Consumption, Computation Mistakes, and Fiscal Policy

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An understanding of the correct model of intertemporal consumption choice is crucial to evaluating the effects of fiscal policies. The debates over whether deficit policy matters (Martin Feldstein, 1974; Robert Barro, 1974) and, if so, how to measure such policy (Robert Eisner and Paul Pieper, 1985; Kotlikoff, 1986) are fundamentally debates about the correct model of consumption. Unfortunately, distinguishing empirically between different consumption theories is a subtle business that has produced no strong conclusions. One problem confronting many tests of alternative consumption theories is that they require joint and quite specific assumptions about preferences, economic resources, and the consumer's information set that may not be justified. In such cases, what is described as a rejection of a particular model may simply be a rejection of restrictive assumptions placed on the model.

A second problem that is also routinely swept under the rug involves the implicit assumption that consumers optimize perfectly given their preferences and resources, and that they correctly value their resources. In order to explore these more fundamental questions we, have conducted an experiment to determine whether individuals, when placed in a controlled life cycle setting, make consistent and coherent consumption choices, and whether they correctly value their future resources. The experiment provides negative answers to both of these questions; in the experiment subjects made significant and systematic errors in their consumption choice, reflecting, in part, an overdiscounting of future income.

This paper reviews several of the findings from our 1987 working paper, and then discusses their implications for fiscal policy. We give a brief description in Section I of the experiment. Section II describes inconsistencies and errors in consumption choice and traces them to the overdiscounting of future labor income. Section III presents some regression results also pointing to an undervaluation of future resources. Section IV discusses the implications of these results for viewing fiscal policy and suggests the need for additional experiments as well as consumption models that acknowledge, rather than avoid computation problems.

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I. Description of the Experiment

"Experiment" may be a somewhat misleading description of our exercise, but we use it for lack of a better term. The experiment was implemented by an interactive computer program in which subjects key in consumption choices in response to a series of questions. Forty-nine subjects (MBA students and undergraduates at Boston University) participated in the life cycle simulation. Subjects were asked what consumption choices they would make if they were single, faced no uncertainty, had specified levels of future earnings and current assets, knew their ages of retirement and death, and could borrow and save at a specified interest rate. The experiment differs from many in that participants, although paid $10 each to participate, were provided no salient rewards for their responses. However, it was strongly and repeatedly emphasized at the beginning of the experiment that subjects do their best to respond to all questions on the basis of what would make them most happy given the situation described.

Most subjects took about an hour and a half to finish; some finished within an hour, and some took as long as two hours. Sixty students completed the questionnaire. However, 11 questionnaires were excluded from the analysis either because they contained

key punch errors or because the subject failed to complete one or more sections. Therefore, the results to be discussed are based, in most cases, upon 49 sets of responses.

The questionnaire's basic economic setting can be summarized as follows. The individual in the experiment has just turned 35 and will live to his 75th birthday on which day he dies (with certainty). In his job he earns an annual salary of $25,000 until he retires on his 65th birthday—that is, he works for thirty years and is retired for ten. The individual can save or borrow as much money as he wishes at 4 percent interest. Subjects were instructed that in the questionnaire setting there is no inflation, deflation, or taxes, no dependents to support, no current or potential health problems, and no uncertainty about the future. All durable goods are rented by the year. Finally, it was assumed that annual consumption expenditures occur and that labor earnings are received on January 1st of each year and that the individual's birthday is also January 1st.

In the various parts of the questionnaire we changed different aspects of the basic setting. Specifically, we changed the initial age, the initial assets, the earnings profile, the interest rate, and the age of retirement. In two parts of the questionnaire, subjects were asked for consumption choices at each age between the initial age and the age of death. In other parts, the subjects were only asked to choose the level of consumption at the initial age specified. In these single-answer parts, we used four key ages, 35, 46, 55, and 69. Several precisely and several economically identical situations were repeated more than once to permit tests of consistency and proper discounting.

II. Inconsistencies and Errors in Consumption Choice

Since there is no uncertainty in our experimental setting, individuals should make the same consumption choice when facing the same present value of resources and the same interest rate. We tested this hypothesis by constructing 17 pairs of situations in which subjects face identical economic resources (at a 4 percent interest rate), but a possibly different mix of human and nonhuman wealth.

TABLE 1—SUMMARY OF ERRORS MADE IN PRECISELY AND ECONOMICALLY IDENTICAL SETTINGS

	Average	Median	Type	*d(Erns/Res)*
Age 35				
II–IIId	−.004	.000	1	.000
IIIc–Vc	−.231	−.250	2	.112
Va–Vb	.255	.250	3	.000
Vb–IIIb	.286	.000	2	−.223
IIIb–Va	−.232	−.200	2	.223
Age 46				
II–IIId	.141	.000	1	.000
IIIa–IVc	.040	.000	2	−.144
IIIc–IVd	−.107	−.087	2	.066
IVa–Vb	.083	.080	3	.038
IVa–IVb	.015	.037	2	.068
IIIb–Vc	−.104	−.065	2	.268
Age 55				
II–IIId	.264	.045	1	.185
Va–IIIc	.034	.000	2	−.009
IIIc–Vb	.059	.050	2	.056
Vb–Va	.030	.000	3	.026
Vc–IIIb	.088	−.042	2	−.015
Age 69				
II–IIId	.198	.042	1	.165

Note: Type 1 = Identical circumstances; Type 2 = Same resources, different *earns/res*; and Type 3 = Same resources, same *earns/res*, different *earns* pattern.

For all but 3 of the 17 cases the average absolute percentage error (defined as the absolute difference between the consumption choices in settings A and B divided by the consumption choice in setting A) exceeds 20 percent. Clearly, this constitutes strong evidence of substantial consumption mistakes. Moreover, consumption errors are widespread across the subjects. Each of the 49 subjects made at least 2 large consumption mistakes—an error in excess of 20 percent in absolute value. Thirty-seven of the 49 subjects made 5 or more large consumption errors in the 17 cases. Thirty-nine subjects made 1 or more very large errors—errors in excess of 40 percent in absolute value and, of these subjects, 11 made 5 or more very large errors.

Table 1 provides a summary of the results for 17 pairs and an indication that many of the consumption errors are systematic. Symbols like IIIb correspond to parts of the experiment providing the 17 pairs of circumstances. In calculating the average and median percentage errors, we divided the

difference in the two consumption choices by the consumption choice in the first of the two parts of the experiment indicated in the table. The table also displays the change in the human wealth share of total resources between the two pairs of questions as well as the way in which the two pairs of questions differed, if at all.

Consider, for example, the age 35 comparison of Part IIIc with Part Vc. In IIIc, the asset level is $130,000, while it is $65,000 in Vc. Since total resources are equal in the two cases, the ratio of the present value of earnings to total resources is greater in Vc. In addition, the timing of labor earnings differs. In IIIc, the earnings path is a constant $25,000 until retirement. In Vc it is $20,700 from ages 35 to 44, $31,000 from ages 45 to 54, and $42,500 from ages 55 to 64. Taking IIIc as the base, the median percentage change in consumption between IIIc and Vc is negative 25 percent. Of the 30 subjects who answered these 2 questions (Vc was added after some initial experiments were conducted), only 3 had nonnegative errors (i.e., they increased their consumption from IIIc to Vc). Some of the errors are quite sizable; 3 subjects reduced their consumption choice by more than 50 percent although they were in exactly the same economic choice situation.

The age 35 comparison of IIIb with Va also involves an increase in the earnings-resource ratio. Again, the median percentage error is negative; it is negative 20 percent. In this case, 10 of the 49 subjects reduced their consumption by 50 percent or more in switching from the IIIb circumstances to the Va circumstances. The age 35 Vb and IIIb comparison is quite similar; here the earnings to resource ratio falls, and while the median error is zero, the mean is .29, with 12 of 49 errors in excess of positive 50 percent. Overall, in 8 of 10 type-2 cases in which the earnings to resource ratio changes, the average error has the opposite sign of the change in the earnings to resource ratio.

In the age 35 comparison of Va and Vb, the earnings to resources ratio is unchanged. Compared with Vb, earnings in Va occur earlier in the life cycle. Again, there seems to be an undervaluation of future earnings. In this case the median consumption error in switching to Vb is positive 25 percent, and 20 of 49 subjects increase their consumption by 30 percent or more.

III. Regression Analysis

To test whether consumption is independent of the mix of resources, we ran regressions of the form:

$$(1) \qquad C = \alpha + \sigma_1 A + \sigma_2 E + u,$$

where A denotes the subject's assets, and E denotes the present value of her future earnings. Of course, the irrelevance of the mix of resources implies that σ_1 should equal σ_2. In addition, if preferences are homothetic, α equals zero. For each subject we estimated (1) separately at ages 35, 46, and 55 (at age 69, future earnings were zero), using the subject's responses to the multiple consumption choices she made at each of these ages.

The results of these regressions indicate that a significant minority of subjects displayed nonhomothetic consumption behavior. At age 35, the hypothesis of a zero intercept was rejected at the 5 percent significance level in 10 cases (of 49), at age 46 in 24 cases, at age 55 in 4 cases, and at age 69 in 8 cases. The age 46 regressions contained the largest number of observations (16 compared to the next largest number 10). Of the 196 estimated constants (49×4), 36 intercepts were significantly positive while only 10 were significantly negative. Thus, for the bulk of nonproportional subjects, the predicted APC falls with income.

Table 2 presents a summary of the distribution of assets and earnings coefficients. In 85 percent of the cases (124 of 147 regressions), the earnings and assets coefficients are both positive as predicted by the life cycle model. The coefficient on assets exceeded that on earnings in slightly more than half of the 147 regressions. In total, 41 of 147 (or 28 percent) of the regressions displayed coefficients that are statistically different from one another at the 5 percent level. In these 41 cases, the coefficient on assets exceed that on earnings 25 times. Finally, there is only a single, insignificant

TABLE 2—TESTS OF THE IMPORTANCE OF THE RESOURCE MIX TO CONSUMPTION[a]

	Age			
	35	46	55	Total
Total	49	49	49	147
σ_1, σ_2 Pos	35	44	45	124
$\sigma_1 > \sigma_2$	36	24	17	77
σ_1, σ_2 sig diff	14	11	16	41
σ_1 sig $> \sigma_2$	14	6	5	25

[a]Entries are number of regressions.

asset coefficient (which is negative) but 16 negative earnings coefficients, 8 of which are significant. It appears from these results that a significant minority of subjects undervalue earnings relative to assets, while a somewhat smaller minority overvalue earnings.

We repeated regression (1) on pooled data. The assumption of equal valuation of assets and earnings is strongly rejected for the pooled age 35 data, but accepted for the pooled age 46 and pooled age 55 data. In the age 35 pooled regression, the assets coefficient is over 7 times greater than the earnings coefficient. These results may reflect an inability of subjects to discount properly far distant earnings streams; that is, at ages 46 and 55 the future earnings streams extend for a shorter interval than at age 35.

We also checked whether squared powers of assets and earnings and the product of assets and earnings help explain consumption in the pooled data. These additional variables are jointly significant for the age 35 and the age 46 regressions.

Two additional results are worth mentioning in passing. First, pooling the data is very strongly rejected for each of the four ages; that is, there is heterogeneity in individual regression coefficients. Second, for a large percentage of subjects the standard time-separable homothetic consumption model explains only a modest fraction of the total variance in consumption choice. For example, if we constrain α to equal zero and σ_1 to equal σ_2 in (1), 70 percent of the $\bar{R}^2$s are below .5 for the age 35 subject-specific regressions. The corresponding percentages at ages 46, 55, and 69 are 51, 68, and 23 percent. Hence, assuming the standard time-separable homothetic life cycle model is correct, error in decision making accounts for a significant fraction of the variance in consumption.

IV. Implications for Fiscal Policy, and the Need for More Experiments and Models of Computation Difficulties

The results presented here suggest both an undervaluation of future resources by a significant minority of subjects and an overvaluation by a small minority. An obvious implication of an undervaluation of future relative to current resources is that Ricardian policies that change the timing, but not the present value of taxes will not be neutral. For example, a cut in taxes today coupled with an equal present value increase in taxes in the future will lead to more current consumption. This result is predicted by the *ad hoc* Keynesian consumption model, that places much greater weight on cash flows.

Our findings, however, should be viewed cautiously. First, they are based on only a small number of subjects. Second, although some analysis reported in our study suggests the ability of subjects to abstract from their own circumstances in making consumption choices, more research on this issue is needed. Indeed, considerably more experimental analysis of this kind is needed both to confirm our results and to pinpoint better the source of consumption mistakes.

Also needed are models that consider the costs of computation and bounded rationality. Models of computation costs could take the form of agents making mean zero errors in choosing their consumption, but being able to reduce the variance of these errors at a utility or monetary cost. A different approach would be to view costly computation as involving the acquisition of new information at a cost. The greater the cost of information acquisition, the less information will be obtained and the less calculation will occur. One problem with models of this kind is that they are not likely to predict the kind of systematic mistakes displayed in Table 1. In addition, they assume that it is costly to engage in some, but not all aspects of the decision-making process; for example,

it is costly to gather information, but is not costly to process information. Thinking about the costs of processing information—the costs of thinking—leads to the conundrum that thinking about thinking should itself be costly and the possible implication that rational choice may be individual-specific. If such is the case and individual-specific *ad hoc* approaches really do characterize behavior (Ken Binmore, 1987), it seems that careful controlled experiments may be the best way to start understanding that behavior.

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