,1%

Table A2 Correspondence between the ordinal answer to questions B1-B6 and C6-C11 and implicit subjective interest rates

(Choice 1 leads to a negative time preference i.e. negative subjective interest rates, they were set close to a null interest rate; for the one year horizon; choices above 3 have been capped; interpolation is done looking at the mid-range of the ordinal answer choice 1:1h; choice 2:1,5h; choice 3:4h; choice 4:9h; choice 5:17h; choice 6:29h; choice 7:44h; choice 8:65h; choice 9:78h; subjective rates are annual equivalent rates)

Variables	Answers
S2 – Gender	0(man)-1(woman)
S12 – Smoking	Yes(0)-No (1)
S14 – Education	1 to 6 increasing with the level of education
S15 - Worker/not	(1) Employed or would be (i.e. unemployed students)-not (0)
S16 Financial Expenses	From 1 to 6 increasing with monthly range of expenses
S18 - Financial planning horizon	From 1 to 4 increasing with long term planning horizon
S19 – Transmission to heirs	yes(0)/ no(1)
S20 – Size of personal capital	From 1 to 6 increasing with the size
French Mother language	(1) yes (0) no
Father’s (yes if French) mother language	(1) yes (0) no
Mother’s (yes if French) mother language	(1) yes (0) no
Birthplace	(1) France (0) others
Father’s birthplace	(1) France (0) others
Mother’s birthplace	(1) France (0) others
Life expectancy	In years calculated according to the INED (French National Institute of Demographic Studies) 2007 table of mortality.

Table A1 Respondent’s characteristics

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