Separation of Intertemporal Substitution and Time Preference Rate from Risk Aversion: Experimental Analysis

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This paper presents discussion of issues related to inter-temporal decision making. This study is intended to test the recursive utility model introduced by Epstein and Zin (1989). This study specifically addresses three factors to determine intertemporal decision making. The recursive utility theory by Epstein and Zin (1989) is developed to generalize the expected utility theory. Epstein and Zin (1989) define a narrower concept of risk aversion and put forth the proposition that the expected utility is a special case in which the level of parameter of risk aversion is at the same level as intertemporal substitution.

This study uses experiments to separately examine values of the discount rate of time, the values of intertemporal substitution, and the intensity of risk aversion or risk preference in intertemporal decision making. The first factor we examine is β: it is defined by the time preference rate δ as $\beta = \frac{1}{(1+\delta)}$. The proportion of $1 - \beta$ to β indicates the subjective weighting of present and future values. The second factor is intertemporal substitution. Epstein and Zin (1989) define intertemporal substitution by the equation $U = [(1-\beta)c^\rho + \beta z^\rho]^{\frac{1}{\rho}}$, where c is the present consumption amount and z represents future consumption. Parameter ρ indicates substitution; the intertemporal elasticity of demand is given by the equation $\sigma = 1/(1-\rho)$. Our experiments examine the tendency of participants to prefer smoothness of consumption. These experimental results show the importance of this factor.

The last factor is 'narrowly' defined risk aversion. This is described as an 'α-mean' approach by Epstein and Zin (1989). The α-mean (or constant relative risk-aversion) specification replaces the expected value on the certainty equivalent value. The 'α-mean' approach has an underlying assumption that people always prefer a 'sure thing' to prospects that are described with probability. For a random variable $\tilde{x}$, the α-mean specification for μ is given as $\mu[\tilde{x}] = [E\tilde{x}^a]^{\frac{1}{a}}$ when $0 \neq \alpha < 1$, and $\log(\mu) = E\log(\tilde{x})$ when $\alpha = 1$. The α is interpreted as a parameter of relative risk aversion.

Epstein and Zin (1989) show that the recursive structure for intertemporal utility (if $\alpha \neq 0$ and $\rho \neq 0$) is given by equation $U_t = [(1-\beta)c_t^\rho + \beta(E_t\tilde{U}_{t+1}^\alpha)^{\rho/\alpha}]^{1/\rho}$ $-(1)$

The concavity of this utility occurs by the influence of parameters ρ, α and δ : substitution, risk attitude, and time preference rate, respectively.

In our experiments, the choice of intertemporal consumption is replaced by the choice of intertemporal receipt of a meal ticket. Subjects are, however, not actually given these tickets. Some of them receive a small remuneration. Students in the first and third years of study at Keiai University and all degree students at Kyoto Sangyo University are participants in our experiments. We used paper questionnaires in our experiments. In those questionnaires, participants selected their most favorable choice. They were instructed to complete all questions and to select only one choice for each question. All questions inquired about preferences regarding receipt of a meal ticket. All questions Q1 – Q12 were included in one questionnaire. Subjects were not required to answer all questions. Units of all numbers in the questions were 10,000 yen.

Procedures of our test of recursive utility question (1) are divided into four steps. The first step is the estimation of the level of $(1-\beta)^{\frac{1}{\beta}}$. The second step is the estimation of the level of ρ and β simultaneously. The 3rd step is the estimation of the level of α. The last step is a test of validity of the recursive utility by Epstein and Zin (1989).

Our experimental results show that the ratios of important questions to determine the sizes of β, ρ and α at both universities are almost equal. At both universities, the ratios of subjects who prefer consumption this year to the consumption next year are 0.75% at Keiai and 0.74% at Kyoto Sangyo University. Ratios of subjects who prefer smooth consumption are 056 at Keiai University and 0.55 at Kyoto Sangyo University. These results demonstrate the reproducibility of our experiments. Risk attitudes are different. More risk avertors were identified at Kyoto Sangyo University than at Keiai University. Ratios of risk avertors were 0.731 at Keiai University and 0.891 at Kyoto Sangyo University. Results of our tests indicated 31.2% of Keiai participants as risk avertors and 36.8% of those participants at Kyoto Sangyo University: these results confirm the theory.

The first chapter of this paper explains the purpose of the experiment. The experimental design and the test procedure are explained in Chapter 2. In the third chapter, experimental results and interpretations are described. The f inal chapter presents conclusions based on results of our experiments: tests of utility theory by Epstein and Zin (1989) were partly successf ul. The results support the validity of the t heory. Nevertheless, our results suggest that a more sophisticated theory is needed to explain intertemporal risk attitude because something may have been overlooked: more than the half of the tests do not conform to the recursive utility model. One explanation is that the three factors are likely to be correlated.