Non-expected Utility, Saving and Portfolios

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Abstract

Existing findings suggest that standard, frictionless, expected-utility models have difficulty accounting for average and for median holdings of wealth and of risky assets, partly as a result of the largely unexplained limited proportion of stockholders among households. We analyze life-cycle wealth accumulation and portfolio choice under career uncertainty and quantifiable departures from expected utility maximization. Our specification nests expected utility and three types of non-expected utility: (i) Kreps-Porteus preferences that disentangle risk aversion from elasticity of substitution, (ii) Yaari's Dual Theory of Choice, and (iii) Quiggin's Rank-dependent Utility. Specifications (ii) and (iii) exhibit "first-order" risk aversion and kinked indifference curves. Solution of such models under multiple sources of risk presents conceptual and computational difficulties. We introduce a notion of equilibrium and a computational algorithm appropriate for such setups. Computed wealth and stockholding, based on calibrated income processes for three education categories, are compared to the 1992 *Survey of Consumer Finances*. Rank-dependent utility enhances the importance of precautionary effects. Contrary to priors in the literature, solutions are not typically at kinks; neither kinks nor actual solutions involve zero stockholding when income risk is recognized; and yet predictions about average wealth and risky assets tend to improve for all education categories. Mere disentangling of risk aversion from elasticity has small effects, while dual theory predictions are farther from the data and the signs of precautionary effects are reversed.

Keywords: Precautionary saving, non-expected utility, stockholding, household portfolios.

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I. Introduction

During the past decade, financial markets have experienced a policy-induced move towards greater liberalization, product innovation, and international integration. Privatization of public utilities and the proliferation of mutual funds, both aided by aggressive advertising, served to broaden the stockholder base. The propensity of households to undertake financial risk, i.e. the emergence of an "equity culture", is of prime importance for successful privatization, absorption of new financial products, and avoidance of stock market thinness. It is similarly important for whether households take advantage of the prospects that EMU generates for increased asset holding across international borders. Household preferences and optimal portfolio composition over the life cycle are also at the center of the policy debate on the design and regulation of private pension systems.

Despite its importance, little is known about household portfolio behavior and about how different preference structures interact with other characteristics to determine whether risky assets are held and in which proportion. This is partly due to the fact that "precautionary" saving and portfolio models that allow for background labor income risk, do not admit analytical solutions except in the highly restrictive case of exponential utility.[1] The issue is of academic and policy interest given the multitude of new and potential stockholders, their varied educational backgrounds, earnings prospects, and attitudes towards risk and intertemporal substitution of consumption. Existing findings suggest that the standard, frictionless, expected-utility model has difficulty accounting for average and median holdings of wealth and of risky assets, partly as a result of the largely unexplained limited proportion of stockholders (see King and Leape, 1984; Mankiw and Zeldes, 1991; Haliassos and Bertaut, 1995, Poterba and Samwick, 1995; Guiso, Jappelli, and Terlizzesse, 1996; Attanasio, Banks, and Tanner, 1998; Bertaut, 1998).

It has been suggested in the literature that departures from expected utility, and in particular preferences that yield kinked indifference curves as a result of "first-order risk aversion" (see Segal and Spivak, 1990), could account for the limited incidence of stockholding and thus improve predictions about average portfolio composition.[2] Based on the literature, our priors were that: (i) setups with first-order risk aversion would typically yield solutions at "kinks" on indifference curves; (ii) these kinks would involve zero stockholding; and (iii) this would bring model predictions closer to the data. In this paper, we find that (i) solutions in such setups are not typically at kinks; (ii) neither kinks nor actual solutions involve zero stockholding when income risk is recognized; and yet (iii) predictions about average wealth and risky asset holdings improve. In the process, we chart portfolio behavior for a variety of preference specifications.

We solve numerically a large number of small-scale models of household portfolio choice that employ a general, constant relative risk aversion preference specification, under various assumptions about the earnings process. Our preference specification nests expected utility and three types of departures from expected utility ("non-expected utility") in a way that makes them quantifiable. These are: (i) Kreps-Porteus preferences that, unlike expected utility, disentangle risk aversion from intertemporal substitution (as in Attanasio and Weber, 1989; Epstein, 1990; Weil, 1990; Campbell, 1993; Restoy and Weil, 1996); (ii) Quiggin's (1982) "Rank-dependent Utility" which overweights inferior outcomes relative to expected utility; and (iii) Yaari's (1987) "Dual Theory of Choice", which also overweights inferior outcomes but imposes piecewise linearity of indifference curves. Specifications (ii) and

(iii) involve “kinked” indifference curves. Solutions show how long-run precautionary motives of households facing career risk interact with life-cycle considerations to determine saving and portfolios. Career risk is calibrated for three education classes (high-school dropouts, high-school graduates, and college graduates), and solutions are compared to portfolio data from the 1992 *Survey of Consumer Finances.*

The combination of background income risk and stockholding risk under rank-dependent utility and under dual-theory preferences presents a conceptual and technical challenge. The ranking of states in terms of desirability depends in general on individual choices (such as the level of risky investment). Optimal choices depend in turn on the conjectured ranking of states, since the latter determines the objective function to be maximized. Reversals in rankings generate points of nondifferentiability of the objective function (“kinks”), where the usual first-order conditions cannot be used to derive solutions. The presence of multiple sources of uncertainty makes it difficult to ascertain such reversal points *a priori*. We introduce a notion of conjectural equilibrium for models where the ranking of outcomes matters and there are multiple sources of uncertainty, and a corresponding computational algorithm that allows for solutions at unknown points of nondifferentiability of the objective function.

Section II presents the preferences nested by our specification, introduces our notion of conjectural equilibrium, and describes the computational algorithm. Section III describes the saving-portfolio model. Section IV discusses calibration. Section V derives effects of each departure from expected utility on optimal saving and portfolios, including precautionary effects. It also examines the sensitivity of results to alternative assumptions about risk aversion, elasticity of substitution, the variance and persistence of earnings shocks, their correlation with stock returns, and the presence of bequest motives. Section VI compares predictions to data. Section VII concludes.

II. Preference Specifications

The intertemporal utility of a household viewed from time t is defined recursively as:

$$U_t = W(c_t, \mu(U_{t+1}|I_t)) \tag{1}$$

The “aggregator function”, W, makes current intertemporal utility a function of current consumption and of a certainty equivalent of next period’s random utility, computed using information up to t, I_t. Following Epstein and Zin (1989), we assume that the aggregator function takes the form

$$W(c_t, \mu(U_{t+1}|I_t)) = \left[(1-\beta)c_t^{\rho} + \beta\mu_t^{\rho}\right]^{1/\rho}, \quad 0 \neq \rho < 1 \tag{2}$$

or

$$W(c_t, \mu(U_{t+1}|I_t)) = \left[(1-\beta)\ln c_t + \beta \ln \mu_t\right], \quad \rho = 0 \tag{3}$$

where $\mu_t(\cdot)$ is an abbreviation for $\mu(\cdot|I_t)$. The CES form of the aggregator function involving current consumption and future utility implies that, in a model without labor income risk, the agent has elasticity of intertemporal substitution, σ, equal to $(1-\rho)^{-1}$. The certainty equivalent function $\mu_t(\cdot)$ collapses a random variable, namely next period’s utility, into an argument of the current utility function and encompasses the agent’s attitudes towards risk. We specify a functional form for $\mu_t(\cdot)$ that exhibits constant relative risk aversion, equal to 1-α:

$$\begin{aligned} \mu_t(U_{t+1}) &= \left[f_t\left(U_{t+1}^{\alpha}\right)\right]^{1/\alpha}, \quad 0 \neq \alpha < 1 \\ \ln \mu_t\left(U_{t+1}\right) &= f_t\left(\ln U_{t+1}\right), \quad \alpha = 0 \end{aligned} \tag{4}$$

where f_t is a linear operator, to be specified for each preference formulation.

Consider a control variable x_t, chosen by the household in period t so as to maximize U_t. This could be real saving in the form of a particular asset, for example. The first-order condition (FOC) for x_t takes the general form:

$$c_t^{\rho-1}\frac{\partial c_t}{\partial x_t}+\beta\left(f_t\left(U_{t+1}^{\alpha}\right)\right)^{\frac{\rho}{\alpha}-1} f_t\left[U_{t+1}^{\alpha-\rho}\, c_{t+1}^{\rho-1}\left(\frac{\partial c_{t+1}}{\partial x_t}\right)\right]=0 \qquad (5)$$

This FOC nests all preference specifications we consider, including expected utility, for suitable parameter restrictions and choices of functional form for $f_t(\cdot)$, as we describe below. This formulation of FOC and its special cases below are general and can be applied to a variety of economic models. The choice of model determines the partial derivatives of consumption with respect to each control x_t. Our specific saving-portfolio model is described in section III below.

II. 1 Expected Utility

Suppose that the relevant attribute of random, next-period utility is its expected value conditional on today's information; and that risk aversion is restricted to be equal to the inverse of the elasticity of substitution. Technically, these translate respectively to $f_t(\cdot)\equiv E_t(\cdot)$, the mathematical expectation conditional on information in period *t;* and $\alpha=\rho$. These restrictions yield the standard FOC for an expected-utility model with constant relative risk aversion:

$$c_t^{\alpha-1}\frac{\partial c_t}{\partial x_t}+\beta E_t\left[c_{t+1}^{\alpha-1}\left(\frac{\partial c_{t+1}}{\partial x_t}\right)\right]=0 \qquad (6)$$

An obvious feature of the expected-utility framework is that the effects of varying α, which governs risk aversion, cannot be disentangled from those of ρ, which reflects intertemporal elasticity of substitution. Another important property is what Segal and

Spivak (1990) termed "second-order risk aversion", which essentially rules out zero positions in risky assets offering expected return premia.[3]

II.2 Kreps-Porteus Preferences

Expected utility theory notwithstanding, there seems no compelling *a priori* reason why an agent's aversion to intertemporal variability of consumption should bear a rigid relationship to the agent's aversion towards intra-temporal variability of consumption across different states of the world. Moreover, the effects of these two types of aversion on saving and portfolios are conceptually distinct, but practically indistinguishable when using an expected utility framework. Kreps-Porteus preferences relax the restriction $\alpha=\rho$, and thus separate the effects of risk aversion from those of the elasticity of substitution while maintaining differentiability of the utility function and second-order risk aversion. The FOC become:

$$c_t^{\rho-1}\frac{\partial c_t}{\partial x_t}+\beta\left(E_t\left(U_{t+1}^{\alpha}\right)\right)^{\frac{\rho}{\alpha}-1}E_t\left[U_{t+1}^{\alpha-\rho}c_{t+1}^{\rho-1}\left(\frac{\partial c_{t+1}}{\partial x_t}\right)\right]=0 \tag{7}$$

confirming that expected utility is a special case of this formulation for $\alpha=\rho$.

II.3 Rank-Dependent Utility

In both formulations above, use of the expectations operator in the certainty equivalent function implies that households attach weights to utilities of stochastic outcomes that are identical with their probabilities of occurrence. It has recently been argued that households may be excessively concerned about inferior outcomes, in the sense of attaching to them weights greater than their probability of occurrence and correspondingly smaller weights to superior outcomes.

Suppose that outcomes are ranked from worst to best for the household. Following Yaari (1987), the weight w_j assigned to the jth outcome is assumed to be:

$$w_j = \left(\sum_{i=1}^{j} p_i\right)^{\gamma} - \left(\sum_{i=1}^{j-1} p_i\right)^{\gamma} \tag{8}$$

If $\gamma<1$, then the household attaches disproportionate weight to bad outcomes. In a two-state example, the weights reduce to p^{γ} for the bad state that occurs with probability p, and $1-p^{\gamma}$ for the good state. The function f is then defined as follows:

$$f_t(\tilde{X}) = \sum_j \left(w_j X_j \middle| I_t\right) \ , \tag{9}$$

where the elements of the sum are based on information available as of period t. If $\gamma=1$, this reduces to the conditional expectation.

The ranking of outcomes from worst to best, which itself depends on the actions of the household with regard to risky projects, causes non-differentiability of the indifference curves. In the absence of background income risk, for example, this occurs at the point of zero investment in the risky asset. If the household holds positive amounts of the risky asset, then high return realizations are “good” and low realizations are “bad”. If, however, the household takes a short position, the ranking is reversed, thus altering the weights attached by the agent to the two states. In other words, the objective function itself changes at the point of zero risky investment where outcomes are equally ranked. This change manifests itself as a point of nondifferentiability or “kink” on the indifference curves (Segal and Spivak, 1990).

In the absence of labor income risk, kinks make it possible that a household will prefer zero risky investment to either positive or negative holdings. When background income risk is recognized, however, the kink no longer involves zero stockholding. The ranking of two states is reversed where the agent is indifferent between them. This occurs at a level of (positive) risky investment where the difference in returns to stockholding between the high and the low state is exactly mitigated by the difference in income realizations.

It is important to realize that disproportionate concern with bad states is conceptually distinct from risk aversion *per se.* The former has to do with the weights attached to utilities in various states, while the latter with the curvature of the utility function. Using (9) as the certainty equivalent, we nest two rank-dependent preference specifications: the Yaari (1987) Dual Theory formulation, and the Quiggin (1982) formulation. Although both entail overweighting of inferior states, their key difference lies in the assumption made about risk aversion.

II.3.1 The Dual Theory Formulation

The Dual Theory formulation is obtained for zero relative risk aversion. Substituting α=1 into the general form of FOC (5), we get:

$$c_t^{\rho-1}\frac{\partial c_t}{\partial x_t}+\beta\left(\varphi_t\left(U_{t+1}\right)\right)^{\rho-1}\varphi_t\left[U_{t+1}^{1-\rho}c_{t+1}^{\rho-1}\left(\frac{\partial c_{t+1}}{\partial x_t}\right)\right]=0 \qquad (10)$$

This formulation results in piecewise linear indifference curves. Generally, the solution will lie at a kink, except in the (uninteresting) special case where the budget line has the same slope as one of the linear segments of the indifference curve and the optimal risky investment is indeterminate.

II.3.2 The Quiggin Formulation

The Quiggin formulation is obtained for positive relative risk aversion. The agent not only cares disproportionately about bad states, but also dislikes variability of consumption across states. The FOC are of the general form (5), and indifference curves are non-differentiable but curved, rather than piecewise linear (see Segal and Spivak, 1990; Epstein and Zin, 1990). Compared to the Yaari formulation, it is more likely that solutions will involve tangency between the budget line and the indifference curve, despite the presence of the kink.

II.3.3 Conjectural Equilibria and Computational Algorithm

Our notion of conjectural equilibrium and its computational counterpart apply when the ranking of states matters for the functional form of the objective, and the agent chooses the amount of risky investment to maximize this function. At particular levels of risky investment, the ranking of states changes, thus altering the objective function. The resulting nondifferentiability of the objective function at those levels is manifested in "kinked" indifference curves.

For purposes of graphical illustration, consider a simple two-dimensional case (Fig.1) analogous to that in Segal and Spivak (1990) and in Epstein and Zin (1990), in which the household faces only stockholding risk but not background income risk. The two states of the world defined by the high and low realizations of stock returns are states 1 and 2 respectively. Consumption bundles under the 45^o line result from positive stockholding, since they involve higher consumption in the high- rather than in the low-stock-return state. Those above the 45^o line are associated with short sales of stock, while the line itself contains combinations facing a non-stockholder.

The two indifference curves shown intersect, because each reflects different conjectured rankings of outcomes. The curve through point A incorporates the conjecture that state 1 is better than 2 (or equivalently that optimal stockholding is positive). It has a valid (solid) segment under the 45° line, namely where conjectured and actual rankings coincide. Above the line, stockholding is negative and the conjecture is not valid (dotted segment). The other curve incorporates the conjecture that state 2 is better, which is valid above the line. They intersect on the 45^o line, because the two states are identical and their relative weights are irrelevant for utility.

Our notion of equilibrium and computational algorithm essentially exploit the observation that kinked indifference curves in rank-dependent utility can be thought of as consisting of the valid (solid) segments of smooth, everywhere differentiable indifference curves. In solving the problem, the household (or the computer programmer) need not know a priori the location of kinks. It simply conjectures a ranking of states, picking the family of (ordinary) indifference curves to consider. It then chooses controls to maximize its utility under the conjecture (i.e., it finds the point of tangency between the budget line and a curve in this family). Once the point is found, the ranking of states is compared to the conjecture. Conjectural equilibrium occurs when they coincide. In Fig. 1, this happens at a point of tangency with the budget line.[4]

In Fig. 2, equilibrium is at a kink. In this case, conjectures postulating an inferior state are not confirmed, since neither B nor C lie on a valid segment. The household then considers "ties" between the ambiguous states. The "kink" which maximizes utility and confirms the conjectured tie is point A.

This equilibrium notion has a natural computational counterpart. First, each objective function defined by a particular conjecture is maximized, ignoring the fact that it holds only for a subset of values of risky investment. The resulting rankings of states are then compared to the conjectures. If all conjectures not involving ties fail, then the solution lies at a point of nondifferentiability that violates the FOC for risky investment. The offending FOC is replaced by the requirement that the tied states yield the same utility. The model is solved, and the ranking is checked against the conjecture.[5] In typical problems with unique solutions, the process stops once an equilibrium is found. Judicious choice of the sequence of conjectures minimizes computation time.

III. The Saving-Portfolio Model

Each household is assumed to have an economic life of three twenty-year periods (20-80 years) and to care about the size of bequests. In our model, households make decisions at the end of each period, after all current-period information is revealed. Household utility in the last (retirement) period of life is:

$$U_3 = \left[(1-\beta)\left\{\lambda G_3^{\rho} + (1-\lambda)c_3^{\rho}\right\}\right]^{1/\rho}, \quad 0 \neq \rho < 1 \qquad (11)$$

where G is the size of bequests. The household decides what proportion of wealth and retirement income to consume, leaving the rest to descendants. The special case of no bequest motive is obtained for $\lambda=0$. Utility in the first and second periods is obtained recursively, using equation (2). At the end of each of these periods, the household decides jointly on the consumption-saving allocation and on portfolio composition. Thus, consumption by period is given by:

$$c_1 = Y_1 - N_1 \frac{S_1}{P_1} - \frac{B_1}{P_1} \qquad (12)$$

$$c_2 = Y_2 + (N_1 d_2 + \frac{B_1 I_2}{P_2})(1-t_b) + (N_1 - N_2)\frac{S_2}{P_2} + \frac{B_1 - B_2}{P_2} \qquad (13)$$

$$c_3 = Y_3 + N_2[\frac{S_3}{P_3} + d_3(1-t_b)] + \frac{B_2[1 + I_3(1-t_b)]}{P_3} - G_3 \qquad (14)$$

$$c_t \geq 0 \;\; \forall t. \qquad (15)$$

where S is the nominal stock price, N the number of stocks, B the nominal amount in bonds, d real dividends per share, I the nominal rate of interest on the riskless asset, P the price of the good, and t_b the tax rate on interest and dividend income.

IV. Calibration

IV. 1 Rates of Return

The twenty-year riskless rate is compounded using the Mehra-Prescott (1985) historical mean annual riskless rate. Calibration of cumulative stock returns is based on a binomial model of annual stock returns which matches the first two moments of the long-run empirical return distribution estimated by Mehra and Prescott (1985). Stock returns can take a high or low value equal to the expected value plus or minus (respectively) the standard deviation of 20-year holding returns, when both moments are computed from the binomial process for annual returns. Following Haliassos (1994), expected dividend yields are set to about half the expected total pre-tax return on equity, which is consistent with the historical findings of Schwert (1990). We first consider the case of no correlation between income and stock returns, and no retirement income risk, as also in Hubbard, Skinner and Zeldes (1994). This gives us four second-period and eight third-period states. Each set consists of equiprobable states in the absence of correlation between incomes and stock returns. We then examine the cases of positive and negative correlation between second-period labor incomes and stock returns. Nonzero correlation is induced while still matching means and standard deviations, by using the same second-period income and return realizations as in the no-correlation case but abandoning the assumption that they are equiprobable.[6]

IV. 2 Labor Incomes

Income calibration follows Bertaut and Haliassos (1997). Our measure of labor income is the present value of earnings over a twenty-year interval. Earnings processes and age-earnings profiles are assumed to depend on the level of education. We distinguish between those with (i) less that high-school education (LS), (ii) high-school education (HS), and (iii) at least a college degree (CL). In our end-of-period model, we start looking at households after their first (twenty-year) period earnings have been realized. Households are still faced with risk regarding human capital returns in the second half of their career that depends on their education level. This risk affects their first period saving and portfolio choices. As in Hubbard, Skinner, and Zeldes (1994, 1995), however, households are assumed to face no uncertainty regarding the pension income available to their educational category. The model is kept small by abstracting also from health risks in old age.[7]

While it would be possible to make assumptions directly on twenty-year incomes, we prefer to derive those for different underlying properties of annual incomes. The annual earnings process consists of the deterministic age-earnings profile, and of stochastic processes followed by persistent and transitory income shocks. It is impossible to estimate all components from the cross sectional data in the 1992 SCF that contains the detailed portfolio data. Instead, we calibrate age-earnings profiles for each education category from the SCF, and use the stochastic processes for (multiplicative) permanent and transitory income shocks estimated by Hubbard, Skinner, and Zeldes (1994) from panel data in the PSID. Since we are interested in model comparisons and precautionary effects, we employ adjustments introduced by Bertaut and Haliassos (1997) to ensure that present-value measures of labor income in models without income risk are equal to expected incomes under career uncertainty, and to average population incomes computed from the data.

Age-earnings profiles represent total annual labor income in models without income risk, and the deterministic component of income in models with income risk. We compute mean annual incomes for each age-education cell in the SCF, based on reported population weights, and we use them to compute twenty-year present values.[8] Since present values may be hard to interpret, we report them as annual incomes that, if received each year over a twenty-year period, would yield these present values. For high-school dropouts, scaled down age-earnings profiles for the three periods of life are (Y_1, Y_2, Y_3)= (15019, 21570, 13633), for high-school graduates (25920, 37583, 22032), and for college graduates (39483, 75527, 49663). Note that they all peak in the second half of working life, and that this hump is likely to induce young households to borrow in order to smooth consumption intertemporally.

Income risk is introduced as lognormally distributed, multiplicative stochastic shocks to annual incomes. We consider persistent shocks, U_t, and transitory shocks, V_t. To a first approximation, an annual income realization in models with income risk is equal to the annual income under certainty times the product of the two earnings shocks.[9] The logarithms of the earnings shocks, denoted by lower case letters, follow the processes estimated by Hubbard, Skinner, and Zeldes (1994):

$$u_{LTHS,t} = 0.955\, u_{LTHS,t-1} + e_{LTHS,t}\,, \quad e_{LTHS,t} \sim i.i.d.\ N(0,0.033), \quad v_{LTHS,t} \sim N(0,0.04) \qquad (16)$$

$$u_{HS,t} = 0.946\, u_{HS,t-1} + e_{HS,t}\,, \quad e_{HS,t} \sim i.i.d.\ N(0,0.025), \quad v_{HS,t} \sim N(0,0.021)$$

$$u_{COL,t} = 0.955\, u_{COL,t-1} + e_{COL,t}\,, \quad e_{COL,t} \sim i.i.d.\ N(0,0.016), \quad v_{COL,t} \sim N(0,0.014)$$

According to these estimates, higher educational categories experience lower variances of labor income shocks, but all experience high serial correlation for persistent shocks. We examine below the sensitivity of results to alternative assumptions regarding shock variances and persistence. This seems worthwhile, in view of the difficulties in disentangling uncertainty from heterogeneity in microeconometric studies.

Since the income measure is the twenty-year present value of incomes and its analytical moments are not readily computed from assumptions on annual income shocks, we stochastically generate time series of annual incomes (for ages 40 to 59) and compute their present value. We thus construct 20,000 present value realizations for each education level and compute their mean and standard deviation. The "high" and "low" labor income values used equal the expected present value plus or minus one standard deviation, respectively. If Y_t refers to income in period *t*,, while *h* and *l* refer to the high and low income states respectively, then the benchmark income figures under labor income risk are the following. For high-school dropouts, (Y_1, Y_{2h}, Y_{2l}, Y_3) equals (15019, 30088.5, 13219.5, 13633), for high-school graduates, (25920, 48691, 26219, 22032), while for college graduates, (39483, 96010, 55338, 49663).

IV. 3 Parameters

The model contains four important parameters: α, γ, ρ, λ. Attitudes towards risk are controlled by α, equal to one minus the degree of relative risk aversion. Our "benchmark" value for relative risk aversion is 3, which is often used for representative-agent models. We solve all model variants for risk aversion between 2 and 10, viewed by Mehra and Prescott (1985) as the relevant range given the size of the stockholding "gamble". Dual Theory preferences entail relative risk aversion of 0.

Overweighting of inferior outcomes is governed by $\gamma \in (0,1]$, the power to which the probability of the worst state is raised. The smaller the γ, the greater is household concern with bad states. Our benchmark model with overweighting postulates γ=0.5, but we have traced the effects of values 1, 0.9, 0.7, 0.5, and 0.15.

Parameter ρ governs the intertemporal elasticity of substitution, the latter being equal to $(1-\rho)^{-1}$. The benchmark value of ρ is -3, but we have also examined the sensitivity of results to values -9, $-5\,{}^{2}/_{3}$, -4, -3, and –1, and to a value that corresponds to elasticity close to unity. The rate of time preference is set at 3.13% per annum, around the values typically assumed, matching Siegel's (1993) estimate for the historical average riskless rate over a very long horizon. Finally, λ is the weight given to bequests in final-period utility, with benchmark value of 0.25 that gave plausible results in Bertaut and Haliassos (1997). We also explore the effects of assuming values of 0.1 and 0.5, and of abstracting from the bequest motive altogether.

V. Saving and Portfolio Effects of Departures from Expected Utility

Table 1 compares predicted wealth-to-income and stock-to-income ratios (W/Y, S/Y) and utility gains from having access to stocks, for various degrees of relative risk aversion and for benchmark values of other parameters. The first set of columns refers to an expected-utility (EU) model, the second to a Kreps-Porteus specification,[10] and the third to specifications that assign weights to utilities of outcomes depending on their desirability ranking. The row for risk aversion of zero in the third set of columns shows predictions from a Yaari Dual-Theory specification, while the remaining rows refer to rank-dependent utility models of the Quiggin variety (see Section II.3).

Within each set of columns, the first two (labeled W/Y and S/Y) report wealth- and stock-to-income ratios at the end of the first period. The portfolio share in risky assets can be obtained by dividing S/Y by W/Y, yielding S/W (not shown). The next three columns (labeled Exp(W/Y), Exp(S/Y), Exp(S/W)) report expected second-period wealth- and stock-to-income ratios, as well as expected portfolio shares of risky assets, all based on information available in the first period. The last column of each set reports the percentage increase in utility resulting from having access to stocks. It is obtained by solving a model where households can only invest in bonds, and comparing lifetime utility to that obtained under the full portfolio model and the same preference and parameter configuration.

Life-cycle patterns are qualitatively similar across preference specifications. Households expect to have a higher wealth-to-income ratio in the second half of their working life than in their first, i.e. Exp(W/Y) is larger than W/Y. The opposite is true of the predicted stock-to-income ratio: it is optimal to invest a larger proportion of income in stocks when young than when middle-aged, in order to take advantage of the equity premium. For the two less educated categories, the tendency to be a net borrower early on in life is present over a wider range of risk aversion for Kreps-Porteus (KP) preferences. However, for low relative risk aversion (less than four), predicted net borrowing is larger in the expected utility (EU) specification. At risk aversion of 4, the EU and KP frameworks coincide, since risk aversion happens to be the inverse of the benchmark elasticity of substitution used in the KP framework (see Section II).

V.1 Disentagling Risk Aversion from Elasticity of Substitution

Comparing EU and KP models, we find that EU models exaggerate the sensitivity of desired first-period wealth to risk aversion, regardless of education category, while underplaying this sensitivity in the second period. Under expected utility, increases in risk aversion are accompanied by reductions in elasticity. In the first period, when the age-earnings profile creates greater incentives to borrow, the negative effects of reduced elasticity on borrowing reinforce the increases in wealth-to-income ratios induced by higher risk aversion. In the second period, when expected wealth and incomes are at their peak, increased risk aversion reduces expected wealth to income ratios, as shown by the KP results where elasticity is kept unchanged. The largely stable ratios shown under EU indicate that reduced elasticity countervails the effect of risk aversion when the household is at the hump of the age-earnings and wealth profile.

Utility gains from access to stocks under KP preferences are substantial and relatively close to those under EU, since both are characterized by second-order risk aversion. For degrees of risk aversion lower (higher) than the cutoff of four, utility gains are somewhat higher (lower) for KP households than for expected utility maximizers, because their optimal stockholding is also higher (lower).

V.2 Introducing Overweighting of Inferior Outcomes

The third set of columns in Table 1 introduces first-order risk aversion by assigning a weight to the worst outcome larger than its associated probability (see Section II). The row for zero relative risk aversion corresponds to Yaari preferences (Y). Notice that first-period optimal stockholding is positive for this preference specification. This is because piecewise linear indifference curves yield a solution where indifference curves are not differentiable, and this occurs when utility is equal in the two states where stock returns and incomes move in opposite directions. Equality is in turn achieved when first-period stockholding is positive and sufficient to hedge fully against income risk in these two states. Second-period stockholding for Y preferences is zero as argued in the literature, but only because pension income is nonstochastic and no hedging requirement exists. Utility gains from stockholding thus mimic the ranking of first-period stockholding. Wealth-to-income ratios are lower than in other models, since households borrow more for consumption smoothing, having eliminated (through stockholding) their background income risk in two of the four states.

Quiggin (Q) preferences (risk aversion 2 to 10 in the third set of columns) tend to induce more “conservative” saving and portfolio behavior compared to EU and KP. Controlling for education and risk aversion, first-period borrowing and stockholding are lower, but the reduction in borrowing is larger, resulting in higher wealth under Q than under EU or KP. Expected second-period stockholding is also lower under Q, and so are expected wealth-to-income ratios except for very low risk aversion under EU. As a result of the smaller use of stocks, utility gains from stocks are significantly smaller under Q than under EU or KP.

Notice that the effects of overweighting are smaller when risk aversion is high. We have also found that, when overweighting of inferior states is substantial, the importance of risk aversion for model predictions diminishes.[11] Thus, although risk aversion and overweighting are distinct attributes of preferences, there seems to be a tradeoff in their importance for saving and portfolios. The importance of overweighting at low risk aversion commonly assumed in representative-agent models, suggests that overweighting could have powerful effects on asset accumulation in a wider class of models, including stochastic growth models.

V. 3 Implications for Precautionary Motives

This section computes precautionary effects on wealth- and on stock-to-income ratios by contrasting predictions from comparable models with and without labor income risk. Since expected labor incomes under income risk are equal to labor incomes received under certainty, differences in predicted asset-to-income ratios represent precautionary effects. Table 2 has the same structure as Table 1, except that it reports precautionary effects under the four preference specifications.

The first set of columns in Table 2 shows precautionary effects for an EU model. Precautionary wealth accumulation ranges from 7 to 13 percentage points. After a small drop between risk aversion of 2 and 3, it increases somewhat with the risk aversion parameter, regardless of education. For any given risk aversion, it is largest for high-school dropouts who face the largest variances of labor income shocks, and smallest for high-school graduates who face an intermediate variance size but less shock persistence. First-period stock-to-income ratios are reduced by background income risk as a consequence of "standard risk aversion" (see Kimball, 1993), and their absolute changes are negatively related to risk aversion.

Effects of income risk need not be confined to periods prior to resolution of income uncertainty. In dynamic models, decisions taken early in life influence the evolution of state variables, which in turn affect decisions later on. This can be missed in atemporal or even two-period saving-portfolio models. In our three-period model, households face no income risk in the third period, and yet their expected second-period asset to income ratios are not the same as if they never faced income risk.

We find that the less risk averse expect to reduce their second-period wealth-to-income ratio (i.e., increase their consumption) relative to its level without income risk. They do so in response to having to hold a precautionary wealth buffer in their first period of life. The more risk averse, however, expect to continue to hold more wealth between the second and third period, after income risk has been resolved. Regardless of risk aversion, a positive effect is also observed for expected stock-to-income ratios. In all cases, second-period effects of income risk are small.

All qualitative results for EU continue to hold under KP and Q. The relative size of precautionary effects for EU and KP preferences is ambiguous and depends on risk aversion. Quiggin preferences yield uniformly larger precautionary wealth and stockholding effects than EU and KP in the first period of life.

Yaari preferences reverse the direction of precautionary effects in the first period and the effects of income risk on expected second-period wealth-to-income ratios. Income risk encourages not only first-period stockholding, but also borrowing to finance the purchase of stocks and higher current consumption, resulting in lower financial net worth.

This occurs because the piecewise linearity of indifference curves typically induces first-period solutions to be at a kink. While the kink without income risk occurs at zero stockholding, as discussed above, the kink under income risk has to occur at positive stockholding if the household is to be indifferent between the two states in which stock returns and incomes move in opposite directions. Thus, the first-period precautionary effect on stocks is positive. The absence of income risk in the third period means that second-period stockholding is at a kink of zero regardless of whether second-period labor incomes are risky or not.

Table 3 explores precautionary effects under extreme overweighting of inferior states (ã= 0.15). Households with Quiggin preferences hold even more precautionary wealth, and this spills over to the second period. Surprisingly, extreme overweighting produces small and even positive effects of income risk on stock-to-income ratios. Holding of stocks that offer an expected return premium is attractive for generating wealth to overcome the effects of low labor income realizations, even though it detracts from consumption when stock returns are low. At low risk aversion, the former consideration overcomes the latter. This positive precautionary effect on stockholding is specific to very low values of ã. Unreported calibrations for γ between 1 and 0.5 confirm that the larger the degree of overweighting, the more powerful is the negative effect on optimal stockholding, regardless of whether income is risky. Its size is inversely related to relative risk aversion.

V. 4 The Role of Variance and of Persistence of Income Shocks

Our benchmark income processes are based on econometric estimates of the stochastic processes for income shocks. Since it is difficult to know how households perceive their own earnings process and what is included in their information sets versus those of econometricians, it is instructive to explore effects of different assumptions about labor income uncertainty and persistence.

Table 4 shows the same information as Table 1, but for variance of (the logarithm of) permanent and transitory income shocks 20% higher than the benchmark. Table 5 repeats the exercise, but for variance 20% lower than the benchmark. Incomes are adjusted to preserve the same expected income regardless of income variance.

Consistent with Section V.3, under EU, KP, and Q preferences, higher (perceived) variance of income shocks leads to higher first-period wealth- and lower stock-to-income ratios, while Y preferences have opposite effects. The twenty percent variations in second-period labor income risk relative to the benchmark do not have noticeable effects on expected second-period asset-to-income ratios. Of course, second-period stockholding under Y preferences is at the zero kink in the absence of third-period income risk. Our qualitative results in Sections V.1 and V.2 regarding alternative preference specifications appear robust with respect to assumed or perceived variances of labor income shocks.

Tables 6 and 7 explore changes in persistence, ñ$_{Y}$, of labor income shocks relative to the benchmarks of 0.955 and 0.946, for unchanged variances of income shocks and mean incomes. Table 6 shows effects of ñ$_{Y}$=1, which entails nonstationarity. The direction of effects of a unit root parallels that of an increase in the variances of shocks, since both result in greater “career” uncertainty. Nonstationarity encourages first-period wealth holding and discourages stockholding relative to the benchmark, except under Y preferences where effects are reversed. Effects on expected second-period wealth are negligible under EU and KP, but positive under Q and Y. Interestingly, there seems to be some intertemporal substitution of stockholding by households faced with permanent income shocks in the second period. They decrease first-period stock-to-income ratios but increase second-period ratios, except under Y preferences where first-period results are reversed and second-period stockholding is zero. Larger effects are obtained when we halve persistence to $ñ_{Y}$=0.5 (Table 7), but their direction is consistent with Table 6, except for an ambiguity in expected second-period wealth-to-income ratios.[12]

Results on effects of persistence and variance of income shocks translate one-for-one into conclusions regarding relative size of precautionary effects. For example, if wealth-to-income ratios are larger under greater shock persistence, so is precautionary wealth. This is because the yardstick against which precautionary effects are measured is the same, namely a model without labor income risk.

V.5 Correlation between Labor Income Shocks and Stock Returns

Our benchmark assumes zero correlation between labor income shocks and excess stock returns, as indeed most of the literature to date. We now explore effects of positive and negative correlation. We use the procedure in Section IV. 1 to induce positive correlation of 0.2 and then negative correlation of –0.03. Both numbers are in the range of findings by Constantinides, Donaldson, and Mehra (1998) for economies without borrowing constraints.

Table 8 shows that positive correlation of 0.2 encourages first-period wealth holding and discourages stockholding, with one minor exception. In view of the increased likelihood of combined adverse shocks to incomes and stock returns, households want to hold more wealth to buffer their consumption and want to limit their stockholding. The exception is that, under Y preferences, stockholding is at a "kink" that is unaffected by the induced correlation.[13] Expected second-period asset-to-income ratios are somewhat lower for all preferences except Y. Effects are small, however, especially at higher risk aversion. Utility gains from stockholding are uniformly smaller under positive covariance than in our benchmark.

Negative correlation of –0.03 enables households to reduce consumption risk through holding of stocks negatively correlated with labor income (Table 9). We find more first-period stockholding and borrowing, slightly higher expected second-period wealth-to-income ratios and hardly noticeable increases in expected stock to income ratios and utility gains from stockholding. As in the previous Section, results translate one-for-one into conclusions about precautionary effects.

V. 6 The Role of Elasticity of Intertemporal Substitution

Elasticity of intertemporal substitution is constrained to be the inverse of relative risk aversion in the EU framework. However, under KP, Q, and Y preferences, it is possible to fix elasticity while varying risk aversion (Section II). In Table 10, we choose elasticity close to unity (0.95), instead of our benchmark of 0.25. Since households are more willing to substitute consumption intertemporally, they borrow more to enhance consumption in the first and second periods of life. Despite this, first-period and expected second-period stockholding drop considerably. Thus, the purpose of borrowing is to enhance consumption rather than to take advantage of the equity premium. Since effects on borrowing reinforce those on stockholding, this high elasticity makes households net borrowers in both periods for a wide range of degrees of risk aversion. Thus, wealth-to-income ratios are much more sensitive to elasticity than are stock-to-income ratios, consistent with the intuition that elasticity matters mostly for wealth accumulation, while risk aversion governs accumulation of risky assets.[14]

Table 11 shows precautionary effects for KP, Q, and Y preferences and elasticity of 0.95. For brevity, we only show results for high-school dropouts. Under KP and Q preferences, first-period precautionary wealth holding is about double that under the benchmark in Table 2, and reductions in stock-to-income ratios are also larger in absolute value. Expected second-period wealth-to-income ratios are reduced relative to those under income certainty. Expected stock-to-income ratios increase more in response to income risk than under lower elasticity. Under Y preferences, precautionary wealth-to-income ratios have the same sign pattern as under the benchmark, but absolute values are larger when elasticity is high. Elasticity does not alter precautionary effects on stocks, because it does not affect stockholding levels at kinks where solutions lie, as explained above.

V. 7 The Role of Bequest Motives

So far we have assumed an operative bequest motive. In unreported experiments, we found that the *magnitude* of concern about bequests (size of ë) has a small effect on predicted borrowing and thus on wealth, and negligible effects on stockholding for our benchmark parameter settings.[15] Still, bequests may be a "luxury good" operative only for households in certain education categories that enjoy higher levels of permanent income. In Table 12, we remove the bequest motive altogether.

In the absence of a bequest motive, households tend to borrow more and to invest less in stocks than in its presence, whether they maximize expected utility or they depart from it. This shows that such households shift more consumption through borrowing towards the first period of life, and they are less concerned about their future debt burden. Indeed, households of all education categories and degrees of risk aversion shown are predicted to be net borrowers in their first (but not in their second) period of life, regardless of the assumption regarding preferences.[16] In addition, since they lack an incentive to generate wealth for their descendants, they are less willing to expose themselves to stockholding risk so as to take advantage of the equity premium in either the first or the second period. As a result, utility gains from stockholding are also lower in the absence of a bequest motive.. Despite these asset level effects, however, our conclusions regarding comparisons across preference specifications continue to hold.

Table 13 reports precautionary effects for high-school dropouts. Comparison with Table 2 shows that, under EU, KP, and Q preferences, first-period precautionary wealth is larger in the absence of bequest motives, and so are expected reductions in second-period wealth. We do not find very different first-period effects on stockholding, except under Q preferences, but second-period effects are somewhat smaller in the absence of a bequest motive. Under Y preferences, there are no differences in precautionary effects on stockholding, but first-period (negative) precautionary effects on wealth holding are now larger in absolute value.

VI. Comparison with US Household Behavior

Table 14 compares predictions under EU, Q, and Y preferences to data from the 1992 *SCF*. The reported "narrow" measure of stocks includes shares of publicly traded stocks, shares in stock mutual funds, and other "directly held" stocks in IRAs and Keogh plans. The broader definition includes also stocks held in trusts, managed investment accounts and defined-contribution pension plans. Riskless assets include checking, saving, money market, and call accounts, CDs, saving and other bonds, and the cash value of life insurance, minus credit card balances, consumer loans, and other non-real-estate loans. Financial net worth corresponding to the broader measure of stocks includes also assets in managed accounts and defined-contribution pension plans. Average financial net worth and holdings of stocks are scaled by average "income", which includes wage and salary income, income derived from a professional business or practice, unemployment and workers' compensation payments, and income from Social Security and other pensions. After-tax labor income from non-retirement sources is estimated from data on each household's tax filing status and adjusted gross income.

Wealth- and stock-to-income ratios at any given age increase with education, regardless of whether we look at narrow or broad measures. Average financial net worth and stockholding among high-school dropouts are both small. Bertaut and Haliassos (1997) found that expected utility models could account fully for the wealth-to-income ratio of this group, but grossly overpredicted average stockholding, even for the highest risk aversion in the grid. For the other two education categories, stockholding could be fully explained by the expected utility model with career risk, but wealth was underpredicted.

We compare the best expected-utility calibrations in Bertaut and Haliassos (1997) to some of the best rank-dependent utility models in our experiments and to their dual-theory counterparts that differ only in risk aversion. Since it is important to avoid asking "What parameters can replicate the data exactly?" (Kydland and Prescott, 1996), we restrict ourselves to parameter grids deemed reasonable a priori (section IV) and, rather than attempting to solve mechanically over the entire grid, we present cases suggestive of our experience with these models.

The first panel of Table 14 shows that Q preferences, unlike EU, can account for wealth accumulation by high school dropouts and for their limited stockholding in the first period. However, the EU model does better in matching expected second-period ratios. For high-school graduates, Q preferences can account for stockholding and yield higher net worth than the EU setup. The increase in predicted net worth is most dramatic for college graduates, but still they appear to be borrowing much less than what their career uncertainty warrants. Q preferences also explain first-period stockholding and more of second-period stockholding than EU. While all models tend to underpredict first-period wealth for the two more educated classes, we have found first-period wealth to be sensitive to initial wealth. Our findings are consistent with inheritance being important for these two groups, especially college graduates. Dual theory predictions are not as close to the data.

What is the size of departures from expected utility associated with these improved predictions? In all cases, elasticity of substitution is not the inverse of risk aversion, although it comes close for high-school graduates. Still, elasticity is positively related with education, as a negative relationship between risk aversion and education would require under the EU framework. In all cases, households overweight inferior outcomes, the departure from EU being substantial for high-school dropouts but still noticeable for college graduates. Implied rankings of education categories with respect to risk aversion and degree of overweighting of inferior states are the same in Q and EU predictions shown.

The implication that the more educated tend to be less risk averse on average and to overweight inferior outcomes to a lesser extent is consistent with attitudinal questions in the *SCF*. The proportion of households refusing to undertake any financial risk diminishes with education, while the proportions willing to undertake average risk for average return and high risk for above average return increase.[17] While precise interpretation of these responses is not always straightforward, they are at least consistent with fear of variance (risk aversion) and of bad states (overweighting) being more prevalent among households of lower education.

VII. Concluding Remarks

In this paper, we explore the implications of non-expected utility for saving and portfolio choice under long-run income and return uncertainty, and compare them to expected utility and to US data on three education categories. We find that, contrary to priors, solutions of rank-dependent utility models are not typically at kinks; neither kinks nor actual solutions involve zero stockholding when income risk is recognized; and yet predictions about average wealth and risky asset holdings improve, especially for high-school dropouts. First-order risk aversion also enhances the implied magnitude of precautionary effects. Mere disentangling of risk aversion from elasticity has small effects, while the Yaari certainty equivalent typically forces solutions to lie at a “kink”, but yields wealth and portfolios farther from the data and reverses the signs of precautionary effects.

In models with more sources of uncertainty or states, one may find more solutions lying at a kink. However, kinks will not involve zero stockholding. Our finding that improved predictions do not presuppose nor require solutions at kinks can be viewed in different ways. Advocates of rank dependent utility can consider our findings as encouraging for further experimentation. Skeptics can interpret them as pointing out that nondifferentiability of preferences per se is not crucial to any predictive improvements and that further experimentation with more flexible functional forms is called for within an expected utility framework.

For all preference specifications, households in the first period of life have an incentive to borrow in order to consume and to invest in stocks. In the second period, they tend to save in the form of bonds and often of stocks. The findings in the overlapping generations, expected-utility model of Constantinides, Donaldson, and Mehra (1998) are consistent with this view. Restrictions to the ability of the young to borrow are bound to have interesting effects. Some of those are explored in Haliassos and Hassapis (1998), where we consider a wide range of income-related and collateral constraints, and discuss theoretical implications for saving and portfolio behavior, as well as complications these imply for econometric work. Generally speaking, we find that borrowing constraints tend to reduce or eliminate precautionary wealth accumulation, that they can even reverse precautionary effects on stockholding, and that they tend to bias empirical estimates of precautionary effects downwards.

Finally, the inability to account for zero stockholding even with first-order risk aversion seems to support the view that resolution of the stockholding puzzle for median portfolios and of the equity premium puzzle under conditions of background income risk is not to be found solely in preferences. Instead, it is likely to require explicit consideration of frictions such as inertia and information costs. Even so, rank-dependent preferences may contribute to the explanation, e.g., by lowering the information costs required to discourage stock market participation. Our notion of conjectural equilibrium and algorithm could be used in such applications, as well as generally in stochastic models of growth, government finance, and equity premia.

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Figure 1: Conjectural equilibrium at a point of tangency.

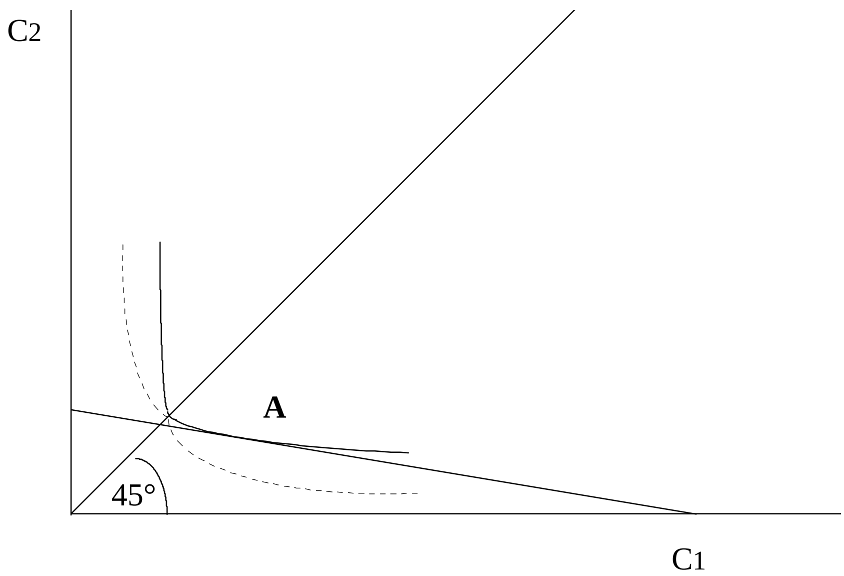

Figure 2: Equilibrium at a point of nondifferentiability of the objective function.

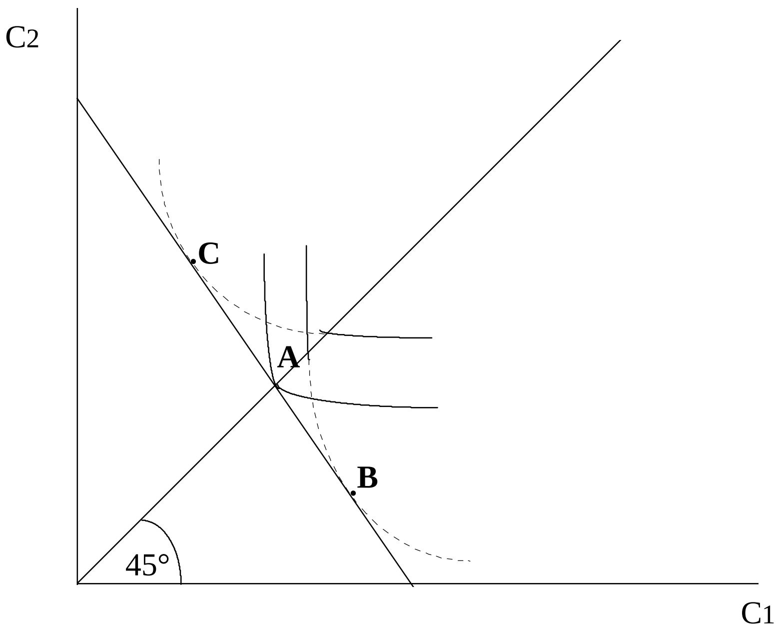

Table 1: Effects of Departures from Expected-Utility Maximization on Wealth and on Stock holding, by Education Group (Benchmark Model)

	Expected Utility Model (EU)						**Kreps-Porteus Model (KP)**						**Overweighting of Inferior States (Y and Q)**					
	Parameters: γ=1, λ=0.25						**Parameters: γ=1, λ=0.25, ρ=-3**						**Parameters: γ=0.50, λ=0.25, ρ=-3**					
Risk Aversion g	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**
LS																		
0													-0.11	0.19	0.45	0.00	0.00	8.22
2	-0.36	0.68	0.57	0.59	0.90	27.06	-0.26	0.73	0.85	0.72	0.41	31.93	-0.05	0.41	0.69	0.36	-32.19	11.41
3	-0.19	0.40	0.52	0.31	0.06	18.12	-0.14	0.41	0.61	0.33	-0.25	19.16	-0.00	0.23	0.52	0.19	0.71	7.12
4	-0.08	0.28	0.51	0.21	-7.74	13.62	-0.08	0.28	0.51	0.21	-7.74	13.62	0.02	0.16	0.46	0.12	0.40	5.19
5	-0.01	0.22	0.52	0.16	0.56	10.92	-0.05	0.21	0.46	0.15	0.93	10.57	0.04	0.12	0.42	0.09	0.29	4.09
6	0.03	0.18	0.52	0.13	0.33	9.12	-0.02	0.17	0.43	0.12	0.51	8.64	0.05	0.10	0.40	0.07	0.23	3.37
7	0.07	0.15	0.53	0.11	0.25	7.83	-0.00	0.14	0.42	0.10	0.37	7.31	0.05	0.08	0.39	0.06	0.19	2.86
8	0.10	0.13	0.53	0.09	0.20	6.86	0.01	0.12	0.40	0.08	0.29	6.34	0.06	0.07	0.38	0.05	0.16	2.49
9	0.12	0.11	0.53	0.08	0.17	6.11	0.02	0.11	0.39	0.07	0.24	5.60	0.07	0.06	0.37	0.04	0.14	2.20
10	0.13	0.10	0.54	0.07	0.14	5.51	0.03	0.09	0.38	0.06	0.21	5.01	0.07	0.05	0.37	0.04	0.13	1.97
HS																		
0													-0.09	0.15	0.44	0.00	0.00	6.37
2	-0.38	0.70	0.60	0.56	0.97	27.45	-0.26	0.91	1.02	0.76	0.34	34.14	-0.06	0.43	0.71	0.35	1.06	11.41
3	-0.21	0.42	0.55	0.29	-0.47	18.34	-0.16	0.43	0.64	0.32	12.26	19.40	-0.02	0.24	0.55	0.18	0.45	7.10
4	-0.10	0.29	0.54	0.20	0.74	13.76	-0.10	0.29	0.54	0.20	0.74	13.76	-0.00	0.17	0.48	0.12	0.30	5.16
5	-0.04	0.23	0.54	0.15	0.37	11.01	-0.07	0.22	0.49	0.14	0.44	10.65	0.01	0.13	0.44	0.09	0.22	4.06
6	0.01	0.18	0.54	0.12	0.26	9.18	-0.05	0.18	0.46	0.11	0.32	8.69	0.02	0.10	0.42	0.07	0.18	3.35
7	0.05	0.15	0.54	0.10	0.21	7.87	-0.03	0.15	0.44	0.09	0.26	7.34	0.03	0.08	0.41	0.06	0.15	2.85
8	0.07	0.13	0.54	0.09	0.17	6.89	-0.01	0.13	0.42	0.08	0.21	6.36	0.04	0.07	0.40	0.05	0.13	2.48
9	0.09	0.12	0.55	0.07	0.15	6.13	-0.00	0.11	0.41	0.07	0.18	5.61	0.04	0.06	0.39	0.04	0.12	2.19
10	0.11	0.10	0.55	0.07	0.13	5.52	0.00	0.10	0.41	0.06	0.16	5.02	0.04	0.06	0.39	0.04	0.10	1.97
CL																		
0													-0.39	0.18	0.31	0.00	0.00	5.78
2	-0.84	0.86	0.42	0.45	-1.20	26.82	-0.64	0.95	0.71	0.57	0.89	32.23	-0.37	0.53	0.55	0.28	-0.48	10.83
3	-0.58	0.53	0.40	0.25	0.31	18.21	-0.50	0.55	0.50	0.27	0.09	19.34	-0.32	0.30	0.41	0.15	3.15	6.79
4	-0.43	0.38	0.41	0.17	-0.23	13.74	-0.43	0.38	0.41	0.17	-0.23	13.74	-0.30	0.21	0.35	0.10	0.71	4.96
5	-0.33	0.29	0.41	0.13	1.40	11.02	-0.39	0.28	0.36	0.12	-0.89	10.64	-0.28	0.16	0.31	0.07	0.43	3.91
6	-0.27	0.24	0.42	0.10	0.44	9.20	-0.36	0.23	0.33	0.10	7.51	8.69	-0.27	0.12	0.29	0.06	0.32	3.23
7	-0.22	0.20	0.42	0.09	0.29	7.89	-0.34	0.19	0.31	0.08	0.99	7.34	-0.26	0.10	0.28	0.05	0.26	2.75
8	-0.18	0.17	0.42	0.08	0.22	6.91	-0.32	0.16	0.30	0.07	0.58	6.35	-0.25	0.09	0.27	0.04	0.22	2.40
9	-0.15	0.15	0.43	0.07	0.18	6.15	-0.30	0.14	0.29	0.06	0.42	5.60	-0.25	0.08	0.27	0.04	0.19	2.13
10	-0.13	0.13	0.43	0.06	0.16	5.76	-0.29	0.13	0.28	0.05	0.34	5.01	-0.24	0.07	0.26	0.03	0.17	1.91

Notes: LS refers to high-school dropouts; HS to high-school graduates, and CL to college graduates. W/Y and S/Y are ratios of net financial wealth to after-tax labor income, and stock to after-tax labor income respectively. S/W is the portfolio share of risky assets. "Exp." denotes expectation about the second period ratio, based on information at the end of the first period. The utility gain from stocks refers to the percentage increase in utility that households experience when they are given access to stocks as well as bonds. γ different from unity indicates overweighting of inferior states relative to an expected utility framework, since the weight attached to the utility of the worst state is $p^{\tilde{a}}$ where p is its probability of occurrence; λ is the weight attached to utility from bequests, g is relative risk aversion, and ρ is equal to one minus the inverse of the intertemporal elasticity of substitution. Zero risk aversion refers to Yaari preferences (see Section II).

Table 2: Effects of Labor Income Risk on Wealth and on Stockholding under Departures from Expected Utility, By Education Group (Benchmark Model)

	Expected Utility Model (EU)					Kreps-Porteus Model (KP)					Overweighting of Inferior States (Y and Q)				
	Parameters: γ=1, λ=0.25					Parameters: γ=1, λ=0.25, ρ=-3					Parameters: γ=0.50, λ=0.25, ρ=-3				
g	**Ä(W/Y)**	**Ä(S/Y)**	**Exp. Ä(W/Y)**	**Exp. Ä(S/Y)**	**Exp. Ä(S/W)**	**Ä(W/Y)**	**Ä(S/Y)**	**Exp. Ä(W/Y)**	**Exp. Ä(S/Y)**	**Exp. Ä(S/W)**	**Ä(W/Y)**	**Ä(S/Y)**	**Exp. Ä(W/Y)**	**Exp. Ä(S/Y)**	**Exp. Ä(S/W)**
LS															
0											-0.029	0.193	0.166	0.000	0.000
2	0.110	-0.089	-0.016	0.040	1.548	0.081	-0.096	-0.007	0.045	26.344	0.121	-0.098	-0.025	0.020	-33.02
3	0.107	-0.063	-0.015	0.022	-1.610	0.095	-0.065	-0.012	0.023	-1.282	0.130	-0.070	-0.020	0.013	0.284
4	0.109	-0.051	-0.010	0.016	-8.299	0.109	-0.051	-0.010	0.016	-8.299	0.139	-0.055	-0.012	0.010	0.113
5	0.112	-0.043	-0.003	0.013	0.210	0.120	-0.042	-0.004	0.013	0.543	0.146	-0.045	-0.005	0.008	0.067
6	0.115	-0.036	0.004	0.011	0.074	0.130	-0.035	0.001	0.011	0.211	0.151	-0.038	0.002	0.007	0.047
7	0.118	-0.032	0.010	0.010	0.040	0.137	-0.030	0.006	0.009	0.121	0.155	-0.033	0.007	0.006	0.036
8	0.121	-0.028	0.015	0.009	0.026	0.143	-0.026	0.010	0.008	0.082	0.159	-0.028	0.011	0.005	0.030
9	0.123	-0.025	0.019	0.008	0.019	0.147	-0.023	0.014	0.008	0.061	0.161	-0.025	0.014	0.005	0.025
10	0.125	-0.022	0.023	0.007	0.014	0.151	-0.021	0.017	0.007	0.048	0.163	-0.023	0.017	0.004	0.022
HS															
0											-0.019	0.149	0.130	0.000	0.000
2	0.074	-0.059	-0.009	0.022	2.000	0.054	-0.076	-0.001	0.026	-20.118	0.090	-0.074	-0.020	0.010	0.331
3	0.072	-0.043	-0.008	0.012	-1.612	0.064	-0.044	-0.007	0.013	11.425	0.097	-0.054	-0.014	0.006	0.067
4	0.074	-0.035	-0.005	0.009	0.254	0.074	-0.035	-0.005	0.009	0.254	0.103	-0.044	-0.008	0.005	0.033
5	0.077	-0.030	-0.001	0.007	0.057	0.083	-0.030	-0.001	0.007	0.094	0.109	-0.037	-0.002	0.004	0.021
6	0.080	-0.027	0.004	0.006	0.026	0.091	-0.026	0.003	0.006	0.052	0.113	-0.032	0.003	0.004	0.016
7	0.083	-0.024	0.007	0.005	0.015	0.097	-0.023	0.007	0.005	0.034	0.117	-0.028	0.007	0.004	0.012
8	0.086	-0.021	0.011	0.005	0.010	0.103	-0.020	0.010	0.005	0.024	0.120	-0.024	0.011	0.003	0.010
9	0.088	-0.019	0.014	0.005	0.008	0.107	-0.018	0.013	0.004	0.019	0.122	-0.022	0.014	0.003	0.008
10	0.090	-0.017	0.017	0.004	0.006	0.111	-0.016	0.016	0.004	0.015	0.124	-0.020	0.016	0.003	0.007
CL															
0											-0.024	0.182	0.110	0.000	0.000
2	0.081	-0.062	-0.021	0.012	-1.042	0.056	-0.066	-0.017	0.013	2.148	0.102	-0.083	-0.031	0.004	-1.790
3	0.077	-0.046	-0.019	0.007	3.004	0.067	-0.047	-0.018	0.007	-2.728	0.110	-0.062	-0.025	0.003	2.602
4	0.079	-0.038	-0.016	0.005	-1.106	0.079	-0.038	-0.016	0.005	-1.106	0.118	-0.051	-0.019	0.003	0.352
5	0.083	-0.034	-0.012	0.004	0.959	0.091	-0.033	-0.012	0.004	-1.427	0.125	-0.043	-0.014	0.003	0.165
6	0.087	-0.030	-0.009	0.004	0.139	0.100	-0.029	-0.009	0.004	7.112	0.130	-0.038	-0.009	0.002	0.103
7	0.090	-0.027	-0.006	0.003	0.059	0.109	-0.026	-0.005	0.003	0.672	0.135	-0.033	-0.005	0.002	0.074
8	0.094	-0.024	-0.003	0.003	0.034	0.115	-0.023	-0.002	0.003	0.310	0.139	-0.030	-0.002	0.002	0.058
9	0.097	-0.022	0.000	0.003	0.023	0.121	-0.021	0.001	0.003	0.190	0.142	-0.027	0.001	0.002	0.047
10	0.099	-0.020	0.002	0.003	0.017	0.126	-0.019	0.003	0.003	0.133	0.145	-0.024	0.003	0.002	0.040

Notes: See Table 1.

Table 3: Effects of Labor Income Risk on Wealth and on Stockholding under Extreme Overweighting of Inferior States
(Households with Less than High School Education)

Parameters:
ã=0.15, λ=0.25, ρ=-3

	Ä(W/Y)	**Ä(S/Y)**	**Exp.Ä(W/Y)**	**Exp. Ä(S/Y)**	**Exp. Ä(S/W)**
0	0.117	0.193	0.239	0.000	0.000
2	0.157	0.016	0.068	0.010	0.026
3	0.162	0.001	0.046	0.005	0.015
4	0.166	-0.003	0.039	0.004	0.012
5	0.168	-0.004	0.037	0.003	0.009
6	0.170	-0.004	0.037	0.002	0.008
7	0.171	-0.004	0.037	0.002	0.007
8	0.172	-0.004	0.037	0.002	0.006
9	0.173	-0.004	0.037	0.002	0.005
10	0.174	-0.003	0.037	0.001	0.005

Notes: See Table 1. γ different from unity indicates overweighting of inferior states relative to an expected utility framework, since the weight attached to the utility of the worst state is $p^{ã}$ where p is its probability of occurrence.

Table 4: Effects of Departures from Expected-Utility Maximization on Wealth and on Stock holding, Under Perceived Variance of Labor Income Shocks Equal to 120% of Benchmark, by Education Group

	Expected Utility Model (EU)						**Kreps-Porteus Model (KP)**						**Overweighting of Inferior States (Y and Q)**					
	Parameters: γ=1, λ=0.25						**Parameters: γ=1, λ=0.25, ρ=-3**						**Parameters: γ=0.50, λ=0.25, ρ=-3**					
g	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**
LS																		
0													-0.11	0.21	0.47	0.00	0.00	9.11
2	-0.34	0.66	0.57	0.60	0.80	26.86	-0.24	0.71	0.85	0.73	0.42	31.69	-0.03	0.40	0.69	0.37	-2.13	11.41
3	-0.17	0.39	0.52	0.32	0.10	18.02	-0.12	0.41	0.62	0.34	-0.12	19.31	0.01	0.22	0.52	0.19	0.89	7.14
4	-0.06	0.27	0.51	0.21	-1.25	13.56	-0.06	0.27	0.51	0.21	-1.25	13.56	0.04	0.18	0.49	0.13	0.46	5.09
5	0.01	0.21	0.52	0.16	0.67	10.89	-0.03	0.21	0.46	0.15	1.61	10.54	0.06	0.14	0.45	0.10	0.32	3.92
6	0.05	0.17	0.52	0.13	0.36	9.10	0.00	0.16	0.43	0.12	0.64	8.62	0.07	0.11	0.42	0.08	0.24	3.19
7	0.09	0.14	0.53	0.11	0.26	7.82	0.02	0.14	0.42	0.10	0.43	7.30	0.08	0.09	0.41	0.06	0.20	2.69
8	0.11	0.12	0.53	0.09	0.21	6.86	0.03	0.12	0.40	0.08	0.33	6.33	0.08	0.08	0.39	0.05	0.17	2.33
9	0.14	0.11	0.54	0.08	0.17	6.11	0.04	0.10	0.39	0.07	0.27	5.59	0.09	0.07	0.39	0.05	0.15	2.06
10	0.15	0.10	0.54	0.07	0.15	5.51	0.05	0.09	0.39	0.06	0.23	5.01	0.09	0.06	0.38	0.04	0.13	1.84
HS																		
0													-0.09	0.16	0.45	0.00	0.00	7.04
2	-0.37	0.69	0.60	0.56	0.84	27.31	-0.26	0.74	0.86	0.69	0.26	32.25	-0.05	0.42	0.71	0.35	1.19	11.41
3	-0.20	0.41	0.55	0.30	-0.30	18.26	-0.15	0.42	0.64	0.32	-4.55	19.31	-0.01	0.24	0.55	0.18	0.47	7.11
4	-0.09	0.29	0.54	0.20	0.83	13.71	-0.09	0.29	0.54	0.20	0.83	13.71	0.01*	0.19*	0.51*	0.12*	0.30*	5.21*
5	-0.02	0.22	0.54	0.15	0.39	10.97	-0.06	0.22	0.49	0.14	0.47	10.62	0.03	0.14	0.47	0.09	0.23	4.00
6	0.02	0.18	0.54	0.12	0.27	9.15	-0.03	0.17	0.46	0.11	0.33	8.67	0.04	0.11	0.44	0.07	0.18	3.24
7	0.06	0.15	0.54	0.10	0.21	7.85	-0.01	0.14	0.44	0.09	0.26	7.33	0.04	0.10	0.43	0.06	0.15	2.72
8	0.09	0.13	0.55	0.09	0.17	6.88	-0.00	0.12	0.43	0.08	0.22	6.35	0.05	0.08	0.42	0.05	0.13	2.35
9	0.11	0.11	0.55	0.08	0.15	6.12	0.01	0.11	0.42	0.07	0.19	5.60	0.05	0.07	0.41	0.04	0.12	2.07
10	0.12	0.10	0.55	0.07	0.13	5.51	0.02	0.10	0.41	0.06	0.17	5.01	0.06	0.06	0.40	0.04	0.10	1.85
CL																		
0													-0.39	0.20	0.32	0.00	0.00	6.32
2	-0.82	0.85	0.42	0.46	-1.91	26.71	-0.62	0.94	0.70	0.57	0.80	32.10	-0.36	0.52	0.55	0.28	-0.30	10.84
3	-0.56	0.52	0.40	0.25	0.30	18.15	-0.48	0.54	0.49	0.27	0.12	19.27	-0.31	0.30	0.40	0.15	-6.41	6.80
4	-0.41	0.37	0.40	0.17	-0.13	13.70	-0.41	0.37	0.40	0.17	-0.13	13.88	-0.28	0.20	0.34	0.10	1.00	4.97
5	-0.32	0.28	0.41	0.13	3.74	10.99	-0.37	0.28	0.36	0.13	-0.46	10.62	-0.26	0.18	0.33	0.08	0.55	3.85
6	-0.25	0.23	0.41	0.11	0.50	9.18	-0.34	0.22	0.33	0.10	-1.66	8.67	-0.25	0.14	0.31	0.06	0.38	3.12
7	-0.20	0.19	0.42	0.09	0.31	7.88	-0.32	0.19	0.31	0.08	2.58	7.33	-0.24	0.12	0.30	0.05	0.29	2.62
8	-0.17	0.17	0.42	0.08	0.24	6.90	-0.30	0.16	0.30	0.07	0.86	6.35	-0.23	0.10	0.29	0.04	0.24	2.26
9	-0.14	0.15	0.43	0.07	0.19	6.14	-0.29	0.14	0.29	0.06	0.55	5.60	-0.23	0.09	0.28	0.04	0.21	1.99
10	-0.11	0.13	0.43	0.06	0.16	5.56	-0.27	0.12	0.28	0.05	0.41	5.01	-0.22	0.08	0.27	0.03	0.18	1.78

Notes: See Table 1. An asterisk * means that the solution is at a point where the utility function is not differentiable (See Section II).

Table 5: Effects of Departures from Expected-Utility Maximization on Wealth and on Stock holding, Under Perceived Variance of Labor Income Shocks Equal to 80% of Benchmark, by Education Group

	Expected Utility Model (EU)						Kreps-Porteus Model (KP)						Overweighting of Inferior States (Y and Q)					
	Parameters: γ=1, λ=0.25						Parameters: γ=1, λ=0.25, ρ=-3						Parameters: γ=0.50, λ=0.25, ρ=-3					
g	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**
LS																		
0													-0.10	0.17	0.43	0.00	0.00	7.21
2	-0.38	0.69	0.58	0.58	1.12	27.28	-0.27	0.75	0.85	0.71	0.42	32.20	-0.06	0.43	0.70	0.36	3.37	11.41
3	-0.21	0.41	0.53	0.31	0.01	18.24	-0.16	0.43	0.62	0.33	-0.48	19.29	-0.02	0.24	0.52	0.18	0.61	7.11
4	-0.10	0.29	0.52	0.21	2.72	13.70	-0.10	0.29	0.52	0.21	2.72	13.70	0.00*	0.19*	0.49*	0.12*	0.37*	5.20*
5	-0.03	0.22	0.52	0.15	0.49	10.97	-0.06	0.22	0.46	0.15	0.70	10.61	0.02	0.14	0.45	0.09	0.27	3.99
6	0.02	0.18	0.52	0.12	0.31	9.15	-0.04	0.17	0.43	0.11	0.44	8.67	0.03	0.12	0.42	0.07	0.21	3.23
7	0.05	0.15	0.52	0.10	0.24	7.85	-0.02	0.14	0.41	0.09	0.33	7.33	0.04	0.10	0.40	0.06	0.18	2.72
8	0.08	0.13	0.53	0.09	0.19	6.88	-0.01	0.12	0.40	0.08	0.27	6.35	0.04	0.08	0.39	0.05	0.15	2.35
9	0.10	0.11	0.53	0.08	0.16	6.12	0.00	0.11	0.39	0.07	0.23	5.60	0.05	0.07	0.38	0.04	0.13	2.07
10	0.12	0.10	0.53	0.07	0.14	5.51	0.01	0.10	0.38	0.06	0.20	5.01	0.05	0.06	0.38	0.04	0.12	1.85
HS																		
0													-0.08	0.15	0.44	0.00	0.00	6.34
2	-0.40	0.71	0.60	0.55	1.14	27.59	-0.28	0.77	0.86	0.68	0.18	32.58	-0.06	0.43	0.72	0.35	1.12	11.41
3	-0.22	0.42	0.55	0.29	-0.87	18.43	-0.17	0.44	0.64	0.31	2.67	19.49	-0.02	0.24	0.55	0.18	0.46	7.10
4	-0.12	0.30	0.54	0.19	0.65	13.82	-0.12	0.30	0.54	0.19	0.65	13.82	0.01	0.17	0.48	0.12	0.30	5.16
5	-0.05	0.23	0.54	0.15	0.36	11.05	-0.09	0.22	0.49	0.14	0.41	10.78	0.02	0.15	0.47	0.09	0.23	4.03
6	-0.00	0.19	0.54	0.12	0.26	9.20	-0.06	0.18	0.46	0.11	0.31	8.72	0.03	0.12	0.44	0.07	0.18	3.26
7	0.03	0.16	0.54	0.10	0.20	7.89	-0.05	0.15	0.43	0.09	0.25	7.41	0.04	0.10	0.43	0.06	0.15	2.74
8	0.06	0.14	0.54	0.08	0.17	6.90	-0.03	0.13	0.42	0.07	0.21	6.37	0.04	0.08	0.41	0.05	0.13	2.36
9	0.08	0.12	0.54	0.07	0.14	6.14	-0.02	0.11	0.41	0.06	0.18	5.62	0.05	0.07	0.41	0.04	0.12	2.08
10	0.10	0.11	0.55	0.07	0.13	5.53	-0.01	0.10	0.40	0.06	0.16	5.02	0.05	0.06	0.40	0.04	0.10	1.85
CL																		
0													-0.39	0.16	0.30	0.00	0.00	5.07
2	-0.86	0.87	0.42	0.45	-0.73	26.95	-0.65	0.96	0.71	0.57	1.11	32.38	-0.39	0.54	0.56	0.28	-0.86	10.82
3	-0.60	0.54	0.41	0.25	0.33	18.29	-0.51	0.56	0.50	0.27	0.06	19.43	-0.34	0.31	0.41	0.15	1.38	6.77
4	-0.45	0.38	0.41	0.17	-0.42	13.80	-0.45	0.38	0.41	0.17	-0.42	13.80	-0.31	0.21	0.35	0.10	0.57	4.94
5	-0.35	0.30	0.41	0.13	0.90	11.06	-0.40	0.29	0.36	0.12	-3.41	10.68	-0.30	0.16	0.32	0.07	0.38	3.90
6	-0.28	0.24	0.42	0.10	0.40	9.23	-0.38	0.23	0.33	0.10	1.34	8.71	-0.29	0.15	0.31	0.06	0.29	3.18
7	-0.24	0.20	0.42	0.09	0.28	7.91	-0.35	0.19	0.31	0.08	0.65	7.36	-0.28	0.13	0.30	0.05	0.23	2.66
8	-0.20	0.17	0.42	0.07	0.22	6.93	-0.34	0.17	0.30	0.07	0.45	6.37	-0.27	0.11	0.29	0.04	0.20	2.29
9	-0.17	0.15	0.43	0.07	0.18	6.16	-0.32	0.14	0.29	0.06	0.35	5.65	-0.26	0.09	0.28	0.04	0.17	2.01
10	-0.15	0.14	0.43	0.06	0.15	6.34	-0.31	0.13	0.28	0.05	0.29	5.04	-0.26	0.08	0.27	0.03	0.15	1.79

Notes: See Table 1. An asterisk * means that the solution is at a point where the utility function is not differentiable (See Section II).

Table 6: Effects of Departures from Expected-Utility Maximization on Wealth and on Stock holding, Under Perceived Persistence of Labor Income Shocks $\tilde{n}_Y$ Equal to Unity, by Education Group

	Expected Utility Model (EU)						**Kreps-Porteus Model (KP)**						**Overweighting of Inferior States (Y and Q)**					
	Parameters: γ=1, λ=0.25						**Parameters: γ=1, λ=0.25, ρ=-3**						**Parameters: γ=0.50, λ=0.25, ρ=-3**					
g	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stock s %**
LS																		
0													-0.12	0.28	0.54	0.00	0.00	12.08
2	-0.27	0.61	0.57	0.66	0.65	26.22	-0.18	0.65	0.86	0.80	0.43	30.86	0.02	0.36	0.70	0.41	-0.25	11.42
3	-0.10	0.36	0.52	0.35	0.17	17.71	-0.06	0.37	0.62	0.37	0.07	18.70	0.08	0.24	0.57	0.22	-1.58	7.03
4	0.00	0.25	0.51	0.24	-0.15	13.41	0.00	0.25	0.51	0.24	-0.15	13.41	0.10	0.16	0.49	0.14	1.40	4.98
5	0.07	0.19	0.52	0.18	-20.3	10.80	0.04	0.19	0.46	0.17	-0.47	10.46	0.12	0.12	0.45	0.11	0.59	3.86
6	0.11	0.16	0.53	0.14	0.58	9.05	0.07	0.15	0.43	0.13	-1.69	8.59	0.13	0.10	0.42	0.08	0.40	3.16
7	0.15	0.13	0.54	0.12	0.34	7.80	0.08	0.13	0.41	0.11	2.59	7.28	0.14	0.08	0.41	0.07	0.30	2.68
8	0.17	0.12	0.55	0.10	0.25	6.84	0.10	0.11	0.40	0.09	0.87	6.32	0.14	0.07	0.39	0.06	0.25	2.32
9	0.19	0.10	0.55	0.09	0.20	6.10	0.11	0.10	0.39	0.08	0.55	5.59	0.15	0.06	0.38	0.05	0.21	2.05
10	0.21	0.09	0.56	0.08	0.17	5.50	0.12	0.09	0.38	0.07	0.42	5.01	0.15	0.06	0.38	0.05	0.18	1.84
HS																		
0													-0.09	0.21	0.50	0.00	0.00	9.29
2	-0.32	0.65	0.59	0.59	0.66	26.82	-0.22	0.70	0.87	0.72	0.32	31.64	-0.01	0.39	0.71	0.36	3.77	11.41
3	-0.15	0.38	0.54	0.31	-0.02	18.00	-0.10	0.40	0.64	0.33	-0.45	19.02	0.03	0.22	0.55	0.19	0.60	7.14
4	-0.04	0.27	0.54	0.21	2.77	13.55	-0.04	0.27	0.54	0.21	2.77	13.55	0.06	0.18	0.51	0.13	0.36	5.08
5	0.02	0.21	0.54	0.16	0.48	10.88	-0.01	0.20	0.49	0.15	0.67	10.53	0.08	0.13	0.47	0.09	0.26	3.92
6	0.07	0.17	0.55	0.13	0.30	9.09	0.02	0.16	0.46	0.12	0.42	8.62	0.09	0.11	0.45	0.07	0.20	3.19
7	0.11	0.14	0.55	0.11	0.23	7.82	0.04	0.13	0.44	0.10	0.32	7.30	0.09	0.09	0.43	0.06	0.17	2.69
8	0.13	0.12	0.56	0.09	0.19	6.86	0.05	0.12	0.43	0.08	0.26	6.33	0.10	0.08	0.42	0.05	0.15	2.33
9	0.15	0.11	0.56	0.08	0.16	6.11	0.06	0.10	0.42	0.07	0.22	5.59	0.10	0.07	0.41	0.05	0.13	2.06
10	0.17	0.10	0.57	0.07	0.14	5.51	0.07	0.09	0.41	0.06	0.19	5.01	0.11	0.06	0.41	0.04	0.11	1.84
CL																		
0													-0.40	0.25	0.35	0.00	0.00	8.11
2	-0.77	0.81	0.40	0.47	3.24	26.34	-0.59	0.90	0.69	0.59	0.62	31.66	-0.32	0.49	0.54	0.29	-0.05	10.86
3	-0.52	0.49	0.39	0.26	0.28	17.94	-0.44	0.51	0.48	0.28	0.16	19.05	-0.26	0.28	0.39	0.15	-0.41	6.84
4	-0.37	0.35	0.39	0.18	0.00	13.57	-0.37	0.35	0.39	0.18	0.00	13.57	-0.23	0.22	0.36	0.10	-0.95	4.91
5	-0.27	0.27	0.40	0.14	-0.57	10.91	-0.32	0.26	0.35	0.13	-0.11	10.54	-0.21	0.17	0.33	0.08	16.12	3.78
6	-0.21	0.22	0.41	0.11	1.04	9.13	-0.29	0.21	0.32	0.10	-0.23	8.62	-0.20	0.14	0.31	0.06	1.09	3.07
7	-0.16	0.18	0.41	0.09	0.41	7.85	-0.26	0.18	0.30	0.08	-0.39	7.30	-0.19	0.11	0.29	0.05	0.61	2.59
8	-0.12	0.16	0.42	0.08	0.28	6.88	-0.25	0.15	0.29	0.07	-0.72	6.33	-0.18	0.10	0.28	0.04	0.43	2.24
9	-0.09	0.14	0.43	0.07	0.22	6.13	-0.23	0.13	0.28	0.06	-1.80	5.59	-0.18	0.09	0.27	0.04	0.34	1.98
10	-0.07	0.13	0.43	0.06	0.18	6.94	-0.22	0.12	0.27	0.05	7.84	5.00	-0.17	0.08	0.27	0.03	0.29	1.77

Notes: See Table 1. An asterisk * means that the solution is at a point where the utility function is not differentiable (See Section II). Persistence refers to parameter $\tilde{n}_Y$ in the stochastic process followed by the logarithm of one type of shocks to annual labor incomes: $u_t=\tilde{n}_Y u_{t-1}+\mathring{q}$. See Section III.

Table 7: Effects of Departures from Expected-Utility Maximization on Wealth and on Stock holding, Under Perceived Persistence of Labor Income Shocks $\tilde{n}_Y$ Equal to 0.5, by Education Group

	Expected Utility Model (EU)						Kreps-Porteus Model (KP)						Overweighting of Inferior States (Y and Q)					
	Parameters: γ=1, λ=0.25						Parameters: γ=1, λ=0.25, ρ=-3						Parameters: γ=0.50, λ=0.25, ρ=-3					
g	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**
LS																		
0													-0.09	0.04	0.33	0.00	0.00	1.84
2	-0.47	0.76	0.59	0.55	-0.90	28.16	-0.33	0.82	0.85	0.67	0.69	33.23	-0.15	0.49	0.71	0.34	0.86	11.36
3	-0.29	0.46	0.54	0.29	3.65	18.80	-0.23	0.48	0.63	0.31	1.18	19.87	-0.11	0.29	0.54	0.17	0.43	7.00
4	-0.18	0.33	0.52	0.19	0.58	14.09	-0.18	0.33	0.52	0.19	0.58	14.09	-0.10	0.20	0.46	0.11	0.29	5.06
5	-0.12	0.26	0.52	0.14	0.36	11.26	-0.16	0.25	0.47	0.14	0.40	10.90	-0.09	0.15	0.42	0.08	0.22	3.97
6	-0.07	0.21	0.52	0.12	0.26	9.37	-0.14	0.20	0.43	0.11	0.31	8.88	-0.08	0.12	0.40	0.07	0.18	3.26
7	-0.04	0.18	0.52	0.10	0.21	8.02	-0.13	0.17	0.41	0.09	0.25	7.49	-0.08	0.10	0.38	0.05	0.15	2.77
8	-0.02	0.15	0.52	0.08	0.17	7.01	-0.12	0.14	0.39	0.07	0.21	6.47	-0.07	0.09	0.37	0.05	0.13	2.41
9	0.00	0.13	0.52	0.07	0.15	6.23	-0.11	0.13	0.38	0.06	0.19	5.70	-0.07	0.08	0.36	0.04	0.12	2.14
10	0.02	0.12	0.52	0.06	0.13	5.60	-0.10	0.11	0.37	0.06	0.16	5.09	-0.07	0.07	0.35	0.04	0.11	1.92
HS																		
0													-0.07	0.04	0.34	0.00	0.00	1.56
2	-0.45	0.75	0.61	0.54	-1.48	28.18	-0.32	0.81	0.87	0.66	-3.66	33.26	-0.14	0.49	0.73	0.34	0.73	11.35
3	-0.27	0.46	0.56	0.28	1.33	18.81	-0.22	0.47	0.64	0.30	0.88	19.89	-0.10	0.29	0.56	0.17	0.38	6.99
4	-0.17	0.33	0.54	0.19	0.49	14.10	-0.17	0.33	0.54	0.19	0.49	14.10	-0.09	0.20	0.48	0.11	0.26	5.05
5	-0.11	0.25	0.54	0.14	0.32	11.27	-0.15	0.25	0.49	0.14	0.35	10.91	-0.08	0.15	0.44	0.08	0.20	3.96
6	-0.06	0.21	0.54	0.11	0.24	9.38	-0.13	0.20	0.45	0.10	0.27	8.89	-0.07	0.12	0.42	0.06	0.16	3.26
7	-0.03	0.17	0.53	0.09	0.19	8.03	-0.12	0.17	0.43	0.09	0.22	7.49	-0.07	0.10	0.40	0.05	0.14	2.77
8	-0.01	0.15	0.53	0.08	0.16	7.02	-0.11	0.14	0.41	0.07	0.19	6.48	-0.06	0.09	0.39	0.05	0.12	2.41
9	0.01	0.13	0.53	0.07	0.14	6.24	-0.10	0.13	0.40	0.06	0.17	5.70	-0.06	0.08	0.38	0.04	0.11	2.13
10	0.03	0.12	0.53	0.06	0.12	5.61	-0.09	0.11	0.39	0.05	0.15	5.09	-0.06	0.07	0.37	0.03	0.10	1.91
CL																		
0													-0.37	0.04	0.23	0.00	0.00	1.28
2	-0.91	0.92	0.44	0.44	-0.17	27.44	-0.69	1.01	0.72	0.56	-1.70	32.92	-0.46	0.60	0.58	0.28	1.45	10.72
3	-0.65	0.57	0.42	0.24	3.68	18.61	-0.56	0.59	0.51	0.26	-9.84	19.75	-0.42	0.35	0.43	0.14	0.56	6.65
4	-0.50	0.41	0.42	0.17	1.01	14.03	-0.50	0.41	0.42	0.17	1.01	14.03	-0.40	0.25	0.36	0.09	0.36	4.82
5	-0.41	0.32	0.42	0.13	0.45	11.25	-0.47	0.31	0.37	0.12	0.58	10.86	-0.39	0.19	0.32	0.07	0.27	3.78
6	-0.35	0.26	0.42	0.10	0.31	9.38	-0.45	0.25	0.34	0.09	0.42	8.86	-0.38	0.15	0.30	0.06	0.22	3.11
7	-0.30	0.22	0.42	0.08	0.24	8.04	-0.44	0.21	0.32	0.08	0.33	7.47	-0.37	0.13	0.29	0.05	0.18	2.65
8	-0.27	0.19	0.43	0.07	0.19	7.03	-0.42	0.18	0.30	0.06	0.28	6.46	-0.37	0.11	0.27	0.04	0.16	2.30
9	-0.24	0.17	0.43	0.06	0.16	6.25	-0.42	0.16	0.29	0.06	0.24	5.69	-0.37	0.10	0.27	0.03	0.14	2.04
10	-0.22	0.15	0.43	0.06	0.14	5.62	-0.41	0.14	0.28	0.05	0.21	5.09	-0.36	0.09	0.26	0.03	0.13	1.83

Notes: See Table 1. Persistence refers to parameter $\tilde{n}_Y$ in the stochastic process followed by the logarithm of one type of shocks to annual labor incomes: $u_t=\tilde{n}_Y u_{t-1}+\mathring{q}$. See Section IV.

Table 8: Effects of Departures from Expected-Utility Maximization on Wealth and on Stock holding, Under Correlation Between Labor Incomes and Excess Stock Returns Equal to 0.2, by Education Group

	Expected Utility Model (EU)						Kreps-Porteus Model (KP)						Overweighting of Inferior States (Y and Q)					
	Parameters: γ=1, λ=0.25						Parameters: γ=1, λ=0.25, ρ=-3						Parameters: γ=0.50, λ=0.25, ρ=-3					
g	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**
LS																		
0													-0.08	0.19	0.46	0.00	0.00	7.09
2	-0.35	0.65	0.56	0.58	0.86	25.49	-0.24	0.71	0.83	0.71	0.38	30.27	-0.04	0.40	0.68	0.36	10.33	10.56
3	-0.18	0.38	0.51	0.31	0.03	16.76	-0.13	0.40	0.60	0.33	-0.36	17.77	0.00	0.22	0.51	0.18	0.68	6.42
4	-0.07	0.27	0.50	0.21	8.79	12.43	-0.07	0.27	0.50	0.21	8.79	12.43	0.03	0.17	0.47	0.12	0.40	4.53
5	-0.01	0.20	0.50	0.16	0.53	9.87	-0.04	0.20	0.45	0.15	0.82	9.54	0.04	0.13	0.43	0.09	0.29	3.45
6	0.04	0.16	0.51	0.13	0.33	8.19	-0.01	0.16	0.42	0.12	0.49	7.74	0.05	0.10	0.41	0.07	0.23	2.79
7	0.08	0.14	0.52	0.10	0.24	7.00	0.00	0.13	0.41	0.10	0.36	6.51	0.06	0.09	0.40	0.06	0.19	2.34
8	0.10	0.12	0.52	0.09	0.20	6.12	0.02	0.11	0.39	0.08	0.29	5.63	0.06	0.07	0.39	0.05	0.16	2.02
9	0.12	0.10	0.53	0.08	0.17	5.44	0.03	0.10	0.39	0.07	0.24	4.96	0.07	0.06	0.38	0.05	0.14	1.78
10	0.14	0.09	0.53	0.07	0.14	4.90	0.03	0.09	0.38	0.06	0.21	4.44	0.07	0.06	0.37	0.04	0.13	1.59
HS																		
0													-0.07	0.15	0.45	0.00	0.00	5.47
2	-0.37	0.68	0.59	0.55	0.91	26.15	-0.26	0.73	0.85	0.68	0.18	31.04	-0.06	0.42	0.70	0.34	1.01	10.70
3	-0.20	0.40	0.54	0.29	-0.64	17.19	-0.15	0.41	0.62	0.31	4.20	18.23	-0.02	0.23	0.54	0.17	0.44	6.49
4	-0.09	0.28	0.53	0.20	0.70	12.73	-0.09	0.28	0.53	0.20	0.70	12.73	0.00	0.16	0.47	0.11	0.29	4.64
5	-0.03	0.21	0.53	0.15	0.37	10.07	-0.06	0.21	0.48	0.14	0.43	9.73	0.02	0.13	0.46	0.09	0.22	3.55
6	0.02	0.17	0.53	0.12	0.26	8.33	-0.04	0.17	0.45	0.11	0.32	7.86	0.03	0.11	0.43	0.07	0.18	2.85
7	0.05	0.14	0.53	0.10	0.21	7.10	-0.02	0.14	0.43	0.09	0.25	6.60	0.03	0.09	0.42	0.06	0.15	2.38
8	0.08	0.12	0.54	0.08	0.17	6.19	-0.01	0.12	0.42	0.08	0.21	5.68	0.04	0.08	0.41	0.05	0.13	2.05
9	0.10	0.11	0.54	0.07	0.15	5.48	0.00	0.10	0.41	0.07	0.18	5.00	0.04	0.07	0.40	0.04	0.11	1.80
10	0.12	0.10	0.54	0.07	0.13	4.93	0.01	0.09	0.40	0.06	0.16	4.46	0.05	0.06	0.39	0.04	0.10	1.60
CL																		
0													-0.37	0.18	0.32	0.00	0.00	4.93
2	-0.82	0.84	0.41	0.45	-1.43	25.61	-0.62	0.92	0.69	0.56	0.83	30.94	-0.37	0.51	0.54	0.28	-0.58	10.17
3	-0.57	0.51	0.39	0.25	0.29	17.12	-0.49	0.53	0.49	0.27	0.06	18.23	-0.32	0.29	0.40	0.15	2.24	6.22
4	-0.42	0.36	0.40	0.17	-0.31	12.75	-0.42	0.36	0.40	0.17	-0.31	12.75	-0.29	0.20	0.34	0.10	0.66	4.45
5	-0.32	0.27	0.40	0.13	1.13	10.12	-0.38	0.27	0.35	0.12	-1.32	9.75	-0.27	0.17	0.33	0.07	0.43	3.42
6	-0.26	0.22	0.41	0.10	0.42	8.37	-0.35	0.21	0.32	0.10	2.65	7.88	-0.26	0.13	0.30	0.06	0.32	2.75
7	-0.21	0.19	0.41	0.09	0.29	7.14	-0.33	0.18	0.30	0.08	0.84	6.61	-0.25	0.11	0.29	0.05	0.25	2.29
8	-0.17	0.16	0.42	0.07	0.22	6.22	-0.31	0.15	0.29	0.07	0.53	5.69	-0.25	0.10	0.28	0.04	0.21	1.96
9	-0.15	0.14	0.42	0.07	0.18	5.51	-0.30	0.13	0.28	0.06	0.40	5.00	-0.24	0.08	0.27	0.04	0.18	1.72
10	-0.12	0.12	0.42	0.06	0.16	5.17	-0.29	0.12	0.27	0.05	0.33	4.46	-0.24	0.07	0.27	0.03	0.16	1.53

Notes: See Table 1.

Table 9: Effects of Departures from Expected-Utility Maximization on Wealth and on Stock holding, Under Correlation Between Labor Incomes and Excess Stock Returns Equal to -0.03, by Education Group

	Expected Utility Model (EU)						Kreps-Porteus Model (KP)						Overweighting of Inferior States (Y and Q)					
	Parameters: γ=1, λ=0.25						Parameters: γ=1, λ=0.25, ρ=-3						Parameters: γ=0.50, λ=0.25, ρ=-3					
g	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain From Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**
LS																		
0													-0.11	0.19	0.45	0.00	0.00	8.57
2	-0.37	0.68	0.58	0.59	0.91	27.55	-0.26	0.74	0.85	0.72	0.42	32.45	-0.05	0.42	0.70	0.36	-13.50	11.68
3	-0.19	0.41	0.53	0.31	0.07	18.55	-0.15	0.42	0.62	0.33	-0.23	19.59	-0.01	0.24	0.53	0.19	0.72	7.35
4	-0.09	0.29	0.52	0.21	-4.69	14.00	-0.09	0.29	0.52	0.21	-4.69	14.00	0.02	0.19	0.49	0.13	0.41	5.33
5	-0.02	0.22	0.52	0.16	0.57	11.26	-0.05	0.22	0.47	0.15	0.98	10.90	0.04	0.14	0.45	0.09	0.29	4.11
6	0.03	0.18	0.52	0.13	0.33	9.42	-0.02	0.17	0.44	0.12	0.52	8.93	0.05	0.12	0.42	0.07	0.23	3.35
7	0.07	0.15	0.53	0.11	0.25	8.10	-0.00	0.14	0.42	0.10	0.37	7.57	0.06	0.10	0.41	0.06	0.19	2.82
8	0.09	0.13	0.53	0.09	0.20	7.10	0.01	0.12	0.40	0.08	0.29	6.57	0.06	0.08	0.40	0.05	0.16	2.44
9	0.12	0.11	0.54	0.08	0.17	6.33	0.02	0.11	0.39	0.07	0.25	5.80	0.07	0.07	0.39	0.05	0.14	2.15
10	0.13	0.10	0.54	0.07	0.14	5.71	0.03	0.10	0.39	0.06	0.21	5.19	0.07	0.06	0.38	0.04	0.12	1.93
HS																		
0													-0.09	0.15	0.44	0.00	0.00	6.64
2	-0.39	0.70	0.60	0.56	0.99	27.86	-0.27	0.76	0.87	0.68	0.25	32.84	-0.07	0.44	0.72	0.35	1.07	11.63
3	-0.21	0.42	0.55	0.29	-0.42	18.70	-0.16	0.44	0.64	0.32	35.97	19.77	-0.03	0.25	0.55	0.18	0.45	7.29
4	-0.11	0.30	0.54	0.20	0.75	14.09	-0.11	0.30	0.54	0.20	0.75	14.09	-0.00	0.17	0.48	0.12	0.30	5.33
5	-0.04	0.23	0.54	0.15	0.38	11.31	-0.07	0.22	0.49	0.14	0.44	10.95	0.01*	0.15*	0.47*	0.09*	0.22*	4.18*
6	0.01	0.19	0.54	0.12	0.26	9.45	-0.05	0.18	0.46	0.11	0.32	8.96	0.02	0.12	0.45	0.07	0.18	3.39
7	0.04	0.16	0.54	0.10	0.21	8.12	-0.03	0.15	0.44	0.09	0.26	7.58	0.03	0.10	0.43	0.06	0.15	2.85
8	0.07	0.14	0.55	0.09	0.17	7.11	-0.02	0.13	0.43	0.08	0.21	6.57	0.04	0.09	0.42	0.05	0.13	2.46
9	0.09	0.12	0.55	0.07	0.15	6.33	-0.01	0.11	0.42	0.07	0.18	5.80	0.04	0.08	0.41	0.04	0.11	2.17
10	0.11	0.11	0.55	0.07	0.13	5.71	0.00	0.10	0.41	0.06	0.16	5.20	0.04	0.07	0.40	0.04	0.10	1.94
CL																		
0													-0.40	0.18	0.31	0.00	0.00	6.04
2	-0.84	0.87	0.42	0.46	-1.14	27.20	-0.64	0.96	0.71	0.57	0.91	6.57	-0.38	0.53	0.56	0.28	-0.45	11.04
3	-0.58	0.53	0.41	0.25	0.31	18.55	-0.50	0.55	0.50	0.27	0.10	12.40	-0.33	0.31	0.41	0.15	3.63	6.97
4	-0.43	0.38	0.41	0.17	-0.21	14.05	-0.43	0.38	0.41	0.17	-0.21	15.36	-0.30	0.21	0.35	0.10	0.73	5.12
5	-0.34	0.30	0.41	0.13	1.51	11.31	-0.39	0.29	0.36	0.12	-0.79	17.44	-0.28*	0.19*	0.34*	0.07*	0.45*	4.04*
6	-0.27	0.24	0.42	0.10	0.45	9.46	-0.36	0.23	0.33	0.10	19.61	19.06	-0.27	0.15	0.32	0.06	0.33	3.27
7	-0.22	0.20	0.42	0.09	0.29	8.14	-0.34	0.19	0.31	0.08	1.06	20.40	-0.26	0.13	0.30	0.05	0.26	2.75
8	-0.18	0.17	0.43	0.08	0.23	7.14	-0.32	0.17	0.30	0.07	0.60	21.53	-0.25	0.11	0.29	0.04	0.22	2.37
9	-0.15	0.15	0.43	0.07	0.19	6.36	-0.31	0.14	0.29	0.06	0.43	22.47	-0.24	0.10	0.28	0.04	0.19	2.09
10	-0.13	0.14	0.43	0.06	0.16	5.95	-0.30	0.13	0.28	0.05	0.34	23.28	-0.24	0.08	0.27	0.03	0.16	1.86

Notes: See Table 1. An asterisk * means that the solution is at a point where the utility function is not differentiable (See Section II).

Table 10: Effects of Departures from Expected-Utility Maximization on Wealth and on Stock holding, Under Elasticity of Substitution Equal to 0.95, by Education Group

	Kreps-Porteus Model (KP)						Overweighting of Inferior States (Y and Q)					
	Parameters: γ=1, λ=0.25, ρ=1-$^{1}/_{0.95}$						Parameters: γ=0.50, λ=0.25, ρ=1-$^{1}/_{0.95}$					
g	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain From Stocks %**
LS												
0							-0.71	0.19	-0.15	0.00	0.00	8.22
2	-0.51	0.60	0.21	0.42	-0.61	20.52	-0.45	0.30	0.01	0.18	-1.66	7.26
3	-0.46	0.32	0.02	0.18	-1.09	12.22	-0.42*	0.20*	-0.06*	0.10*	24.3*	4.53*
4	-0.44	0.21	-0.05	0.11	-2.94	8.69	-0.41	0.13	-0.10	0.06	1.41	3.18
5	-0.42	0.16	-0.09	0.08	4.25	6.74	-0.40	0.10	-0.13	0.05	0.78	2.45
6	-0.41	0.13	-0.11	0.06	1.41	5.50	-0.39	0.08	-0.14	0.04	0.55	2.00
7	-0.40	0.10	-0.12	0.05	0.89	4.65	-0.39	0.07	-0.15	0.03	0.44	1.69
8	-0.40	0.09	-0.13	0.04	0.67	4.02	-0.39	0.06	-0.16	0.03	0.37	1.46
9	-0.39	0.08	-0.14	0.04	0.54	3.54	-0.39	0.05	-0.16	0.02	0.32	1.29
10	-0.39	0.07	-0.15	0.03	0.46	3.17	-0.39	0.05	-0.16	0.02	0.28	1.15
HS												
0							-0.67	0.15	-0.11	0.00	0.00	6.37
2	-0.54	0.61	0.25	0.39	-0.36	20.72	-0.49	0.31	0.06	0.17	-0.61	7.21
3	-0.51	0.33	0.06	0.17	-0.43	12.29	-0.47	0.17	-0.03	0.09	0.02	4.51
4	-0.48	0.22	-0.01	0.10	-0.43	8.71	-0.45	0.14	-0.05	0.06	-2.13	3.24
5	-0.46	0.16	-0.04	0.07	1.87	6.74	-0.44	0.11	-0.08	0.04	-2.98	2.49
6	-0.45	0.13	-0.06	0.06	-1.71	5.50	-0.44	0.08	-0.09	0.03	-17.15	2.02
7	-0.44	0.11	-0.07	0.05	-2.21	4.65	-0.43	0.07	-0.10	0.03	4.67	1.70
8	-0.44	0.09	-0.08	0.04	-3.98	4.02	-0.43	0.06	-0.10	0.02	2.14	1.46
9	-0.43	0.08	-0.09	0.03	-19.35	3.54	-0.43	0.05	-0.11	0.02	1.42	1.29
10	-0.43	0.07	-0.10	0.03	7.45	3.17	-0.43	0.05	-0.11	0.02	1.08	1.15
CL												
0							-1.29	0.18	-0.26	0.00	0.00	5.78
2	-1.14	0.73	0.04	0.30	0.27	19.42	-1.06	0.37	-0.12	0.13	3.65	6.55
3	-1.09	0.40	-0.11	0.13	1.10	11.61	-1.04	0.21	-0.20	0.07	0.22	4.14
4	-1.06	0.27	-0.17	0.08	-0.12	8.26	-1.01	0.17	-0.21	0.05	0.74	2.98
5	-1.03	0.20	-0.20	0.06	0.24	6.41	-1.00	0.13	-0.23	0.03	-0.63	2.28
6	-1.02	0.16	-0.22	0.05	1.63	5.24	-0.99	0.10	-0.24	0.03	-0.28	1.85
7	-1.01	0.13	-0.23	0.04	-0.89	4.43	-0.99	0.08	-0.25	0.02	-0.19	1.56
8	-1.00	0.11	-0.24	0.03	-0.41	3.83	-0.99	0.07	-0.25	0.02	-0.15	1.34
9	-0.99	0.10	-0.24	0.03	-0.27	3.38	-0.98	0.06	-0.26	0.02	-0.12	1.18
10	-0.99	0.09	-0.25	0.02	-0.21	3.02	-0.98	0.06	-0.26	0.01	-0.10	1.06

Notes: The elasticity of substitution used in this Table is substantially higher than the elasticity used in the benchmark runs, namely 0.25. In the expected utility model, elasticity is the inverse of risk aversion and cannot be fixed independently. See Table 1 for symbols and definitions. An asterisk * means that the solution is at a point where the utility function is not differentiable (See Section II).

Table 11: Effects of Labor Income Risk on Wealth and on Stockholding When Elasticity of Substitution is Equal to 0.95, (Less than High School Education)

	Kreps-Porteus Model (KP)					Overweighting of Inferior States (Y and Q)				
	Parameters: $\gamma=1$, $\lambda=0.25$, $\rho=1-{}^{1}/_{0.95}$					Parameters: $\gamma=0.50$, $\lambda=0.25$, $\rho=1-{}^{1}/_{0.95}$				
g	**Ä(W/Y)**	**Ä(S/Y)**	**Exp. Ä(W/Y)**	**Exp. Ä(S/Y)**	**Exp. Ä(S/W)**	**Ä(W/Y)**	**Ä(S/Y)**	**Exp. Ä(W/Y)**	**Exp. Ä(S/Y)**	**Exp. Ä(S/W)**
0						-0.044	0.193	0.036	0.000	0.000
2	0.168	-0.072	-0.023	0.037	-0.735	0.214	-0.080	-0.046	0.015	-1.819
3	0.206	-0.048	-0.026	0.020	-1.255	0.246	-0.024	-0.011	0.014	24.020
4	0.233	-0.036	-0.022	0.014	-3.215	0.258	-0.021	-0.012	0.010	0.056
5	0.249	-0.029	-0.018	0.011	3.736	0.265	-0.018	-0.012	0.007	1.705
6	0.260	-0.024	-0.015	0.009	-0.475	0.269	-0.015	-0.011	0.006	0.920
7	0.265	-0.021	-0.013	0.008	2.300	0.271	-0.013	-0.010	0.005	0.671
8	0.269	-0.018	-0.012	0.007	1.206	0.272	-0.011	-0.010	0.004	0.540
9	0.271	-0.016	-0.011	0.006	0.883	0.273	-0.010	-0.010	0.004	0.456
10	0.272	-0.014	-0.011	0.005	0.714	0.274	-0.009	-0.009	0.003	0.397

Notes: See Table 1. In the expected-utility model, elasticity is the inverse of risk aversion and cannot be fixed independently.

Table 12: Effects of Departures from Expected-Utility Maximization on Wealth and on Stock holding, Without a Bequest Motive, by Education Group																		
	Expected Utility Model (EU)						**Kreps-Porteus Model (KP)**						**Overweighting of Inferior States (Y and Q)**					
	Parameters: γ=1, λ=0						**Parameters: γ=1, λ=0, ρ=-3**						**Parameters: γ=0.50, λ=0, ρ=-3**					
g	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**	**W/Y**	**S/Y**	**Exp. (W/Y)**	**Exp. (S/Y)**	**Exp. (S/W)**	**Utility Gain from Stocks %**
LS																		
0													-0.29	0.19	0.13	0.00	0.00	8.22
2	-0.45	0.63	0.30	0.46	-2.59	23.60	-0.41	0.65	0.36	0.49	9.46	25.68	-0.21	0.37	0.29	0.26	0.42	9.47
3	-0.32	0.36	0.19	0.23	0.69	15.14	-0.30	0.37	0.22	0.23	0.60	15.60	-0.16	0.21	0.17	0.13	0.24	5.95
4	-0.24	0.25	0.16	0.15	0.35	11.17	-0.24	0.25	0.16	0.15	0.35	11.17	-0.13	0.17	0.15	0.09	0.17	4.26
5	-0.18	0.19	0.15	0.11	0.23	8.87	-0.20	0.19	0.13	0.11	0.26	8.71	-0.12	0.13	0.13	0.07	0.15	3.28
6	-0.15	0.16	0.14	0.09	0.18	7.36	-0.17	0.15	0.11	0.08	0.23	7.14	-0.11	0.10	0.11	0.05	0.16	2.67
7	-0.12	0.13	0.14	0.07	0.14	6.30	-0.16	0.13	0.10	0.07	0.21	6.05	-0.10	0.08	0.10	0.04	0.17	2.25
8	-0.09	0.11	0.14	0.06	0.11	5.51	-0.14	0.11	0.09	0.06	0.21	5.26	-0.09	0.07	0.09	0.04	0.20	1.95
9	-0.08	0.10	0.14	0.05	0.09	4.90	-0.13	0.10	0.09	0.05	0.22	4.65	-0.09	0.06	0.09	0.03	0.26	1.72
10	-0.06	0.09	0.14	0.05	0.07	4.41	-0.12	0.09	0.08	0.04	0.24	4.17	-0.08	0.06	0.08	0.03	0.36	1.54
HS																		
0													-0.27	0.15	0.15	0.00	0.00	6.37
2	-0.47	0.65	0.34	0.44	-1.20	23.99	-0.43	0.67	0.40	0.47	-5.76	26.16	-0.23	0.39	0.33	0.24	0.36	9.47
3	-0.34	0.38	0.23	0.21	0.75	15.36	-0.32	0.38	0.26	0.22	0.60	15.84	-0.19	0.22	0.22	0.12	0.14	5.93
4	-0.26	0.26	0.20	0.14	0.30	11.30	-0.26	0.26	0.20	0.14	0.30	11.30	-0.16	0.15	0.22	0.12	0.14	6.71
5	-0.21	0.20	0.19	0.10	0.15	8.95	-0.23	0.20	0.17	0.10	0.19	8.78	-0.15	0.13	0.17	0.08	0.07	4.96
6	-0.17	0.16	0.18	0.08	0.07	7.41	-0.20	0.16	0.15	0.08	0.14	7.18	-0.14	0.11	0.17	0.06	0.04	3.87
7	-0.14	0.14	0.18	0.07	0.00	6.33	-0.19	0.13	0.14	0.06	0.11	6.08	-0.13	0.09	0.15	0.05	0.02	3.14
8	-0.12	0.12	0.18	0.06	-0.07	5.53	-0.17	0.11	0.13	0.05	0.09	5.27	-0.12	0.08	0.14	0.04	0.01	2.63
9	-0.11	0.10	0.18	0.05	-0.15	4.91	-0.16	0.10	0.13	0.05	0.08	4.66	-0.12	0.07	0.13	0.04	0.01	2.26
10	-0.09	0.09	0.18	0.04	-0.28	4.42	-0.15	0.09	0.12	0.04	0.07	4.17	-0.11	0.06	0.13	0.03	0.01	1.97
CL																		
0													-0.65	0.18	0.03	0.00	0.00	5.78
2	-0.97	0.80	0.18	0.36	0.04	23.48	-0.86	0.85	0.27	0.40	-0.17	26.16	-0.60	0.48	0.19	0.20	2.38	9.04
3	-0.77	0.48	0.10	0.18	-0.36	15.30	-0.73	0.49	0.14	0.19	-0.82	15.88	-0.55	0.27	0.09	0.11	0.57	5.70
4	-0.66	0.34	0.08	0.12	3.43	11.34	-0.66	0.34	0.08	0.12	3.43	11.34	-0.52	0.19	0.09	0.11	0.57	4.17
5	-0.58	0.26	0.07	0.09	0.57	9.01	-0.61	0.26	0.05	0.09	0.80	8.82	-0.50	0.17	0.05	0.07	0.43	3.24
6	-0.53	0.21	0.07	0.07	0.36	7.48	-0.58	0.20	0.03	0.07	0.56	7.21	-0.49	0.13	0.05	0.05	0.35	2.62
7	-0.49	0.18	0.07	0.06	0.29	6.40	-0.56	0.17	0.02	0.06	0.53	6.10	-0.48	0.11	0.03	0.04	0.47	2.20
8	-0.46	0.15	0.07	0.05	0.25	5.59	-0.54	0.15	0.02	0.05	0.67	5.29	-0.47	0.10	0.02	0.04	2.19	1.90
9	-0.43	0.13	0.07	0.05	0.23	4.96	-0.53	0.13	0.01	0.04	1.90	4.67	-0.47	0.08	0.01	0.03	-0.43	1.67
10	-0.41	0.12	0.07	0.04	0.21	4.88	-0.52	0.11	0.01	0.04	-0.94	4.19	-0.46	0.07	0.01	0.03	-0.15	1.49

Notes: See Table 1. It is assumed that the size of bequests does not enter the utility function, unlike in our benchmark model. See Section II.

Table 13: Effects of Labor Income Risk on Wealth and on Stockholding Without a Bequest Motive, (Less than High School Education)															
	Expected Utility Model (EU)					**Kreps-Porteus Model (KP)**					**Overweighting of Inferior States (Y and Q)**				
	Parameters: γ=1, λ=0					**Parameters: γ=1, λ=0, ρ=-3**					**Parameters: γ=0.50, λ=0, ρ=-3**				
g	**Ä(W/Y)**	**Ä(S/Y)**	**Exp. Ä(W/Y)**	**Exp. Ä(S/Y)**	**Exp. Ä(S/W)**	**Ä(W/Y)**	**Ä(S/Y)**	**Exp. Ä(W/Y)**	**Exp. Ä(S/Y)**	**Exp. Ä(S/W)**	**Ä(W/Y)**	**Ä(S/Y)**	**Exp. Ä(W/Y)**	**Exp. Ä(S/Y)**	**Exp. Ä(S/W)**
LS															
0											-0.033	0.193	0.096	0.000	0.000
2	0.123	-0.089	-0.037	0.030	-2.572	0.099	-0.097	-0.043	0.028	9.598	0.143	-0.095	-0.047	0.014	1.192
3	0.126	-0.063	-0.039	0.016	0.934	0.116	-0.065	-0.040	0.016	0.951	0.155	-0.067	-0.040	0.010	1.591
4	0.132	-0.050	-0.035	0.012	0.855	0.132	-0.050	-0.035	0.012	0.855	0.167	-0.027	-0.008	0.010	3.083
5	0.139	-0.041	-0.029	0.010	1.374	0.146	-0.040	-0.028	0.010	0.935	0.175	-0.023	-0.007	0.008	-676.7
6	0.145	-0.035	-0.023	0.008	10.952	0.156	-0.034	-0.023	0.008	1.113	0.181	-0.020	-0.005	0.006	-2.993
7	0.149	-0.030	-0.019	0.007	-1.657	0.164	-0.029	-0.018	0.007	1.425	0.185	-0.017	-0.003	0.006	-1.457
8	0.153	-0.026	-0.015	0.007	-0.772	0.170	-0.025	-0.014	0.007	2.018	0.189	-0.015	-0.001	0.005	-0.915
9	0.157	-0.023	-0.011	0.006	-0.511	0.175	-0.022	-0.011	0.006	3.512	0.191	-0.013	0.000	0.004	-0.603
10	0.160	-0.020	-0.008	0.005	-0.389	0.179	-0.019	-0.009	0.005	14.536	0.193	-0.012	0.001	0.004	-0.338

Notes: See Table 1. It is assumed that the size of bequests does not enter the utility function, unlike in our benchmark model. See Section II.

Table 14. Ratios of Average and Median Financial Net Worth and Stocks to After-tax Labor Income, for U.S. Households, by Age and Level of Education of Household Head

MODEL PREDICTIONS						***DATA***				
Preferences	Parameters g, ñ, ã, ë	Predicted Asset-to-income Ratios				Household Age	Directly Held Assets		Directly and Indirectly Held Assets	
		First Period		Second Period						
		W/Y (1)	S/Y (2)	Exp W/Y (3)	Exp S/Y (4)	(years)	W^d/Y (5)	S^d/Y (6)	W^b/Y (7)	S^b/Y (8)
Education: less than high school degree										
EU	6, -5, 1, .25	0.03	0.18	0.52	0.13	20 – 29	0.16	0.00	0.25	0.02
Quiggin	9,-3, .15,.25	0.09	0.02	0.34	0.01	30 – 39	0.07	0.01	0.08	0.02
Yaari	0,-3, .15,.25	0.04	0.19	0.52	0.00	40 – 49	0.88	0.36	0.90	0.37
						50 – 59	0.61	0.12	0.61	0.14
Education: high school degree										
EU	8, -7, 1, .25	0.07	0.13	0.54	0.08	20 – 29	0.26	0.02	0.33	0.05
Quiggin	$6,-5^2/_3,.5,.25$	0.10	0.12	0.54	0.08	30 – 39	0.36	0.04	0.46	0.13
Yaari	$0,-5^2/_3,.5,.25$	0.01	0.15	0.54	0.00	40 – 49	0.90	0.50	1.07	0.63
						50 – 59	1.72	0.73	2.04	1.09
Education: college degree										
EU	4, -3, 1, .25	-0.43	0.38	0.41	0.17	20 – 29	0.66	0.37	0.78	0.41
Quiggin	3, -9, .7, .25	-0.23	0.44	0.63	0.23	30 – 39	0.63	0.35	0.77	0.45
Yaari	0, -9, .7, .25	-0.24	0.18	0.45	0.00	40 – 49	1.51	0.55	1.81	0.74
						50 – 59	2.33	0.84	2.97	1.42

Data Source: 1992 *Survey of Consumer Finances*, and Bertaut and Haliassos (1997).
Notes: See Table 1.
W/Y and S/Y: model predictions for wealth- and stock-to-income ratios. Second period figures refer to expected asset-to-income ratios based on period 1 information. W^d: Directly held financial net worth. S^d: Directly held stocks. Y: After-tax labor income. Directly held stocks include shares of publicly traded stocks, shares in mutual stock funds, and stocks in IRAs and Keoghs. Directly held financial net worth includes directly held stocks, checking, saving, money market, and call accounts, CDs, saving and other bonds, and the cash value of life insurance, minus balances on credit cards, consumer loans, and other non-real estate loans. W^b: Directly and indirectly held financial net worth S^b: Directly and indirectly held stocks. Directly and indirectly held stocks include all directly held stocks, plus stocks held in defined contribution pension plans, trusts, and managed investment accounts. Directly and indirectly held household financial net worth includes directly held financial net worth, plus assets held in defined contribution pension plans, trusts, and managed investment accounts. W^d/Y and W^b/Y: Ratio of average financial net worth in age-education cell to average after-tax labor income in age-education cell. S^d/Y and S^b/Y: Ratio of average stocks to average after-tax labor income.

Endnotes

[1] For analyses of single-asset precautionary saving models, see Leland, 1968; Sandmo, 1970; Kimball, 1990, 1993; Zeldes, 1989; Carroll, 1992; Hubbard, Skinner, and Zeldes, 1994.

[2] This suggestion was made by Epstein and Zin (1990) and by Haliassos and Bertaut (1995) in the context of models without income risk.

[3] In expected-utility theory, the risk premium that a risk averse agent with a differentiable utility function is willing to pay to eliminate the risk arising from an actuarially fair random variable ı e is proportional to ϕ^2 when ϕ is small. Thus, the risk premium approaches zero faster than ϕ, making the agent almost risk neutral for small risks. For our problem at hand, starting from zero stockholding, the agent is concerned with the equity premium and does not pay much attention to risk for small investments in stock. This is because, for small risks, a differentiable utility function is almost linear. Segal and Spivak term this "second order risk aversion" to distinguish it from preferences displaying "first order risk aversion", for which the risk premium is proportional to ϕ and agents are not locally risk neutral at zero risk.

[4] Since no two indifference curves are valid in the same region, the tangency conjectural equilibrium is unique, and this is confirmed in our calibrations. Notice that the alternative family of indifference curves would have yielded a point of tangency on their dotted, invalid segment.

[5] Note that in the Yaari specification of preferences, the most we can solve for is the point of nondifferentiability, so the first stage of checking alternative conjectures does not apply.

[6] The original means and variances of incomes and stock returns are preserved by making sure that the probabilities of the two states that involve high stock returns sum to 0.5, and that the same is true of the probabilities of the two states that involve high labor incomes. This results in having only one of the four state probabilities as a free parameter, chosen so as to yield the desired correlation between stock returns and labor incomes. In order to generate positive correlation equal to 0.1, the probability of the high-return, high-income state is set to 0.275, the probabilities for the two high-low states are set to 0.225, and the probability of the worst state is set again to 0.275. The corresponding probabilities for generating correlation equal to –0.03 are 0.2425, 0.2575, and 0.2425.

[7] Thus, our model shares with Constantinides, Donaldson, and Mehra (1998) the assumption that the uncertainty about human capital returns is resolved in the second period. In effect, this stacks the cards against finding sizeable precautionary saving and portfolio effects. The presence of such risks is likely to induce households to accumulate even more precautionary wealth, and to expose themselves less to stockholding risk at least when choosing portfolios to hold during retirement.

[8] It is not possible to use single-year cells, because of the small number of observations once we condition both on education and on age. Five-year cells are used whenever possible. For example, we identify college graduates between 20 and 25 years of age, compute their mean income, and use this observation as the deterministic component of income for ages 20 to 25 when computing the present value of income in the first twenty-year period of life. We repeat the exercise for all other 5-year ranges until the age of 80. We should note that estimating deterministic profiles from a cross section does not incorporate any cohort effects that may be present in the data.

[9] In fact, since shocks are assumed to be lognormally distributed, we adjust these annual income realizations so as to remove the unwanted effects of lognormally distributed shocks on the mean. These adjustments are described in detail in Bertaut and Haliassos (1997). Annual income realizations, so adjusted, are then used to compute realizations of twenty-year present values.

[10] These two sets coincide for risk aversion of 4, since this happens to equal the inverse of the postulated elasticity of 0.25.

[11] At γ=0.15, optimal wealth for the two less educated categories is positive even at low risk aversion, but not so for college graduates. Predicted wealth-to-income ratios for college graduates range from -0.23 to -0.21. The corresponding ranges for high-school dropouts and for high-school graduates are 0.07-0.09 and 0.05-0.07 respectively. Stockholding gets down to 0.03 at risk aversion of 7, regardless of education category.

[12] For EU, KP, and Q preferences, persistence lowers these ratios at low degrees of risk aversion and raises them at high degrees of risk aversion. For Yaari preferences, persistence raises the expected ratio.

[13] As explained above, stockholding at the kink is set at a level that makes the household indifferent between the two states in which stock returns and labor income realizations are in opposite directions (high and low). This is a function of the realizations themselves and not of the probabilities with which they occur.

[14] In Table 1, the EU framework understates the sensitivity of stockholding to risk aversion in both periods, relative to the KP framework where elasticity remains unchanged. Comparison with Table 10 shows that this finding is not robust to high elasticity values.

[15] For example, if we vary risk aversion from 2 to 10 and we consider the Quiggin specification for benchmark values of ã=0.50 and ñ=-3, but double the size of ë to 0.5, then the corresponding ranges of first-period wealth-to-income ratios of the three education classes are -0.04 to 0.08; -0.06 to 0.05; and -0.36 to -0.23 respectively. These are very close to the ranges reported in the last set of columns of Table 1 where ë is only equal to 0.25.

[16] This extends an observation made in Bertaut and Haliassos (1997) which was derived only for expected utility models.

[17] In the 1992 *SCF*, for example, the percentages of those refusing to undertake any financial risk in the three education categories (starting with high school dropouts) are 78%, 52%, and 27% respectively.