

How Prudent Are Consumers?

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Using data from the Consumer Expenditure Survey, this paper presents a simple test that provides an explicit estimate of the parameter in the utility function that reflects the strength of the precautionary saving motive, the coefficient of relative prudence. The test yields a fairly precise estimate of a small precautionary motive; in fact, the estimate is too small to be consistent with widely accepted beliefs about risk aversion. The presence of liquidity-constrained households does not appear to explain this finding, and there is some evidence that self-selection of households into risky environments also cannot explain the results.

I. Introduction

Theories of precautionary saving have intuitive appeal and important empirical implications. Despite the recent emphasis on such theories, however, there have been few direct tests of whether the precautionary motive actually is an important force in consumer behavior. Using data from the Consumer Expenditure Survey, this paper presents a simple test that not only indicates whether a precautionary motive is present but also provides an explicit estimate of the parameter in the utility function that reflects the strength of the precautionary motive, the coefficient of relative prudence.

As Deaton (1992) emphasizes, uncertainty may substantially alter consumers' behavior. Skinner (1988) derives an approximation for optimal life cycle consumption that implies that, with plausible amounts of income uncertainty and risk aversion, precautionary sav-

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ing is more than half of total life cycle saving. Barsky, Mankiw, and Zeldes (1986) show that precautionary saving is one reason that Ricardian equivalence could fail: if a reduction in current taxes is balanced by an increase in future taxes that reduces the variance of future after-tax income, then consumers will increase current consumption. Caballero (1990) shows that the presence of a precautionary motive can explain several stylized facts about aggregate consumption: its "excess" growth, its "excess" smoothness in the face of persistent income innovations, and its "excess" sensitivity to anticipated income changes.

This study improves on prior empirical work on precautionary saving in several ways. First, the paper uses consumption variability as the measure of risk, whereas some previous studies use the variability of income. Consumption variability is a better measure of risk because the consumption of an optimizing household changes only in response to *unexpected* changes in income, which represent true risk.¹ Second, the paper uses a broad measure of consumption in contrast to the narrower measure of food consumption used in some previous studies.² As will be shown, changes in food consumption do not closely follow changes in total consumption. Third, the paper produces an explicit estimate of the coefficient of relative prudence. Previous research is designed to answer the question, Can we find evidence of precautionary motives in consumer behavior? I try to answer the more precise question, How prudent are consumers?

The test yields a small estimated coefficient of relative prudence with a small standard error; in contrast to common presumption, the data suggest that precautionary saving is an unimportant part of consumer behavior. The results suggest that not only is prudence smaller than recent research speculates, it is too small to be consistent with widely accepted views about risk aversion. Given this puzzling implication, the paper goes on to explore several alternative explanations for the results.

II. The Model

Consumer i 's problem at time t is to

$$\max_{C_{i,t+j}} E_t \left[\sum_{j=0}^{T-t} (1 + \delta)^{-j} U(C_{i,t+j}) \right] \quad (1)$$

¹ Note that optimizing households that expect a decline in income will save more in order to smooth consumption. If the measure of income variability disproportionately reflects these declines, one would find that it is positively related to saving even in the absence of a precautionary motive.

² For example, Kuehlwein (1991) studies food expenditure data from the Panel Study on Income Dynamics and finds no evidence of precautionary saving.

subject to

$$A_{i,t+j+1} = (1 + r_i)A_{i,t+j} + Y_{i,t+j} - C_{i,t+j}, \quad A_{it} \text{ given}, A_{i,T+1} = 0, \quad (2)$$

where E_t represents the expectation conditional on all information available at time t ; T represents the time of death; C_{it} is consumption, Y_{it} labor income, and A_{it} nonhuman wealth, all in period t ; δ represents the time preference rate, which is assumed to be constant over time and across households; and r_i represents the real after-tax interest rate, which varies across households. Utility is additive over time and concave ($U'' < 0$), and labor income is uncertain.

Solving the consumer's problem yields the following first-order condition for $j = 1$:

$$\left(\frac{1 + r_i}{1 + \delta} \right) E_t[U'(C_{i,t+1})] = U'(C_{it}). \quad (3)$$

This condition shows that greater uncertainty is linked to greater saving when the third derivative of utility is positive. An increase in uncertainty raises the expected variance of consumption, which in turn implies higher expected marginal utility when marginal utility is convex. For condition (3) to be satisfied, consumption in period t must fall and saving must rise.

Applying a second-order Taylor approximation of $U'(C_{i,t+1})$ to condition (3) and rearranging yield

$$E_t \left[\frac{C_{i,t+1} - C_{it}}{C_{it}} \right] = \frac{1}{\xi} \left(\frac{r_i - \delta}{1 + r_i} \right) + \frac{\rho}{2} E_t \left[\left(\frac{C_{i,t+1} - C_{it}}{C_{it}} \right)^2 \right], \quad (4)$$

where $\xi = -C_{it}(U''/U')$, the coefficient of relative risk aversion, and $\rho = -C_{it}(U'''/U'')$, the coefficient of relative prudence, as defined in Kimball (1990). If ρ is positive, then higher expected consumption growth (which reflects higher saving) is associated with higher expected squared consumption growth (which reflects greater uncertainty). This condition holds for the constant relative risk aversion (CRRA) utility function, $U(C) = (1 - \gamma)^{-1}C^{1-\gamma}$, and the constant absolute risk aversion (CARA) function, $U(C) = -\theta^{-1} \exp(-\theta C)$. It does not hold for quadratic utility for which $U''' = 0$; in this case, consumers' utility is affected by the presence of uncertainty, but their behavior does not change in response to it.

Equation (4) suggests a way to measure the strength of the precautionary motive using panel data on consumption. One can estimate

$$\frac{1}{M} \sum_{t=1}^M GC_{it} + \mu_i = \frac{1}{\xi} \left(\frac{r_i - \delta}{1 + r_i} \right) + \frac{\rho}{2} \left(\frac{1}{M} \sum_{t=1}^M GC_{it}^2 \right) + v_i + \eta_{it}, \quad (5)$$

where GC_{it} is individual i 's consumption growth in period t , M represents the number of periods in the sample, μ_i and v_i are error terms associated with replacing expected values with their sample means, and η_i represents "taste shifters," shocks to marginal utility that change consumption growth. Combining the error terms yields

$$\text{avg}(GC)_i = \frac{1}{\xi} \left(\frac{r_i - \delta}{1 + r_i} \right) + \frac{\rho}{2} \text{avg}(GC^2)_i + \epsilon_i. \quad (6)$$

The error term ϵ_i is correlated with $\text{avg}(GC^2)_i$, so two-stage least squares is used to obtain consistent estimates of $\rho/2$.³

The size of ρ determines the strength of the precautionary saving motive. Under the widely used CRRA utility function, $U(C) = (1 - \gamma)^{-1} C^{1-\gamma}$, the coefficient of relative prudence is $\gamma + 1$. Common choices for γ range from one (log utility) to four; thus the expected size of ρ is between two and five.

III. The Data

The data are drawn from the 1985 Consumer Expenditure Survey (CEX), which contains information on the income, demographic characteristics, and quarterly expenditure patterns of approximately 5,000 households. A given household's expenditures are recorded in the survey for four consecutive quarters, and the public-use tape for 1985 contains the complete four quarters of data for 1,875 households.

Durable expenditures are excluded from the analysis because they affect utility for more than one quarter, violating the assumption that utility is time separable. I construct nondurables and services consumption for each household by aggregating all expenditures classified as such in the National Income and Product Accounts. The data are adjusted for household size by dividing consumption by the number of adult equivalents in each household. I also adjust the data for aggregate seasonal and price trends by using the residuals from a regression of the log of consumption on dummy variables corresponding to the month in which the household was interviewed.⁴

A preliminary look at the CEX data reveals that this paper does indeed improve on earlier work by using both a more direct measure of uncertainty and a broader measure of consumption. The correlation between households' income changes and consumption changes

³ The obvious macroeconomic time-series analogue to this experiment is not interesting because most risk is idiosyncratic and averages out in the aggregate.

⁴ Dynan (1993a) contains a more detailed discussion of these adjustments.

is only .15; the correlation between the variance of income changes and the variance of consumption changes is only .17. Such low correlations may imply that many changes in income are expected. In addition, the correlation between households' food consumption growth and nondurables and services consumption growth is .46, and the correlation between the variances of these measures is just .28.

The CEX contains several variables that might predict uncertainty and thus be good instruments for $\text{avg}(GC^2)$: occupation, industry, and education for both male and female heads of household, the number of earners in a household, and the amount of dividend and interest income earned by a household during the 12 months prior to the survey, which proxies for liquid asset holdings. Although age is also likely to be correlated with uncertainty, it is an inappropriate instrument because it is probably a taste shifter and thus appears in the error term ϵ_t . To ensure that the instruments are uncorrelated with the error term, I choose realizations of these variables from the first quarter of data for a household.

Although the short length of the CEX panel implies that actual squared consumption growth is a poor measure of risk, two-stage least squares will generally yield consistent estimates of ρ . Further, if squared consumption growth reflected only noise, then it would be impossible to obtain precise estimates of ρ . In fact, as shown below, ρ can be estimated fairly precisely.⁵

The short length of the panel could lead to inconsistent estimates, however, if shocks affect entire groups of similar households at once. For example, an adverse shock to all households in an occupation could bias $\hat{\rho}$ downward by inducing low ex post consumption growth and high ex post consumption variability for these households. In the presence of group-specific shocks, consistency requires that the length of the sample, not merely the number of households, approaches infinity. To reduce the likelihood that group-specific shocks drive the results, I use several combinations of the instruments.

IV. Results

Basic Specification

I estimate equation (6) with three alternative sets of instruments. The first set consists of all the instruments, the second set omits education, and the third set omits occupation and industry. All regressions in-

⁵ Carroll (1992) argues that the estimates of ρ may reflect other phenomena linking consumption variability to the instruments. Yet he offers little persuasive justification for such linkages, and the range of instruments used here should protect against any problems connected with a single instrument.

clude age dummies in both stages as taste shifters and monthly dummies in both stages to allow for time-specific effects.

I also estimate equation (6) both allowing the term $(r_i - \delta)/(1 + r_i)$ to vary across households and restricting it to be the same. I construct household i 's real after-tax interest rate using its marginal tax rate (derived from the National Bureau of Economic Research's TAXSIM model) and the Treasury bill interest rate and consumer price index inflation rate for the four quarters during which the household was in the survey. The quarterly time discount rate is assumed to be 0.005.⁶ To ensure that this term is uncorrelated with the error term, I instrument for it with the household's beginning-of-sample real interest rate and marginal tax rate.

Table 1 summarizes the results. The first-stage results show that the instruments explain only a small part of the variability of consumption. The R^2 statistics for the first-stage regressions range from .040 to .062, and only for the education dummy variables can we reject the hypothesis that their coefficients are equal to zero.

In the second stage, the estimated coefficients on the interest rate term are small and positive with very large standard errors. These estimates of $1/\xi$ are consistent with those from similar studies of household expenditure data such as Zeldes (1989) and Lawrance (1991). The estimated coefficients on $\text{avg}(GC^2)$ reveal that risk affects consumption growth positively. This is what the precautionary saving hypothesis predicts: households that face more risk save more. The implied coefficients of relative prudence are very small, however, and the standard errors are small as well (though often larger than the coefficients). We cannot reject the hypothesis that the coefficient of relative prudence is zero, and the range of estimates is well below that used in many of the studies that emphasize the potential significance of precautionary saving. Thus the precautionary motive appears to be an unimportant part of consumer behavior.

In fact, the estimated strength of the precautionary motive appears to be simply *too* small. The highest estimate of ρ is .312 with a 95 percent confidence interval that ranges from $-.124$ to $.748$, so we can overwhelmingly reject the hypothesis that the coefficient of relative prudence is in the range implied by a reasonably parameterized CRRA utility function. Further, consider the more general class of utility functions for which absolute risk aversion is decreasing, an assumption that holds whenever additional wealth causes individuals to increase their absolute holdings of risky assets. Kimball and Weil (1991) show that for *any* such utility functions, the coefficient of rela-

⁶ Changing the interest rate and the assumed time discount rate has little effect on the results.

TABLE 1
BASIC RESULTS

	<i>r</i> CONSTANT ACROSS HOUSEHOLDS			<i>r</i> VARIES ACROSS HOUSEHOLDS		
	(1)	(2)	(3)	(1)	(2)	(3)
First-Stage <i>F</i> -Tests*						
Education	.013	...	.000	.014	...	.000
Occupation	.980	.657	...	.784	.290	...
Industry	.675	.501	...	.562	.442	...
Earners	.104	.094	.131	.362	.309	.338
Initial assets	.577	.455	.597	.298	.240	.353
First-stage <i>R</i> ²	.053	.040	.041	.062	.047	.047
Second-Stage Results						
$(r_i - \delta)/(1 + r_i)$	...	...	...	.098 (.852)	.108 (.851)	.116 (.872)
$\text{avg}(GC^2)_i$	.028 (.088)	.012 (.109)	.146 (.109)	.045 (.087)	.029 (.108)	.156 (.109)
Implied ρ	.056 (.176)	.024 (.218)	.292 (.218)	.090 (.164)	.058 (.216)	.312 (.218)
Test of overidentifying restrictions*	.883	.849	.851	.873	.857	.885

NOTE.—Full specification is described in the text. Corrected standard errors are in parentheses.
* *P*-values.

tive prudence must be greater than the coefficient of relative risk aversion. Mehra and Prescott (1985) cite a variety of studies that conclude that the coefficient of relative risk aversion is at least one, and their own analysis of the historical equity premium implies that the coefficient must be much larger than 10. Thus the small estimates of prudence reported here are extremely puzzling. In an attempt to resolve the puzzle, I consider two possible sources of bias in the results: the presence of liquidity-constrained households and the self-selection of households into risky environments.

Liquidity Constraints

As Zeldes (1989) emphasizes, the usual first-order condition will not be satisfied for liquidity-constrained consumers. Instead, these consumers will have faster consumption growth because the constraints force them to defer consumption that they would otherwise do. If liquidity-constrained consumers also have less variable consumption, the estimates of prudence in table 1 would be biased downward.⁷

⁷ As Deaton (1992) explains, the variance of permanent income innovations will exceed the variance of current income changes if shocks to labor income are very

Following Zeldes, I explore the role of liquidity constraints in my results by estimating equation (6) separately for high-wealth and low-wealth subsamples. High-wealth (presumably unconstrained) households are those for which liquid assets (the total value of checking and savings accounts, stocks, bonds, and money owed to the household) exceed one month's after-tax income; low-wealth households have liquid assets below that threshold. There were 134 households with incomplete wealth data, and they are dropped from the sample.

Table 2 presents results for the same three sets of instruments used previously, with the interest rate held constant across households. In all cases, the instruments explain more of the variability of consumption for the high-wealth households than for the low-wealth households. Further, the estimates of ρ for high-wealth households are larger than those for low-wealth households, with smaller standard errors. Nevertheless, one cannot reject the hypothesis that the estimated coefficient of relative prudence is zero for high-wealth households. It appears that the presence of liquidity-constrained households does not explain the failure to find significant precautionary saving in the full sample.

Self-Selection

Risk-hating households are more likely to choose professions with predictable incomes than households that are indifferent to risk. For a given level of income uncertainty, however, risk-hating households will do more precautionary saving. If the selection effect is stronger than the precautionary saving effect, then we would observe households that face less risk saving more; the estimate of $\rho/2$ in equation (6) would be negative. More formally, a downward bias arises because the true ρ differs across households and is correlated with the instruments; there is a violation of the overidentifying restrictions that the instruments are related to the dependent variable, $\text{avg}(GC)$, only through their correlation with the independent variable, $\text{avg}(GC^2)$.

One may investigate whether self-selection significantly biases the estimates of ρ by directly testing the overidentifying restrictions. If the restrictions are valid, the R^2 from a regression of the second-stage residuals on the instruments can be multiplied by the sample size to produce a variable with a χ^2 distribution with degrees of freedom equal to the number of restrictions minus one. Tables 1 and 2 contain the p -values from this test, and in no case can the restrictions be

persistent. So if shocks are persistent and liquidity-constrained agents consume their current income, they will have less variable consumption than agents who consume their permanent income.

TABLE 2

RESULTS FOR UNCONSTRAINED AND CONSTRAINED HOUSEHOLDS

	UNCONSTRAINED (<i>n</i> = 792)			CONSTRAINED (<i>n</i> = 941)		
	(1)	(2)	(3)	(1)	(2)	(3)
Second-stage results:						
$\text{avg}(GC^2)_i$	.070 (.086)	.118 (.100)	.083 (.119)	.018 (.141)	-.049 (.183)	-.001 (.181)
Implied ρ	.140 (.172)	.236 (.200)	.166 (.238)	.036 (.282)	-.098 (.366)	-.002 (.362)
Test of overidentifying restrictions*	.827	.757	.496	.944	.883	.781
First-stage R^2	.096	.078	.061	.058	.043	.044

NOTE.—Full specification is described in the text. Corrected standard errors are in parentheses.

* *P*-values.

rejected at any sensible level. This test may have low power when so many instruments are used; note that one can increase the critical value without changing the test statistic by arbitrarily adding instruments that are orthogonal to $\text{avg}(GC^2)$ and $\text{avg}(GC)$. But results in Dynan (1993a) reveal that even when only the education dummy variables are used, the *p*-value of the test is .751.

Another way to address the problem of self-selection is to focus on instrument sets for which self-selection is less likely to occur. While it is plausible that people will choose their occupations or industries partly on the basis of their attitudes toward risk, it seems less likely that risk plays a noticeable role in people's decisions concerning education, number of earners in a household, or holdings of liquid assets. Thus estimation results based only on the latter group of instruments are less likely to be biased by self-selection. Table 1 offers some confirmation of this argument: the estimates of ρ for the third set of instruments are indeed larger than the estimates based on the other instrument sets. But even these estimates are quite close to zero and quite far from the values that we expected. One caveat is that these variables may be invalid instruments for other reasons. For example, the overidentifying restrictions for these instruments would be violated if educational attainment was correlated with households' time preference rates.⁸

⁸ Lawrance (1991) finds striking differences in the consumption growth rates of households with different levels of education; she attributes this finding to differences in time preference rates. But Dynan (1993b) shows that the finding can also be explained by recent changes in relative wages.

V. Conclusion

This paper uses household expenditure data to test for precautionary saving motives, improving on previous studies by using a more direct measure of risk and a broader measure of consumption. The test yields a precise estimate of a small precautionary motive; in fact, the estimate is too small to be consistent with widely accepted beliefs about risk aversion. The presence of liquidity-constrained households does not appear to explain the failure to find a strong precautionary motive, and there is some evidence that self-selection of households into risky environments also cannot explain the results. We are left with a puzzle, and future research should investigate whether the results in this paper hold for other data sources and under broader specifications.

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