ESTIMATING PRUDENCE

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INTRODUCTION

It is widely understood that risk-averse individuals prefer a guaranteed income to an uncertain income, and that prudent individuals take precautions when faced with risk. Indeed, shortly after Pratt [1964] and Arrow [1965] introduced formal measures of risk aversion based on decreasing marginal utility, Leland [1968] showed that precautionary behavior requires convex marginal utility—a condition Kimball [1990] later termed "prudence". Because of the behavioral implications, estimates of prudence would seem to be at least as valuable as estimates of risk aversion, and arguably more so; yet few attempts have been made to measure prudence, either directly or indirectly. Indeed, precautionary saving is the only manifestation of prudence to have received serious empirical attention, and much of that has been disappointing. While numerical simulations have suggested that the magnitude of precautionary saving is potentially quite large, most empirical tests using actual data have found little or no evidence of precautionary saving, and thus have failed to observe any significant degree of prudence.

The present paper develops a revealed-preference approach to the measurement of prudence, which appears to have greater empirical potential than earlier estimation methods. After a brief review of the existing literature to provide a context for the current study, we derive a reduced-form equation for the coefficient of relative prudence from an expected utility model of life insurance demand. Estimates of prudence for members of various demographic and behavioral subgroups are then calculated from a data set containing a cross-section of the population, and the paper concludes with a discussion of caveats and potential extensions.

PREVIOUS RESEARCH

It has long been established that an individual whose utility (U) of wealth (W) increases at a decreasing rate is risk averse in the sense of preferring the certainty of wealth to its mere expectation. Because the concavity of utility (the extent to which $U'(W) > 0$ and $U''(W) < 0$)) governs one's attitude toward risk in this manner, both Pratt [1964] and Arrow [1965] suggested that $A = -U''(W) / U'(W)$ is an appropriate measure of absolute risk aversion, and that $R = -WU''(W) / U'(W)$, the wealth-elasticity of marginal utility, is a reasonable measure of relative risk aversion. But Leland [1968] demonstrated that under additive risk, in which gains are simply added to

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wealth and losses are subtracted, precautionary saving—the accumulation of wealth in response to risk—also requires convex marginal utility, whereby $U'''(W) > 0$. And Mirman [1971] showed that when risks to wealth are multiplicative (as from uncertain inflation or interest rates), precautionary saving occurs only if $R > 1$ and $R = -WU'''(W) / U''(W) > 2$. Because the convexity of marginal utility governs precautionary behavior in this way, Kimball [1990] describes the $U'''(W) > 0$ condition as prudence, and defines two measures of the intensity of the precautionary motive: absolute prudence, $\eta = -WU'''(W)/U''(W)$, and relative prudence, $\rho = -WU'''(W)/U''(W)$.

The relationship between prudence and risk aversion can be seen by differentiating A to get $\eta = A-(A'/A)$. Equivalently, after multiplying both sides by wealth, relative prudence can be expressed as the difference between its two component parts, relative risk aversion and the wealth-elasticity of absolute risk aversion:

$$\rho = R-(WA'/A). \tag{1}$$

If the utility function exhibits decreasing absolute risk aversion (DARA) as hypothesized by Pratt and Arrow, then $A' < 0$ and the individual is more prudent than risk averse: more inclined to take precautions than to avoid risk. This implies complementarity between saving and risk, or equivalently, that saving and insurance are substitutes [Kimball, 1990; 1991]; additionally, it implies that risk-bearing is a normal good. One often-used example of DARA is the constant relative risk aversion (CRRA) utility function, $U(W) = (W^{1-\alpha})/(1-\alpha)$, for which $R = \alpha$ and the wealth-elasticity of absolute risk aversion is negative one, so that $\rho = R + 1$. In contrast, under constant absolute risk aversion (CARA), $\rho = R$. And with increasing absolute risk aversion (IARA), the individual is more risk averse than prudent; in that case, saving and insurance are complements, and risk-bearing is an inferior good.

Thus, as one of the underlying parameters of the utility function, the magnitude of relative prudence is closely related to the magnitude of relative risk aversion, and yet has important behavioral implications of its own. A value of $\rho < 0$ implies imprudence, or increasing consumption as risk increases; $\rho = 0$ indicates a lack of precautionary motives; $\rho > 0$ implies a tendency to undertake precautionary saving in the face of additive risk, while $\rho > 2$ implies precautionary saving under multiplicative risk; and the difference between ρ and R determines whether risk-bearing is a normal or inferior good. As a policy matter, these results suggest that government provision of social insurance will displace precautionary saving if consumers are sufficiently prudent [Baily, 1978], but uncertainty regarding future tax rates, interest rates, or price levels may not affect saving unless $R > 1$ and $\rho > 2$. The effects of stabilization policy thus depend in part on how prudent individuals are. Empirical estimates of prudence should therefore be of value to both policymakers and economists interested in understanding behavior under uncertainty, yet such estimates have thus far been elusive.

Indeed, there has been a notable discrepancy between *assumed* values of prudence used to simulate precautionary saving, and those *implied* by actual savings data. In order to estimate a plausible magnitude for the volume of precautionary

saving, Skinner [1988] inserted what he believed to be reasonable parameter values into a theoretical model, and found that under CRRA with $R = 3$ (or equivalently, $\rho = 4$), precautionary saving might account for as much as 56 percent of all life-cycle saving. At similar parameter values, Zeldes' [1989] numerical simulation suggested that precautionary saving could be up to 20 percent as large as optimal consumption, and Deaton's [1992] calibration suggested that prudent consumers might save 20 percent of income on a precautionary basis. Additional simulations by Caballero [1991] and Carroll and Samwick [1998] indicated that between 45 percent and 60 percent of net household wealth might ultimately be accumulated through precautionary saving.

But despite the potentially great magnitude of precaution suggested by these hypothetical simulations, most formal empirical tests have found little or no evidence of prudent behavior. Skinner's [1988] test results, in fact, contradicted the premise of precautionary saving by showing that workers in jobs with greater income risk actually save significantly less than those with greater certainty of income. Likewise, Kuehlwein [1991], Grossberg [1991], and Parker [1999] each failed to observe precautionary saving, and by implication, failed to obtain evidence of prudence. Guiso, Jappelli, and Terlizzese [1992] found some evidence of prudence in Italy, but it was manifested by an extremely low rate of precautionary saving, equal to about 0.1 percent of permanent income, which they estimated would accumulate over 20 years to only about 2 percent of wealth. Kazarosian's [1997] research indicated that a 10 percent increase in uncertainty, as measured by the standard deviation of transitory income, would increase the ratio of wealth to permanent income by just 2.9 percent.[1] And in the only study to attempt an outright estimation of the magnitude of prudence, Dynan obtained implausibly small and insignificant values; she concluded,

> 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. [1993, 1109]

Clearly, there has been a wide divergence between the numerical simulations and the formal tests using actual data; evidently, either the simulations assumed unreasonable parameter values, or the empirical tests failed to capture the true extent of prudence. The widespread belief in prudent attitudes and precautionary motives tends to suggest the latter, although it is difficult to judge *a priori*, especially because of methodological difficulties in both types of analyses.

One limitation of existing research is the use of specific utility functions. In order to obtain reduced-form equations for estimation, earlier models almost invariably imposed either constant absolute risk aversion (CARA) or constant relative risk aversion (CRRA) on utility. Because such an assumption guarantees prudence, it makes precautionary behavior inevitable. This is particularly troubling in the simulations, as it suggests a possible exaggeration of the importance of prudence. By contrast, the present model uses an unrestricted utility function, which assumes only that households are risk averse, so that no preordained conclusion arises.

A second common feature of the studies cited above is the context in which they were undertaken. Specifically, investigations of precautionary saving have tended to focus on consumer responses to speculative risk; that is, to situations involving potential gain as well as potential loss. But precautionary behavior may be more prevalent under conditions of pure risk, (i.e., in situations where loss is possible but gain is impossible [Eisenhauer, 1995]). Consequently, prudence is more likely to be found in an analysis of insurance or other contingent-claims contracts than in a study of transitory income, gambling, or other speculative risk situations. Several recent studies have confirmed that individuals respond differently to these different forms of risk [Powell and Ansic, 1997; Schubert, et al., 1999; Halek and Eisenhauer, 2000], and evidence of prudence has begun to emerge from investigations of behavior in pure risk contexts. Eisenhauer [1994] obtained evidence of precautionary saving against the threat of job loss, while Levin [1995] found that the elderly undertake precautionary saving against the risk of illness. Examining mortality risk, Eisenhauer [1998] and Eisenhauer and Halek [1999] found households to be approximately as prudent, on average, as they are risk averse. The latter two studies, the first using aggregate data and the second using disaggregated data, calculated the ratio of prudence to risk aversion, without isolating the magnitude of prudence *per se*. The present study extends that line of research by directly estimating the coefficient of relative prudence for each of several demographic subgroups, using survey data on life insurance coverage.

An additional problem inherent in most previous empirical research is the self-selection of individuals into situations involving different degrees of risk based on their risk preferences, so that their subsequent behavior cannot rightly be construed as a response to exogenously imposed risk. In their survey of the literature, Browning and Lusardi point out that of all the difficulties in empirical work,

> The exogeneity issue is...the most problematic. ...Suppose, for instance, that risk aversion and prudence are positively correlated across the population. Risk averse agents will choose less risky jobs but they will also be more prudent and, *ceteris paribus*, save more. Thus even if there is a strong precautionary motive for all agents we may not observe a positive cross-section correlation between earnings risk and saving rates. [1996, 1837][2]

Consequently, while the most novel departure from earlier work is the examination of life insurance purchases rather than savings, a related advantage of the present paper is the use of an unambiguously exogenous source of risk: a mortality rate based on age and gender.

A less obvious methodological improvement over several prior empirical studies is that the present work uses a direct estimation approach without resorting to instrumental variables. Taken together, these changes in procedure appear to pay off. The estimates of relative prudence obtained below range from about 1.51 to 5.15, almost precisely the range anticipated (but not obtained) by Dynan [1993], and assumed in most of the simulation studies.[3]

MODEL

We begin with a standard model of life insurance demand. A household's concave utility function is given by $U(W)$ such that $U''(W) < 0 < U'(W)$. For simplicity, assume that the head of the household is the sole wage earner, and let Y represent the present value of his or her expected future earnings, conditional on his or her survival. Y thus captures the human capital component of household wealth. There is a probability (p) of the breadwinner's death causing the loss of Y, and a complementary probability $(1 - p)$ of survival during the period in question. The household's accumulated stock of non-contingent assets (X), excluding human capital, is not subject to the same risk as Y. Thus, bank accounts, automobiles, and other such assets are retained by survivors, regardless of the breadwinner's fate. Term life insurance coverage (V) is available at a premium rate (or per-dollar cost of coverage) of m, such that $0 < m < 1$,, and the premium rate reflects a markup (or loading) over the mortality rate of the insured, so that $m > p$. The total premium for life insurance is mV, and is paid regardless of the prevailing state of nature. If a death and the consequent loss of Y occurs, the household recovers V in life insurance claims. The household's expected utility is therefore given by

$$EU = (1 - p)U(X + Y - mV) + pU(X + V - mV). \tag{2}$$

This conventional, single-period model is adopted for convenience; but because a rational, forward-looking household takes all known information into account in the initial purchase decision, the central results extend to multiple periods [Campbell, 1980].[4]

Constructing a second-order Taylor series expansion of equation (2) around the point of full coverage $(V = Y)$ gives

$$\begin{aligned} EU \approx\ & (1 - p)U(W) - m(1 - p)(V - Y)U'(W) + (1/2)m^2(1 - p)(V - Y)^2U''(W) \\ & + pU(W) + (1 - m)p(V - Y)U'(W) + (1/2)(1 - m)^2p(V - Y)^2U''(W), \end{aligned} \tag{3}$$

where

$$W = X + (1 - m)Y. \tag{4}$$

For small m, W is approximately equal to $X + Y$, and may thus be interpreted as overall wealth, consisting of both human capital and non-contingent assets.[5]

The household chooses V to maximize expected utility, and this yields an optimal level of insurance, V^*, defined by the first-order condition

$$(V^* - Y)U''(W) = \theta U'(W) \tag{5}$$

where insurance loading is captured by the parameter

$$\theta = (m - p)/[m^2(1 - p) + (1 - m)^2 p] \tag{6}$$

Notice that for any loaded premium ($m > p$), $\theta > 0$ and thus overinsurance is precluded, since optimal coverage is less than the potential loss ($V^* < Y$).

The measures of risk aversion and prudence can now be derived from equation (5). Simply rearranging equation (5) yields absolute risk aversion as

$$A = \theta/(Y - V^*) \tag{7}$$

and multiplying by W gives relative risk aversion as

$$R = W\theta/(Y - V^*). \tag{8}$$

Differentiating equation (5) with respect to X gives[6]

$$(V^* - Y)U'''(W) + U''(W)\partial V^*/\partial X = \theta U''(W) \tag{9}$$

and rearranging equation (9) yields the measure of absolute prudence,

$$\eta = (\theta - \partial V^*/\partial X)/(Y - V^*); \tag{10}$$

multiplying equation (10) by W then gives relative prudence as

$$\rho = W(\theta - \partial V^*/\partial X)/(Y - V^*). \tag{11}$$

Finally, by using equation (8), equation (11) can be decomposed in the manner of equation (1) as

$$\rho = R - \varepsilon \tag{12}$$

where

$$\varepsilon = W(\partial V^*/\partial X)(Y - V^*) = W(\partial V^*/\partial W)(Y - V^*) = WA'/A \tag{13}$$

represents a conditional wealth-elasticity of absolute risk aversion, given that the human capital component of wealth remains constant while non-contingent assets increase.

Conveniently, equations (10) and (11) (or equivalently, equations (8), (12), and (13)) provide reduced forms for estimating the prudence parameters without the need for imposing additional restrictions (such as constant relative risk aversion) on the utility function. They therefore allow a variety of outcomes. Indeed, note that negative coefficients, reflecting imprudence, are possible with this model (if $\theta < \partial V^*/\partial X$).

ESTIMATION

The model above is estimated using 1992 survey data from Wave I of the University of Michigan's Health and Retirement Study (HRS). The full HRS data set consists of 12,652 individuals in 7,607 households; for present purposes, we include only households that had purchased individual term life insurance policies on the head of the household. The total face value of all such term policies is the empirical measure of V^* from the model above; for consistency with the model, group coverage is excluded, as are whole life and other forms of insurance containing cash value components. The resulting sample contains 1,198 households with term life insurance on the primary breadwinner. The potential loss to the household if the breadwinner dies (Y) is constructed by separating out the head's contribution to gross household income, deducting income taxes using the Internal Revenue Service's [1992] rate schedules, extending the net earnings over the reported number of years to retirement, and discounting back to present value at an assumed rate of two percent. For those survey respondents who did not report a planned retirement age, we assume a retirement age of 65. A mortality rate (p) for each insured is obtained by gender and age from actuarial tables in Bell et al. [1992]. Due to missing and inconsistent data on premiums, a premium rate (m) for each policyholder is computed as a function of mortality and insurance coverage, based on average rate schedules published by the Federal Trade Commission [1979]. The mortality and premium rates are used to compute θ for each insured head of household according to equation (6). The non-contingent assets variable (X) measures the household's net worth, including housing; mortgages and other household debt are thereby taken into account. The overall wealth variable (W) is constructed according to equation (4).

The estimation proceeds as follows. First, the partial derivative $\partial V^*/\partial X$ is estimated by a linear, ordinary least squares regression of term insurance coverage on X, Y, θ, and a vector of control variables consisting of the age, education, and gender of the head of the household. The resulting regression coefficient of X is then substituted into equation (11) along with mean values of θ, Y, V^* and W to calculate ρ. Table 1 reports relative prudence along with its risk aversion and wealth-elasticity components for the overall sample and several demographic subgroups.[7] The estimated coefficient of relative prudence is 3.28 for the overall sample, and the estimates range between about 1.51 and 5.15 across demographic groups; indeed, for most groups, $\rho > 2$. This is remarkably consistent with the range from 2 to 5 that has been assumed in most simulations, and suggests that previous failures to obtain empirical evidence of prudence may have resulted from type II statistical errors, due perhaps to the context or exogeneity problems described above.

Moreover, despite considerable differences in methodology, the estimates of relative risk aversion, which range from 1.7 to 5.3, are consistent with those of Barsky et al. [1997]; yet the estimates are well below those implied by the equity premium

TABLE 1
Demographic Estimates of Relative Prudence
(Standard errors in parentheses.)

Sample	Obs.	θ	Y	V	W	∂V/∂X	R	ε	ρ
All	1,198	.8054 (.02862)	125,566 (6,847)	47,203 (2,851)	339,299 (17,730)	.04754[a] (.005)	3.4872	.2058	3.2814
Men	603	.3999 (.01879)	175,395 (12,502)	70,725 (5,163)	454,576 (31,077)	.05307[a] (.007)	1.7367	.2305	1.5063
Women	595	1.2164 (.04888)	75,066 (4,598)	23,366 (1,926)	222,472 (15,425)	.01896[a] (.005)	5.2343	.0816	5.1527
Age >= 56	652	.6615 (.03126)	76,976 (7,270)	39,162 (3,747)	304,633 (22,347)	.05534[a] (.007)	5.3291	.4458	4.8833
Age < 56	546	.9773 (.04954)	183,589 (11,797)	56,806 (4,340)	380,695 (28,229)	.03904[a] (.007)	2.9346	.1172	2.8173
Married	831	.7177 (.03367)	139,869 (8,608)	56,431 (3,882)	403,267 (22,911)	.05003[a] (.006)	3.4687	.2418	3.2269
Unmarried	360	1.0002 (.05320)	94,991 (10,952)	26,669 (2,823)	197,536 (24,478)	.02858[a] (.007)	2.8918	.0826	2.8092
Parents	634	1.1358 (.04624)	85,677 (7,020)	26,523 (2,050)	244,881 (19,040)	.01990[a] (.004)	4.7019	.0824	4.6195
Childless	564	.4340 (.02312)	170,405 (11,945)	70,451 (5,436)	445,435 (30,393)	.05986[a] (.008)	1.9341	.2668	1.6673

a. Significant at the .01 level

puzzle [Mehra and Prescott, 1985]. Furthermore, the values of $\partial V^*/\partial X$ are positive and significant for most groups in the study, yielding small but positive estimates of ε, and indicating that absolute risk aversion is increasing slightly with respect to non-contingent assets. This finding would tend to suggest that risk-bearing, at least within the context of pure risk, is a somewhat inferior good. Alternatively, it may simply reflect greater financial sophistication and awareness of insurance needs among the wealthy than among the non-wealthy.[8] What is of most interest for present purposes, however, is that with low R and positive ε values, one might anticipate extremely small measures of relative prudence, yet our estimates are much higher than those of Dynan [1993], whose largest point estimate for ρ was 0.312. On the other hand, the exclusion of uninsured households tends to bias the present estimates upward. Households who choose not to insure (those for whom $V^* = 0$) tend to have fairly low degrees of relative risk aversion (according to the model, excluded households must have $R \leq \theta\, W/Y$), and may be expected to have correspondingly low levels of prudence. The difference between these two cohorts, however, may not be very great: Barsky et al. [1997] estimate an eight percent difference in the average relative risk aversion of those with life insurance and those without it.

In addition to the estimated range of values, the demographic differences in prudence and risk aversion are of interest in their own right. While it has been widely reported in the literature, for example, that women are more risk averse than men [Powell and Ansic, 1997; Jianakoplos and Bernasek, 1998; Sunden and Surette, 1998], the present study indicates that women are also more prudent than men in the Leland-Kimball sense. Indeed, female heads of households exhibit a coefficient of relative prudence nearly 3.5 times as great as male heads of households. Dividing the sample at the median age (56) reveals that prudence is also higher among the older cohort than among the younger cohort, by nearly 75 percent. Married heads of households appear to be somewhat more prudent than unmarried heads, and parents are more than twice as prudent as those without children. Evidently, prudence—the propensity to take precautions when faced with risk—is not independent of familial relationships. And it is useful to bear in mind that these comparisons are not based solely on differences in insurance coverage *per se*. Indeed, households without children purchased more insurance on the primary breadwinner, on average, than households with children, both in absolute terms and relative to their potential losses. Yet the latter are found to be more prudent after controlling for differences in mortality risk, insurance loading, age, and other factors as described above.

To investigate the relationship between the derived measures of prudence and actual precautionary behaviors, we next divide the sample into several behavioral subsets. As Table 2 indicates, nondrinkers appear to be about 56 percent more prudent than those who consume alcohol on a regular basis, and nonsmokers are approximately 20 percent more prudent than smokers. Moreover, among the nonsmokers, those who have never smoked are about 78 percent more prudent than those who quit smoking. Inasmuch as abstinence from addictive and carcinogenic consumption corresponds to one common understanding of what constitutes prudent behavior, these results are intuitively appealing. At the same time, those who report having an active lifestyle evince somewhat greater prudence than those who tend toward inactivity, and those who regularly attend churches, synagogues, mosques, or other places of worship appear to be slightly more prudent than those who do not.

The HRS survey also questioned respondents about their willingness to gamble on a new job opportunity. Specifically, respondents were asked whether they would accept a new position, otherwise equal to their current employment, but with a 50 percent chance of doubling their current income and a 50 percent chance of cutting their income by one-third. Although this question is strictly hypothetical, and hence the answers must be viewed with some degree of skepticism, it provides an opportunity for assessing whether avoidance of speculative risk is consistent or inconsistent with greater prudence as measured in a pure risk context. Note that, because the question offers a favorable gamble with an expected income one-third higher than current income, one need not be risk-loving to accept the proposal; either acceptance or refusal of the proposed gamble is therefore consistent with the concave utility function modeled above. The point estimates derived in Table 2 suggest that those who would refuse this gamble are approximately 12 percent more prudent than those who

TABLE 2
Behavioral Estimates of Relative Prudence
(Standard errors in parentheses.)

Sample	Obs.	θ	Y	V	W	∂V/∂X	R	ε	ρ
Drinkers	703	.7063	155,741	57,797	407,796	.0456[a]	2.9407	.1899	2.7509
		(.0346)	(10,589)	(4,226)	(26,699)	(.006)			
Nondrinkers	495	.9462	82,711	32,158	242,019	.05116[a]	4.5299	.2449	4.2850
		(.04817)	(6,503)	(3,295)	(19,295)	(.008)			
Smokers	320	.8495	117,563	37,475	269,434	.00007	2.8579	.0002	2.8577
		(.05898)	(14,898)	(4,098)	(27,864)	(.008)			
Nonsmokers	878	.7894	128,483	50,749	364,762	.05649[a]	3.7042	.2651	3.4391
		(.03261)	(7,606)	(3,586)	(21,903)	(.006)			
Never Smoked	435	.8716	118,685	46,227	389,930	.04473[a]	4.6905	.2407	4.4498
		(.05085)	(12,240)	(4,312)	(37,845)	(.006)			
Quit Smoking	443	.7086	138,103	55,190	340,049	.09909[a]	2.9062	.4064	2.4998
		(.0407)	(9,088)	(5,705)	(22,427)	(.013)			
Active Lifestyle	280	.6624	182,708	86,348	531,942	.03276[a]	3.6567	.1808	3.4758
		(.05523)	(18,371)	(8,945)	(54,028)	(.011)			
Inactive Lifestyle	918	.8490	108,137	35,264	280,541	.05337[a]	3.2684	.2055	3.0629
		(.03322)	(6,864)	(2,400)	(15,765)	(.005)			
Churchgoers	674	.8442	105,215	40,016	284,859	.06829[a]	3.6884	.2984	3.3900
		(.03944)	(6,632)	(3,347)	(15,413)	(.009)			
Non-church	524	.7555	151,742	56,448	409,323	.0408[a]	3.2452	.1753	3.0699
		(.04128)	(13,045)	(4,869)	(35,144)	(.006)			
Gamblers	295	.8183	142,874	55,001	344,614	.05592[a]	3.2092	.2193	2.9898
		(.06085)	(18,872)	(6,007)	(34,775)	(.011)			
Nongamblers	876	.7935	122,056	45,321	343,354	.04650[a]	3.5506	.2081	3.3425
		(.03294)	(6,787)	(3,315)	(20,991)	(.006)			

a. Significant at the .01 level

would willingly wager their income. Consequently, the results suggest that individuals exhibiting higher degrees of prudence are somewhat more likely than others to avoid speculative risks, even when the prospects involve favorable odds and positive expected gains; this is consistent with the higher degree of relative risk aversion computed for "nongamblers" (3.55) than for "gamblers" (3.21).

Indeed, because ε appears to be more stable than R across most of the groups in the study, differences in relative prudence generally mimic differences in relative risk aversion. Thus, for example, the older cohort, females, nondrinkers, and nonsmokers are all more risk averse, as well as more prudent, than their respective counterparts. These demographic and behavioral contrasts in risk aversion are consistent with the findings of Barsky et al. [1997], who used the hypothetical income gambles in the HRS to assess risk tolerance.[9]

A notable exception to the correspondence between prudence and risk aversion in Table 2 is that smokers, who exhibit CARA with $R = \rho = 2.858$, are slightly less risk averse but more prudent than those who quit smoking, among whom $R = 2.91$ and $\rho = 2.5$. Thus, the tendency for those with higher degrees of risk aversion to exhibit higher levels of prudence appears to be common but not universal.

CONCLUSION

This paper has attempted to estimate the Leland-Kimball coefficient of relative prudence, along with its risk aversion and elasticity components, for a sample and several sub-samples of the U.S. population drawn from the HRS survey. It has been more successful in some respects than others. In particular, the life insurance model forming the basis for the estimation has several convenient properties: it establishes a reduced-form equation for the coefficients of prudence without imposing undue restrictions on utility and the resulting equations can be estimated directly, without the use of instrumental variables.[10] Additionally, the empirical estimates made from this model allow us to draw at least a few broad conclusions. First, our results suggest that low, positive measures of relative prudence are indeed reasonable parameter values for numerical simulations undertaken to gauge the importance of precautionary saving. Second, we find that the economic conception of prudence is generally consistent with several behavioral and lifestyle choices commonly perceived to be prudent, such as attending religious services and abstaining from the use of tobacco. And third, it seems the usual but not universal tendency is for those with greater relative risk aversion to demonstrate greater relative prudence.

The equations derived to measure prudence, however, should ideally be estimated using longitudinal data, with several periodic observations per household.[11] This would permit an estimation to be carried out for each household, as the theoretical model envisions. Unfortunately, longitudinal data at the household level containing the necessary variables are not presently available, and so the aggregation of households into demographic and behavioral subgroups has been undertaken as a second-best approach. Because this implicitly assumes consistent utility functions within groups, the robustness of the theoretical model is offset to some degree by a lack of empirical robustness. Thus, while the resulting estimates are consistent with intuition and prior expectations, and appear to represent an improvement over previous measurements, they should be regarded as primarily illustrative. Nonetheless, the present methodology appears to have significant potential as an estimation technique, and should become increasingly useful as the quality of data collection improves.

NOTES

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1. Kazarosian's interpretation of his regression coefficients is somewhat more grandiose: "A doubling of uncertainty increases the ratio of wealth to permanent income by 29%" [1997, 244]. That, however, would seem to be an implausible extrapolation. First, an increase of that magnitude in the standard deviation of transitory income—a quadrupling of the variance—is unlikely to occur in practice. Second, if such a shock did occur, it would very likely alter the coefficients of the regression equation. Thus, a marginal interpretation appears more reasonable. Either way, the finding indicates an inelastic response to risk.
2. Note that this would explain the apparent contradiction between Skinner's [1988] numerical simulation and his formal empirical test.
3. The range of relative prudence from 2 to 5 suggested by Dynan [1993] is based on previous studies which assumed constant relative risk aversion with R ranging from 1 to 4 across households.
4. Additionally, the use of a single-period model of term insurance prevents any confusion from arising between precautionary and intertemporal motives, as might occur under a multiple-period model of whole life insurance.
5. For the overall sample used in the empirical estimation below, the mean value of m is less than 2 percent.
6. Note from equation (4) that the partial derivative of W with respect to X is given by $\partial W/\partial X = 1$. Hence $U''(W)\ \partial W/\partial X = U''(W)$ and $U'''(W)\partial W/\partial X = U'''(W)$.
7. For expository convenience, the tables report only the coefficient of relative prudence. The coefficient of absolute prudence can be retrieved by simply dividing ρ by W.
8. The latter interpretation was suggested by a referee. Eisenhauer [1997] also finds evidence of IARA in a life insurance context, whereas earlier studies by Szpiro [1983] and Wolf and Pohlman [1983] yielded mixed results.
9. For a more detailed comparison of demographic differences in risk aversion in both pure and speculative risk contexts, see Halek and Eisenhauer [2000].
10. Moreover, it is interesting to observe that the life insurance context is merely one example of this pure-risk approach; more generally, it appears that any expected utility model of pure-risk decision-making which distinguishes contingent from non-contingent income, assets, or expenditures could be manipulated to yield equations equivalent to equations (10) and (11).
11. Because the regression has $n - 7$ degrees of freedom for n observations, a minimum of eight or more observations per household would be required. Since life insurance coverage is unlikely to change more frequently than once per year, the periodicity of observations would probably need to be annual.

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