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Earnings uncertainty and precautionary saving*

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We test for the presence of precautionary saving using a self-reported measure of earnings uncertainty drawn from the 1989 Italian Survey of Household Income and Wealth. The effect of uncertainty on wealth accumulation is consistent with the theory of precautionary saving and with decreasing prudence, but explains only a small fraction of saving. The results cast doubts on the empirical relevance of precautionary saving in response to earnings uncertainty, but are not in contrast with the importance of the precautionary motive *per se*. Beside earnings uncertainty, other risks, such as health and mortality, may be important determinants of wealth accumulation.

1. Introduction

The idea that people accumulate assets to face unexpected drops in income dates back to Friedman (1957). Later studies by Leland (1968), Sandmo (1970), and Drèze and Modigliani (1972) stated the theoretical conditions about preferences under which an increase in uninsurable risk leads to higher saving. Recent research has further sharpened the theory of precautionary saving. Zeldes

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(1989), Caballero (1990), and Weil (1990) have extended the two-period framework used by earlier authors to multiperiod models and established that the amount of precautionary saving increases in response to an increase in the variance of the shocks of the income-generating process and in its degree of persistence. Kimball (1990) has shown that if people have decreasing prudence, precautionary saving declines as individual wealth rises.

Precautionary saving has several empirical and policy implications. Zeldes (1989) points out that precautionary saving may explain some of the consumption 'puzzles', such as the excess sensitivity of consumption to anticipated income fluctuations, the growth of consumption even in the presence of low real interest rates, and the slow rate of wealth decumulation of the elderly. If uncertainty affects consumer behavior, government insurance programs and tax policies may reduce individual risks and may increase welfare [Barsky, Mankiw, and Zeldes (1986)]. Since generation-specific risks may be offset by a chain of intergenerational transfers, a finding that consumers react strongly to uncertainty would therefore question not only the quadratic utility model, but Barro's (1974) dynastic model as well.

Most of these discussions have proceeded in an empirical vacuum. There is almost no evidence on the importance of precautionary saving. Invariably, empirical studies must face a fundamental problem: how should one measure the subjective uncertainty of future income fluctuations? Since this variable is unobservable, research to date relied on simulations or on indirect proxies for risk. While useful, both approaches have serious drawbacks.

Simulations performed by Kotlikoff and Spivak (1981), Skinner (1988), Zeldes (1989), and Caballero (1991) have shown that with realistic parameter values, earnings uncertainty can generate a substantial amount of saving and wealth. For example, Skinner (1988) and Caballero (1991) find that earnings uncertainty alone may account for as much as 60 percent of U.S. households' net worth. But these simulation results depend on maintained assumptions about preferences and the process that generates income. More importantly, simulations do not test whether people actually respond to risk as predicted by the theoretical models.

Econometric tests that use indirect proxies for risk run into a number of different problems. Time series studies rely on proxies that reflect aggregate risk only. As noted by Kimball (1990), individual risks – that are likely to be the main determinants of precautionary saving – tend to wash out in the process of aggregation. At the cross-sectional level, proxies for risk are almost invariably correlated with other consumer attributes, and it is impossible to distinguish whether they are truly measuring risk or capturing some other effect. More fundamentally, indicators of risk are subject to a problem of self-selection. Households in risky categories may have chosen to belong to that category simply because they are less risk-averse, in which case their average propensity to save might not be higher than that of the average household. This problem casts doubt on Friedman's (1957) original approach – recently replicated by Skinner (1988) – based on occupational dummies to classify households in different risk categories.

To avoid these shortcomings in assessing the empirical relevance of precautionary saving, and given the unobservable nature of households' perceived uncertainty, there is no alternative as to rely upon direct survey information on the households' subjective assessment of specific risks.[1] Our empirical approach to precautionary saving was shaped by these considerations. We therefore decided to include a question on the subjective probability distribution of earnings in the 1989 Survey of Household Income and Wealth (SHIW).[2] In principle, this survey allows us to assess the effect of uncertainty on consumption and wealth accumulation in a way that is free of the problems that plague empirical studies based on indirect measures of risk.

Our analysis is subject to one important qualifier. What matters for saving decisions is human wealth uncertainty. The available data, however, provide information only on the probability distribution of earnings one year ahead. Thus, in order to estimate the effect of uncertainty on consumption and wealth accumulation we need to make two assumptions: (i) the degree of persistence in the income generating process is identical for all households; (ii) the probability distribution from which earnings are drawn is time-invariant. While restrictive, we provide evidence that the first assumption is not a bad description of the data, at least not enough to cast serious doubts on our main findings. The second is a maintained hypothesis and rules out jumps in the income-generating process. It implies, for example, that uncertainty is age-independent.

The paper is organized as follows. Section 2 briefly reviews the theory of precautionary saving. Section 3 describes the 1989 SHIW and the self-reported measure of earnings uncertainty. Sections 4 and 5 report the empirical tests of the effect of uncertainty on consumption and wealth accumulation. Section 6 explores the validity of our maintained assumption, i.e., that the persistence of earnings is the same across individuals, and section 7 the implications of our results for the explanation of some of the consumption puzzles. Section 8 summarizes our main findings and their implications for current research. An appendix contains detailed information about the survey and the definitions of the variables used in the empirical tests.

[1] In the words of Kotlikoff (1989, p. 30): 'Pinning down empirically the extent of precautionary saving will require new surveys that examine two issues: first, the nature of the implicit family insurance agreement and, second, the extent of subjective uncertainty. This latter issue has been thoroughly finessed in the precautionary saving literature by simply assuming the nature of subjective probabilities.' This paper takes a modest step towards addressing these issues.

[2] The SHIW is a survey representative of the Italian population run every two years by the Bank of Italy.

2. The theoretical model

In this section we briefly review a model of precautionary saving with earnings uncertainty. Following Caballero (1990) and Weil (1990), we assume that the household maximizes a time-separable utility function over an infinite horizon and that the within-period utility function is exponential, with constant degree of absolute prudence equal to θ.[3] We further assume that after-tax labor income y follows the stochastic process

$$y_t = \gamma y_{t-1} + (1-\gamma)\hat{y} + \varepsilon_t, \tag{1}$$

which is the sum of a deterministic component $\hat{y}$ and a stochastic component ε, identically and independently distributed with zero mean and variance σ^2. The parameter γ measures the degree of persistence of the innovations in income.

The consumer chooses a sequence of consumption values to maximize the expected value of utility under the budget constraint $w_t = Rw_{t-1} + y_t - c_t$, where w_t is end-of-period wealth, c_t is consumption, and R the interest factor, assumed to be constant. The problem is then

$$\max -\frac{1}{\theta}\mathrm{E}\sum_{i=0}^{\infty}\beta^i \exp(-\theta c_{t+i}),$$

subject to

$$w_t = Rw_{t-1} + y_t - c_t, \qquad y_t = \gamma y_{t-1} + (1-\gamma)\hat{y} + \varepsilon_t.$$

It can be shown that the solution to this problem has two parts. The first part is the certainty equivalence level of consumption, the second can be identified with precautionary saving. In the case where the interest rate is equal to the discount rate ($\beta R = 1$),

$$c_t = \frac{R-1}{R-\gamma}\left(y_t + \frac{1-\gamma}{R-1}\hat{y} + w_t\right) - \frac{\Pi}{R}, \tag{2}$$

where

$$\Pi = \frac{R-\gamma}{\theta R}\log\left[\mathrm{E}\exp\left(-\frac{\theta R}{R-\gamma}\varepsilon\right)\right]. \tag{3}$$

[3] Kimball (1990) defines absolute prudence as the ratio between the third derivative and the second derivative of the within-period utility function. If utility is exponential, absolute prudence coincides with absolute risk aversion.

The first term in eq. (2) is the optimal level of consumption when income is certain and equal to $E(y_t)$. The term Π is the precautionary component of saving. When the income shock is normally distributed, this term reduces to

$$\Pi = \frac{\theta R}{R - \gamma} \sigma^2, \tag{3'}$$

which increases with the variance of the shock σ^2, the degree of earnings persistence γ, and the degree of prudence θ.

Caballero (1991) considers the finite-life version of the exponential utility model assuming that labor income follows a random walk, and derives the implications for wealth accumulation: the higher the risk, the higher the amount of assets accumulated by prudent consumers at each stage of the life cycle.

Exponential utility, though analytically convenient, is restrictive. It implies that the sensitivity of consumption to uncertainty, measured by the degree of prudence, is independent of the level of individual resources. Kimball (1990) argues convincingly that, like risk aversion, prudence declines with wealth. People who have already accumulated substantial assets may choose to respond less to sudden drops in earnings than those with little assets. Unfortunately, closed form solutions for consumption can be obtained only in the case of exponential utility, where prudence is constant. However, the intuition behind eq. (2) is more general. Provided that prudence is positive, uncertainty lowers the optimal level of current consumption and the level of assets that individuals choose to hold.

In sections 4 and 5 we test these predictions of the theory of precautionary saving, i.e., that uncertainty lowers consumption and raises wealth accumulation. We will also test the assumption that the effect of uncertainty does not depend on the level of households' resources (constant prudence). In the next section we describe the data and the self-reported measure of uncertainty used in this study.

3. The data and the self-reported measure of uncertainty

Since 1965 the Bank of Italy has conducted the Survey of Household Income and Wealth (SHIW) as a series of independent cross-sections. In this paper we use the most recent wave of the survey, referring to the year 1989. The appendix describes the sample design, the characteristics of the survey, the unit of observation, and the definitions of the variables used in this study.

The 1989 SHIW contains detailed information about income, wealth, consumption, and a series of demographic characteristics of 8,274 households divided into two groups: (i) a random sample of 7,066 households interviewed for the first time at the beginning of 1990 and (ii) 1,208 households which were also interviewed at the beginning of 1988 (the panel component of the SHIW). The overall sample is representative of the Italian resident population, as shown by a comparison of population and sample means of selected demographic variables (see table A.1 in the appendix). Balance sheets items are reported as of December 31 of 1989, while income and consumption refer to the year 1989.

The 1989 SHIW included two new questions regarding the probability distribution of the rate of growth of nominal earnings and inflation for the year following the survey. Every income recipient was asked to attribute weights, summing to 100, to given intervals of inflation and nominal earnings percentage increases one year ahead.[4] These two marginal distributions are then used, following the procedure illustrated below, to measure the subjective uncertainty of real earnings in 1990.

We assume that the variance of household earnings can be proxied by the variance of the earnings of the head of the household.[5] To obtain an estimate of the variance we proceed as follows. Let z denote the percentage growth rate of nominal earnings, π the rate of inflation, and x the rate of growth of real earnings. The variables x, z, and π are three stochastic variables that satisfy the identity

$$z = x + \pi. \tag{4}$$

With obvious notation, the variance of z can be expressed as

$$\sigma_z^2 = \sigma_x^2 + \sigma_\pi^2 + 2\rho\sigma_x\sigma_\pi. \tag{5}$$

We wish to recover the variance of x, σ_x^2.

From the survey we have information about σ_z and σ_π. However, in order to use eq. (5) we need to make an assumption about the value of ρ, the correlation coefficient between the rate of growth of real earnings x and the rate of inflation π. For given ρ, eq. (5) can be solved for σ_x, giving

$$\sigma_x = -\rho\sigma_\pi \pm \sqrt{\sigma_z^2 - (1-\rho^2)\sigma_\pi^2}. \tag{6}$$

[4]The wording of these questions is reported in the appendix. The intervals are the same for the two variables. They are: > 25, 20–25, 15–20, 13–15, 10–13, 8–10, 7–8, 6–7, 5–6, 3–5, 0–3, < 0 percent. The size of the classes was intentionally smaller in those classes which, *a priori*, were thought to include the majority of the observations.

[5]Thus, we only use the probability distributions that can be derived from the answers of heads of households. This procedure is certainly correct for all households with only one income recipient. We show below that limiting the analysis to these households does not affect our main conclusions. Our procedure yields a biased measure of the 'true' measure of uncertainty to an extent that depends on both risk-sharing schemes within the family and on the stochastic process that generates the incomes of the family members other than the head of the household.

Table 1a

Inflation and earnings uncertainty.

Group 1 980 households	Group 2 673 households	Group 3 172 households	Group 4 1,084 households
$\sigma_z^2 = 0, \sigma_\pi^2 = 0$	$\sigma_z^2 > 0, \sigma_\pi^2 = 0,$	$\sigma_z^2 = 0, \sigma_\pi^2 > 0$	$\sigma_z^2 > 0, \sigma_\pi^2 > 0$
$\Rightarrow \sigma_x^2 = 0$	$\Rightarrow \sigma_x^2 = \sigma_z^2$	$\Rightarrow \sigma_x^2 = \sigma_\pi^2$	$\Rightarrow \sigma_x^2 = (\sigma_z + \sigma_\pi)^2$

Table 1b

Frequency distribution of the ratio of the subjective standard deviation to the mean of earnings in selected classes (σ_i/Y_i).

σ/Y (%)	Number of observations in the sample	Frequency (%)
0	980	33.7
0–0.5	302	10.4
0.5–1.5	752	25.6
1.5–2.5	532	18.4
2.5–3.5	173	6.0
3.5–4.5	88	3.0
4.5–6.5	63	2.2
6.5–10.0	13	0.5
10.0–15.0	6	0.2
Mean: 1.15	2,909	100.0

Since σ_z and σ_π can be either positive or equal to zero, there are four possible cases: each defines a sample region in table 1a. The analysis of these cases, together with the condition that $\sigma_x \geq 0$, helps in identifying the value of ρ.

Consider first the group of households that has point expectations for both inflation and the rate of growth of earnings, i.e., $\sigma_z^2 = 0$ and $\sigma_\pi^2 = 0$. Here the value of ρ is immaterial, and from eq. (6) we immediately obtain that $\sigma_x^2 = 0$. A second group of households has point expectations about inflation ($\sigma_\pi^2 = 0$) but not about earnings ($\sigma_z^2 > 0$). Eq. (6) implies that in this case the variance of real earnings must be equal to the variance of nominal earnings, i.e., $\sigma_x^2 = \sigma_z^2$.

A third group of households has point expectations about earnings ($\sigma_z^2 = 0$) but not about inflation ($\sigma_\pi^2 > 0$). In this case eq. (6) reduces to

$$\sigma_x = -\rho\sigma_\pi \pm \sqrt{(\rho^2 - 1)\sigma_\pi^2}. \tag{7}$$

The only solution to eq. (7) that is both real and positive can be obtained by setting $\rho = -1$, implying $\sigma_x^2 = \sigma_\pi^2$.

A fourth group is uncertain about both earnings and inflation ($\sigma_z^2 > 0$ and $\sigma_\pi^2 > 0$). As we shall see below, one of the main findings of this paper is that earnings uncertainty is small. Thus, we are interested in generating the largest possible estimate of the variance, since any lower measure would strengthen our results. We therefore concentrate on the larger solution, corresponding to the plus sign in eq. (6), which is decreasing in ρ.[6] Choosing $\rho = -1$ yields the largest possible estimate of the variance that is consistent with the data.[7] Thus, in this case we set $\sigma_x^2 = (\sigma_z + \sigma_\pi)^2$.

Finally, the variance of the *level* of real earnings σ^2 can be obtained by noting that next year's income, as perceived by the household, is $y_{t+1} = y_t(1 + x)$, where y_t is labor income in the year of the survey. Thus, $\mathrm{var}(y_{t+1}) \equiv \sigma^2 = y_t^2\sigma_x^2$.

Table 1b displays the frequency distribution of the ratio between the subjective standard deviation and current earnings (σ/y). More than one third (34 percent) of those surveyed hold point expectations about expected real earnings one year ahead. For almost two thirds of the sample the standard error is less than 2 percent of current earnings. The remaining third display a measure of uncertainty that in the majority of cases does not exceed 5 percent of current earnings.

The magnitude of the figures in table 1b contrasts considerably with the size of uncertainty generally assumed in the literature on precautionary saving. In fact, most simulations assume values of the standard error of earnings shocks between 10 and 20 percent of the level of earnings.[8] In Italy sufficiently long household panel data are not available, so we cannot compare these values with those implied by earnings function estimates. However, estimates of uncertainty obtained with U.S. panel data under the hypothesis that earnings follow a univariate stochastic process yield values between 5 to 10 times higher than what we find in the SHIW.[9]

There are three possible explanations that may account for the differences between the self-reported measure of earnings uncertainty and the standard errors of earnings found in U.S. panel data. First, it is possible that part of the variability in income in panel data is due to measurement errors. For instance, Pischke (1990) shows that accounting for these measurement errors may reduce by 10 to 20 percent the estimate of the standard error of earnings shocks.

[6] The observations falling in the fourth group can be further partitioned into $\sigma_z^2 \geq \sigma_\pi^2$ and $\sigma_z^2 < \sigma_\pi^2$ (581 and 503 households, respectively). In the first case there is no ambiguity for the choice of the solution in eq. (6), since the only positive solution corresponds to the plus sign.

[7] Alternatively, assuming that ρ is the same for all individuals, one could use the result for the third group and set $\rho = -1$.

[8] In their simulations, Skinner (1988), Caballero (1990, 1991), and Carroll (1991) assume that the standard error of the shock to earnings is between 10 and 20 percent.

[9] For instance, Hall and Mishkin (1982) and MaCurdy (1982), using the PSID, obtain estimates on the order of 20 percent.

A second possibility is that Americans face more earnings uncertainty than Italians. In the absence of better measures, the income distribution might be a useful index to compare earnings risks across countries: a more unequal distribution might signal higher chances of very bad and very good income draws. In the appendix we compare the income distribution implied by the 1989 Italian Survey and by the 1983–86 Survey of Consumer Finances (tables A.2 and A.3). The main insight of this comparison is that the distribution of income is less equal in the U.S. than in Italy, but not by a very large extent. If income distribution is indeed correlated with earnings risks across countries, the difference between the self-reported measure of uncertainty used in this study and the estimates of uncertainty found in econometric studies of U.S. households may in part be attributed to the fact that Italian households live in a less risky environment.

The third and more important element to be considered is that the error of the time series process for earnings estimated with panel data is not the same as the uncertainty faced by individuals. Stochastic processes of earnings estimated with panel data overestimate the 'true' uncertainty to the extent that households have better information about their earnings prospects than the econometrician. The discrepancy between our measure of uncertainty and that obtained in panel studies could therefore be ascribed to households forecasts being conditional on a much larger set of variables than those observed by the econometrician.[10]

A comparison of our measure of uncertainty and the indicators of risk most commonly adopted by other authors is instructive. Many of the characteristics of households with lower uncertainty (table 2, column 2) are not dramatically different from those with higher uncertainty (table 2, column 3). Yet, among the latter, young households, professionals, managers, and residents in Southern regions are relatively more numerous. Also the self-employed face higher uncertainty, in line with the commonly adopted assumption that this is a 'high-risk' category.[11]

Households with higher education may report a higher value of uncertainty simply because they understand the survey questions better than households with little education. However, on average, households with high uncertainty have only one year of schooling more than households reporting lower uncertainty. A regression of (σ/Y) on the sample characteristics (column 4 in table 2)

[10] The estimates of uncertainty in table 1b are slightly downward-biased because in computing the variances of earnings and inflation we have ignored the variance within the intervals. This effect could be of some importance only in those cases where the answers are concentrated in the extreme intervals, i.e., the wider intervals. Where the concentration of responses is greatest, i.e., in the central classes which are only one percentage point wide, the bias is actually very small. Even assuming that the probability distribution within the interval is uniform, the effect on the estimated standard deviation of earnings amounts to 0.3 percentage points of current earnings.

[11] For instance, Friedman (1957) and Skinner (1988) assume that the self-employed are a 'high-risk' group.

Table 2

Sample characteristics for varying levels of earnings uncertainty and regression of uncertainty on characteristics.

Variable	Total sample (1)	Low uncertainty ($\sigma\ Y < 3\%$) (2)	High uncertainty ($\sigma\ Y \geq 3\%$) (3)	Coefficients of the regression[a] $\sigma\ Y = X\beta + \varepsilon$ (4)	t-statistics (5)
Demographics					
Male	0.91	0.91	0.91	0.198E-3	0.175
Married	0.84	0.85	0.81	− 0.206E-2	− 1.980
Family size	3.39	3.40	3.38	− 0.547E-4	− 0.087
Number of children	1.44	1.43	1.44	0.952E-4	0.141
Education	10.47	10.30	11.04	0.122E-3	1.675
Age	42.88	43.25	41.66	− 0.585E-4	− 2.110
Occupation					
Operative and laborer	0.27	0.29	0.22	− 0.215E-4	− 2.659
Clerical	0.34	0.35	0.31	− 0.286E-2	− 3.674
Precision craft	0.10	0.09	0.13	− 0.550E-3	− 0.534
Professional	0.07	0.06	0.08	− 0.644E-3	− 0.544
Manager	0.03	0.03	0.04	− 0.442E-3	− 0.422
Entrepreneur	0.02	0.02	0.01	− 0.197E-2	− 0.931
Self-employed	0.16	0.15	0.20		
Other	0.01	0.01	0.01	− 0.108E-2	− 0.258
Sector					
Agricultural	0.04	0.05	0.03	− 0.254E-2	− 1.817
Industry	0.25	0.25	0.23	0.479E-3	0.620
Services	0.44	0.43	0.47	0.439E-3	− 0.010
Public administration	0.27	0.27	0.27		
Regional location					
North	0.46	0.48	0.38	− 0.752E-5	− 0.010
Centre	0.16	0.17	0.16		
South	0.38	0.35	0.46	0.319E-2	4.134
Constant				0.146E-1	6.61
Income and balance sheet[b]					
Earnings	33.24	33.18	33.44		
Permanent earnings	31.86	31.86	31.87		
Consumption	30.95	30.58	32.18		
Net worth	204.38	201.85	212.69		
Av. prop. to consume[c]	0.79	0.79	0.79		
Number of observations	2,909	2,229	680		2,909
Adjusted R^2					0.019

[a]The mean of the dependent variable in column 4 is 0.0115. Excluded attributes from the regression are: self-employed, residents in the Centre, and employed in the public sector.

[b]Expressed in millions of 1989 lire.

[c]As a percentage of disposable income.

shows that education has a small coefficient and is significantly different from zero only at the 10 percent level. On the other hand, the regression confirms that self-employed and households living in the South tend to report higher variance.

The difference between the values displayed in table 2 and those assumed in simulation studies or found in panel data is substantial, even if one takes into account the three reasons why the self-reported measure may differ from the econometric estimates. One may even be inclined to question the validity of the survey responses altogether. Our only rebuttal is that the responses about the inflation variable are highly plausible. Unlike individuals' earnings, inflation is an aggregate variable and can be verified *ex post*. The average expected inflation in the sample is 7 percent, which is quite close to that predicted in 1989 for 1990 by the most sophisticated econometric models. Nor does the mean hide numerous implausible extreme values. Actually, for more than 50 percent of the sample the entire probability distribution for inflation is bunched between 5 and 7 percent. Finally, as already pointed out, the self-reported measure of uncertainty correlates with the risk categories that *a priori* are thought to be most subject to risk and is not explained by the fact that only households with higher education understand the survey questions. Thus, we regard our measure of uncertainty as a reliable indicator of individual risks.

4. The effect of earnings uncertainty on consumption

As shown in section 2, the appropriate measure of uncertainty is human wealth uncertainty, which depends, in turn, on the variance of the one-period shocks to income and on the persistence of the disturbance. The more persistent the shocks, the greater the uncertainty faced by the individual. In the cross-section we lack a measure of persistence, but if the degree of persistence is the same for all households, knowledge of one-period-ahead uncertainty is sufficient to estimate the amount of precautionary saving. Accordingly, we assume that individual incomes follow a process with idiosyncratic variance but common persistence (in section 6 we offer some evidence corroborating this assumption).

4.1. Development of the empirical model

To test for the presence of precautionary saving we estimate three specifications of the consumption function. As mentioned in section 2, only in the case of constant absolute risk aversion an explicit closed form solution for optimal consumption can be derived. In this special case individual consumption is the sum of two components. The first is a fraction λ of the certainty equivalence level of lifetime resources L, where L is the sum of human wealth and nonhuman wealth; the second is the precautionary component, which, under the assumption of normality, is proportional to the variance of the earnings shocks:

$$c_i = \lambda L_i - \mu \sigma_i^2, \tag{8}$$

where i indexes households. The problem of this specification derived from exponential utility is that it constrains the degree of prudence to be constant.

Since deviations from absolute risk aversion utility functions may result in nonlinearities, we also estimate a second-order Taylor expansion of a general consumption function that includes quadratic and interaction terms between lifetime resources L and the measure of uncertainty. The advantage of this specification is that it does not constrain the degree of prudence to be constant. But this unrestricted specification does not guarantee that the effect of uncertainty on consumption decreases with lifetime resources, as implied by the hypothesis of decreasing prudence.

A tighter use of Taylor series expansion is suggested by Skinner (1988). Assuming a CRRA utility function, he approximates the solution of the consumer's intertemporal maximization problem taking a second-order expansion of the Euler equations.[12] The insight of Skinner's approximation can be captured in a two-period simplified version of his multi-period model.[13] In this case, setting $\beta = R = 1$, the approximation to the first-period consumption function is

$$c_{i1} = \frac{L_{i1}}{1 + [1 + \phi\sigma^2/\mathrm{E}(L_{i2})^2]^{1/\theta}}, \tag{9}$$

where $\phi = \delta(\delta + 1)/2$, δ is the degree of relative risk aversion, E is the expectation operator, and the expectation for time 2 is conditional on information as of time 1.[14]

The important insight of eq. (9) is that the effect of uncertainty on consumption depends on the amount of total resources at risk, i.e., the variance of earnings is scaled by the expectation of lifetime resources. In order to capture the interaction of uncertainty and individuals' resources, we also estimate the

[12] Skinner's (1988) work is more suited to the estimation of Euler equations, because the consumption function that he derives involves a forward-looking representation of lifetime uncertainty that is difficult to implement empirically with cross-sectional data.

[13] Equivalently, we might consider Skinner's model under the simplifying assumption that the ratio of current income to lifetime resources is constant over age. This would yield an equation slightly more complex, but similar to our eq. (9).

[14] Note that the expectation involves, as Skinner recognizes, the value of consumption that appears on the left-hand side. Thus, eq. (9) is not, strictly speaking, a closed form solution.

following consumption equation:

$$c_i = \lambda L_i - \mu(\sigma_i^2 / L_i^\alpha). \tag{10}$$

The parameter α measures the sensitivity to the level of nonhuman wealth exhibited by the reaction to uncertainty. If $\alpha = 0$, eq. (10) reduces to the case of constant absolute prudence [eq. (8)]. If $\alpha > 0$, the effect of uncertainty on consumption declines with households' total resources. This decline is faster the higher the value of α.

4.2. Sample selection and empirical results

The original sample of the 1989 SHIW numbers 8,274 households. We exclude all households in which the head is not in the labor force or reports zero earnings in 1989. Since older households may spend down accumulated precautionary saving, we also exclude households in which the head is older than 65 (further restricting the sample to those younger than 55 does not change the results). After these exclusions the sample shrinks to 5,347 households. A sizable fraction of these households (2,419) did not answer the questions concerning the probability distribution of income and inflation. Excluding also households with negative net worth (19 observations), the sample shrinks further to 2, 909 observations (this is the sample whose characteristics are reported in table 2).[15]

For entrepreneurs and some managers, most income is property income. The effect of capital income uncertainty on consumption – in particular, the effect of interest rate uncertainty – is theoretically ambiguous [Sandmo (1972)]. Since we do not want to bias the test against the presence of precautionary saving, we also exclude 159 managers and entrepreneurs. This reduces the sample further to 2,750.

To reduce heteroskedasticity, all variables are divided by permanent earnings. Following King and Dicks-Mireaux (1982), these are defined as normal annual earnings adjusted for cohort effects. The procedure used in constructing this variable is described in the appendix.[16] Transitory earnings are defined as the difference of permanent earnings and current earnings. Human wealth is the

[15] In table 2 we show that education and uncertainty do not covary significantly within the sample. But respondents might be on average richer and more educated than nonrespondents. In this case the estimates would be affected by sample selection bias. We have therefore estimated a probit equation for respondents using the set of variables in table 2, and the consumption function by the Generalized Tobit estimator. The coefficient of the Mill's ratio was not significantly different from zero, and the values of the other parameters were almost identical to those reported in tables 3a and 3b.

[16] Our empirical results are unaffected if we exclude from the estimation of permanent earnings and from the consumption function estimates households with less than 5 million lire of earnings.

product of permanent earnings and the age of the household to retirement, assumed to be 65.[17] Lifetime resources are the sum of households' net worth and the constructed measure of human wealth. Since assets and liabilities are measured at the end of the period, we proxy beginning-of-period net worth by subtracting 1989 savings from end-of-period net worth.

To take into account the effects of preferences and family composition on the propensity to consume, we add a set of demographic variables to the regressors. After dropping nonsignificant variables, the estimated consumption function includes age, education, and family size. The dependent variable is the ratio of consumption of nondurables and services divided by permanent earnings.

The results of the three specifications of the consumption function are reported in table 3a. All estimated equations explain a large fraction of the variability of the ratio of consumption to permanent earnings (the adjusted R^2 is around 0.45 in all specifications). In all cases the estimated coefficient of permanent earnings is higher than that of transitory earnings.

Column 1 reports the specification with constant prudence. The coefficient of σ^2 is small and not significantly different from zero. Column 2 adds the interaction term between σ^2 and total resources.[18] In this case the two coefficients have opposite signs, and are both significantly different from zero. The effect of earnings uncertainty, however, becomes negative for high values of wealth.

In column 3 of table 3a we constrain the interaction term between resources and uncertainty to be consistent with the hypothesis of decreasing prudence. The coefficient α is computed by a grid search maximizing the value of the likelihood function; its estimated value is 1.2.[19] The effect of uncertainty is again statistically significant. Evaluating this effect at the sample means of permanent earnings, wealth, and variance, we find that the shortfall of consumption in response to uncertainty is 0.14 percent of permanent earnings. This effect tends to zero as the level of wealth increases.

Overall, the coefficients in table 3a indicate that the effect of uncertainty on consumption is rather small. The specification of column 2 clearly rejects the assumption of constant prudence. The likelihood ratio test between the specification of column 3 and the specification with constant prudence yields a value of 5.80, as opposed to a theoretical value of a $\chi^2(1)$ of 3.84: the restriction $\alpha = 0$ is rejected at the 5 percent confidence level.

One possibility to account for a small effect of uncertainty on consumption is that the family provides earnings' insurance, either by intergenerational

[17] The calculation of human wealth assumes that the real rate of interest is equal to the rate of productivity growth (see appendix).

[18] We have also introduced quadratic terms in uncertainty and total resources: the implied effect of uncertainty on consumption is similar to that displayed in column 2.

[19] Note, however, that the likelihood is relatively flat around the estimated value of α.

Table 3a

Consumption function estimates, dependent variable: ratio of nondurable consumption to permanent earnings, total-sample estimates.[a]

Variable	Constant prudence (1)	General specification (2)	Decreasing prudence[b] (3)	Variables' mean[c] (4)
Permanent earnings	0.632	0.614	0.630	1.000
	(29.61)	(28.82)	(29.63)	
Transitory earnings	0.560	0.544	0.566	0.027
	(37.03)	(35.72)	(38.68)	
Net worth	0.010	0.009	0.010	6.146
	(15.98)	(15.00)	(15.86)	
σ^2	0.398E-1	− 1.111		0.012
	(0.32)	(− 5.29)		
$\sigma^2 L$		0.143E-02		12.642
		(6.82)		
σ^2/L^{α}			− 281.0	0.493E-05
			(− 2.43)	
Age	0.021	0.034	0.024	1.52
	(1.31)	(2.15)	(1.55)	
Family size	0.812	0.789	0.792	0.118
	(6.70)	(6.57)	(6.53)	
Education	0.290	0.285	0.291	0.351
	(6.71)	(6.65)	(6.75)	
Constant	1.282	1.354	1.278	0.036
	(1.45)	(1.55)	(1.45)	
Adjusted R^2	0.452	0.461	0.453	
Standard error	0.295	0.293	0.295	
Number of observations	2,750	2,750	2,750	
Log-likelihood	− 542.8	− 519.6	− 539.9	

[a]With respect to the sample of table 2, we exclude 159 managers and entrepreneurs. Consumption, income, wealth, and earnings' variance are expressed in millions of 1989 lire. The mean of the dependent variable is 0.983. Asymptotic t-statistics are reported in parentheses.

[b]The value of α that maximizes the likelihood function is 1.2.

[c]All variables are divided by permanent earnings.

transfers or by transfers within the family [Kotlikoff and Spivak (1981)]. While it is hard to test for the former effect, it is possible to test for the latter by restricting the sample to households with one income recipient. It is indeed plausible that households with two or more income earners pool their risks and are better insured than isolated households.

The results for this restricted sample of 1,311 households are reported in table 3b. The main difference with respect to the estimates of table 3a is that the coefficient of σ^2 in the constant prudence specification (column 1) is negative and significant at the 10 percent level. In the specification of column 3 the coefficient of the uncertainty variable is also larger than the corresponding coefficient in table 3a, indirectly supporting the hypothesis that families share risks. Even if at sample means the effect of uncertainty is estimated to be

Table 3b

Consumption function estimates, dependent variable: ratio of nondurable consumption to permanent earnings, sample of one income recipients.[a]

Variable	Constant prudence (1)	General specification (2)	Decreasing prudence[b] (3)	Variables' mean[c] (4)
Permanent earnings	0.814	0.787	0.802	1.000
	(15.10)	(14.53)	(14.90)	
Transitory earnings	0.666	0.642	0.662	– 0.003
	(29.61)	(27.42)	(30.56)	
Net worth	0.010	0.009	0.010	6.338
	(11.09)	(10.48)	(11.03)	
σ^2	– 0.296	– 1.102		0.012
	(– 1.82)	(– 3.91)		
$\sigma^2 L$		0.149E-02		8.848
		(3.49)		
σ^2/L^α			– 330.0	0.657E-05
			(– 2.70)	
Age	0.016	0.025	0.019	1.87
	(0.84)	(1.30)	(1.02)	
Family size	0.608	0.600	0.592	0.140
	(4.09)	(4.05)	(3.98)	
Education	0.130	0.129	0.129	0.433
	(1.98)	(1.97)	(1.96)	
Constant	– 0.103	0.135	0.066	0.045
	(– 0.09)	(0.12)	(0.06)	
Adjusted R^2	0.515	0.519	0.516	
Standard error	0.305	0.304	0.305	
Number of observations	1,311	1,311	1,311	
Log-likelihood	– 301.1	– 295.0	– 299.1	

[a]With respect to the sample of table 2, we exclude 159 managers and entrepreneurs and 1,459 households with more than one income recipient. Consumption, income, wealth, and earnings' variance are expressed in millions of 1989 lire. The mean of the dependent variable is 1.039. Asymptotic t-statistics are reported in parentheses.

[b]The value of α that maximizes the likelihood function is 1.2.

[c]All variables are divided by permanent earnings.

0.22 percent of permanent earnings, 50 percent higher than in the whole-sample estimates, its impact on consumption remains small.[20]

In table 4 we report the frequency distribution of the effect of uncertainty on saving for the specification that is consistent with decreasing prudence. We note: (i) precautionary saving declines as the ratio of total resources to permanent earnings increases; (ii) the magnitude of precautionary saving is of some importance (greater than 0.5 percent of permanent earnings) for a small proportion of the sample; (iii) the frequency distribution of households with more than one income recipient is more concentrated towards smaller values of precautionary saving than the distribution of households with one income recipient.

[20]Also in this case the value of α that maximizes the likelihood function is 1.2.

Table 4
Precautionary saving for varying levels of lifetime resources.

Precautionary saving (as % of permanent earnings)	Total sample estimates[a]		Sample of one income recipients[a]	
	% of cases	L/Y_P	% of cases	L/Y_P
(1)	(2)	(3)	(4)	(5)
0	33.1	29.1	32.7	31.0
0–0.05	34.9	25.2	31.4	28.3
0.05–0.1	10.8	23.6	11.7	24.9
0.1–0.5	16.9	20.7	18.7	22.6
0.5–1.0	2.6	21.2	3.0	21.9
1.0–2.0	1.0	18.5	1.4	19.7
> 2.0	0.6	17.8	1.1	18.8
Effect at sample means	0.14	29.4	0.22	31.2

[a]See tables 3a and 3b for the definition of the sample and of the empirical specifications.

The amount of precautionary saving that we find in the data is not totally inconsistent with that assumed in theoretical simulations. Caballero (1990), assuming an exponential utility function with relative degree of prudence equal to one, an AR(1) process for income, and a coefficient of variation of the stochastic component of income equal to 10 percent, presents simulation results for varying levels of persistence. When the AR coefficient is equal to 0.8, the effect of uncertainty is slightly larger than 0.01 percent. When the AR coefficient is increased to 0.95, the effect rises to 0.1 percent. Substantial effects of uncertainty arise only when the income shocks persist for a long time; and in particular, when income is difference-stationary.

5. Earnings uncertainty and wealth accumulation

If uncertainty increases savings, it will increase also assets accumulation. In principle, savings and wealth are linked through the intertemporal budget constraint, and calculating the impact of uncertainty on saving or net worth should be equivalent. In practice, however, measured saving and net worth are not constrained to obey to the intertemporal budget constraint. Besides the well-known problem that differences in net worth may differ from saving flows because of capital gains, in a cross-section saving and net worth result from rather different sources of information. Saving is computed as the difference between disposable income and consumption, while net worth results from the aggregation of numerous and detailed questions about households' balance sheets.[21]

[21] In the previous section we proxy beginning-of-period net worth by subtracting to wealth 1989 savings. In the tests presented in this section, instead, there is no need for this adjustment.

Thus, testing whether uncertainty affects wealth accumulation provides an independent test of the theory of precautionary saving and a check of the validity of the findings of the previous section. It also allows us a direct computation of the contribution of precautionary savings due to earnings uncertainty to total wealth accumulation.

The life cycle hypothesis implies a nonlinear relationship between the ratio of wealth to permanent earnings and age. Extending the work of King and Dicks Mireaux (1982), we posit the following relation for the ratio of wealth to permanent income:

$$\ln(W/Y_p) = f(\text{age}, \sigma^2, X) + u, \tag{11}$$

where Y_p is permanent earnings, X is a vector of variables which influences the age–wealth relationship, and u is an error term.[22] The vector X will include permanent income if preferences are nonhomothetic [King and Dicks-Mireaux (1982)]. The relation between age and net worth is modelled using a piecewise linear function: the rate of wealth accumulation is assumed to be constant within years brackets until retirement (this function is described in the appendix). As our sample excludes households with heads over 65, we do not deal with the issue of wealth decumulation of the elderly after retirement. In addition to age and uncertainty, we introduce a set of additional variables which may alter the age–wealth profile via tastes and family needs (number of children, family size, and regional location).

Column 1 of table 5 shows the basic specification where wealth depends only on age and uncertainty. The ratio of wealth to permanent earnings increases until retirement at an average yearly rate of roughly 4 percent, except for households in the age bracket 45 to 54, where wealth accumulation is considerably smaller. The effect of uncertainty is statistically significant: at sample means, it is equal to 1.82 percent of net worth (roughly 10 percent of permanent earnings).[23] In levels, the amount of assets accumulated in response to earnings uncertainty is estimated to be 3.7 million lire, corresponding to almost \$3,000.[24]

The second regression of table 5 introduces additional variables. Large families and residents in Central regions possess greater wealth than that implied by the basic specification, while the number of children, given family size, reduces wealth.

[22] We use logs in order to reduce heteroskedasticity. However, the results using the ratio of wealth to permanent income, rather than the log of the ratio, yield results that are very similar to those reported in table 5.

[23] Regression 1 in table 5 implies that the percentage contribution of uncertainty to total wealth is $1 - [1/\exp(b\sigma^2/Y)]$, where b is the estimated coefficient of the uncertainty term.

[24] This result is very similar if the variance of earnings is entered in levels, rather than being scaled by permanent earnings.

Table 5

Effect of earnings uncertainty on wealth accumulation, dependent variable: logarithm of the ratio of net worth to permanent earnings.

Variable[a]	Regressions (1)	Regressions (2)	Regressions (3)	Variables' means (4)
Age < 25	0.013	0.027	0.003	23.984
	(0.13)	(0.28)	(0.03)	
Age 25–34	0.049	0.053	0.049	8.968
	(4.12)	(4.43)	(4.09)	
Age 35–44	0.040	0.044	0.047	6.255
	(5.02)	(5.49)	(5.85)	
Age 45–54	0.006	0.005	0.004	2.983
	(0.73)	(0.63)	(0.56)	
Age 55–64	0.043	0.037	0.037	0.543
	(3.09)	(2.65)	(2.61)	
$\sigma^2 Y_p$	0.149E-02	0.148E-02	0.594E-02	12.372
	(3.50)	(3.45)	(2.84)	
σ^2 Age Y_p			– 0.946E-04	549.14
			(– 2.29)	
Number of children		– 0.167	– 0.071	1.427
		(– 3.35)	(– 1.38)	
Family size		0.093	– 0.022	3.383
		(2.27)	(– 0.50)	
Resident in the North		– 0.103	– 0.156	0.455
		(– 1.78)	(– 2.73)	
Resident in the South		– 0.045	0.039	0.382
		(– 0.75)	(0.63)	
Log(Y_p)			0.464	10.287
			(6.12)	
Constant	0.240	– 0.169	– 4.114	1.000
	(0.105)	(– 0.07)	(– 1.75)	
Adjusted R^2	0.080	0.084	0.098	
Standard error	1.052	1.049	1.041	
Number of observations	2,750	2,750	2,750	
Log-likelihood	– 4037.5	– 4,028.8	– 4,006.0	

[a]The mean of the dependent variable is 1.288. The definition of the age spline is given in the appendix. Asymptotic t-statistics are reported in parentheses.

In the third regression of table 5 we further add the interaction of uncertainty with age and the log of permanent earnings as separate regressors. The coefficient of the interaction term is negative, a finding that is consistent with the hypothesis that uncertainty affects more strongly the behavior of young households who have not yet accumulated enough assets to cushion against bad draws of income. This finding is therefore again consistent with decreasing prudence.

The results of column 3 also indicate that the higher is permanent income, the higher is the ratio of wealth to permanent income, thus rejecting homotheticity. Nonhomotheticity is also consistent with the failure of certainty equivalence, thus indirectly supporting the theory of precautionary saving. But in all cases the estimated effect of uncertainty is basically unaffected and precisely estimated.

Overall, the results of this section are remarkably consistent with the results of the previous section and shed further light on the magnitude and pattern of the effect of uncertainty over the life cycle. In section 4 we estimate that precautionary saving is equal to 0.1 percent of permanent earnings. The sample average age to retirement is 20 years. Cumulating these savings one obtains a value of the ratio of wealth held for precautionary reasons to permanent earnings that is close to the 1.82 percent contribution to wealth accumulation implied by the estimates of column 1 in table 5.

6. Persistence

So far, we have maintained the assumption that the degree of persistence of the income shocks is the same (at least in mean) for all households. Since our estimates might be biased if this assumption were not valid, in this section we provide some evidence about the differences in the degree of persistence among households in the sample.

Ideally, we would need a long panel to address this issue properly. However, in the present context, we are mainly interested in testing whether the degree of persistence varies across households. For this purpose we can draw some inferences using a two-year panel, i.e., merging the information of the 1989 SHIW with that provided by the 1987 SHIW. As mentioned in section 3, one of the features of the 1989 SHIW is that it contains a small panel component of 1,208 households who were interviewed also in 1987. Thus, for these households we have information on earnings and demographic characteristics at two points in time.

If we exclude households whose head is not in the labor force and households who experienced major changes in status and family composition between 1987 and 1989, we are left with a sample of 603 households. This sample can be partitioned into four groups, according to the occupation of the head: operative and laborers, clerical workers, professionals, and self-employed. These groups represent 85 percent of the 603 panel observations. The other groups are too small to provide reliable estimates.

Since we only have two observations for each household (in 1987 and in 1989), the only process that we can estimate is an AR(1) process. We assume that income, in deviations from its mean, follows the process $y_{jt} = \gamma_j y_{jt-1} + \varepsilon_{jt}$,

Table 6

Estimates of the degree of persistence of household earnings, by occupation of the head.[a]

	Operative and laborer (1)	Clerical (2)	Self-employed (3)	Professionals (4)
Log specification	0.756	0.739	0.730	0.848
Level specification	0.804	0.808	0.815	0.835
Number of observations	214	165	114	42

[a]All estimated coefficients are significant at the 1 percent level.

where γ measures the degree of persistence of the shocks ε and j indexes each group of households ($j = 1,2,3,4$). Lagging this expression one period and substituting the result in the previous equation, we get

$$y_{jt} = \gamma_j^2 y_{jt-2} + \eta_{jt}, \quad \text{where} \quad \eta_{jt} = \varepsilon_{jt} + \gamma\varepsilon_{jt-1}. \tag{12}$$

In table 6 we report the results of estimating eq. (12) in logarithms and in levels.[25] In the first three groups the differences in the estimated γ_j are not statistically significant. The degree of persistence varies in fact from 0.73 to 0.76 when the specification is in logarithms and from 0.80 to 0.82 when it is in levels. For professionals the estimated γ is ten points higher than in other groups in the log-specification, but only three points higher in the specification in levels. On the whole, the assumption that the degree of persistence is the same for all households is not unreasonable. The patterns of table 6 cannot substantially affect the results presented in sections 4 and 5.

7. Implications for consumption puzzles

Skinner (1988) and Zeldes (1989) have pointed out that precautionary saving may explain, at least partly, the empirical failure of the permanent income hypothesis. As in many other countries, several recent studies indicate that in Italy consumption growth is correlated with lagged disposable income and expected income growth, and that consumption growth has been high even in the presence of low real interest rates. For instance, Guiso, Jappelli, and Terlizzese (1991), using aggregate annual data, regress the growth rate of

[25]We have included in each equation a set of demographic variables (age, gender, regional location, and sector of activity) to account for individual differences. Note that the error of the estimated equation, η, is autocorrelated. However, it is uncorrelated with ε_{jt-2}, and therefore the estimate of γ is consistent.

consumption on the expected growth rate of disposable income and a measure of the expected real interest rate and find that the coefficient of disposable income growth is about 0.6.[26] Given that we estimate that precautionary saving is small, it is not surprising that our results cannot account for these failures, as we show below.[27]

Assuming $\beta R = 1$, constant prudence, and normally distributed earnings shocks, the first-order condition of the consumer maximization problem in section 2 is

$$\frac{\Delta c}{c} = \frac{\theta c}{2} \frac{\sigma^2}{c^2}. \tag{13}$$

In this special case, consumption grows only if there is uncertainty ($\sigma^2 > 0$), to an extent that depends on the degree of relative risk aversion θc. Eq. (13) is the base for the claim that precautionary saving may be responsible for consumption growth even when the real interest rate is low. Approximating average consumption by average permanent earnings, our results give us the opportunity to evaluate eq. (13) at sample means and to check what it implies for consumption growth.

The ratio of the (average) variance to the square of (average) consumption is equal to 0.04 percent. The constant prudence specification in table 3b implies that precautionary saving, i.e., the term $\theta/(R - \gamma)$ in eq. (2), is equal to 0.3. Assuming that $\gamma = 0.75$, a number that is consistent with the results reported in table 6, and that the real interest rate is 4 percent, the implied value of θ is 0.09. The sample mean of consumption is 30. Thus relative risk aversion, θc, is about 3. This implies that consumption growth in excess of the growth implied by the certainty equivalence model of consumption is a modest 0.06 percent per year.

Even values of θ as high as 0.5 (that imply an implausible degree of relative risk aversion of 15) account for a growth in consumption of less than 0.1 percent per year, a very small number if compared with the fact that in Italy in the last three decades, on average, consumption growth has been 3 percent.

8. Conclusions

The main contribution of this paper to the literature on precautionary saving is to test the theory using a self-reported measure of uncertainty of future earnings. On the whole, the results indicate that subjective earnings uncertainty affects the level of saving in the direction predicted by the theory and in a way

[26] Jappelli and Pagano (1989) also find high excess sensitivity in Italian macroeconomic data.

[27] Given that we do not test for the effect of mortality risk on saving, we cannot address the issue of the slow wealth decumulation by the elderly.

that is consistent with decreasing prudence. At sample means, the results indicate that, on average, precautionary saving accounts for 2 percent of households' net worth; in level, this implies that households hold a nonnegligible amount of assets (almost \$3, 000) to protect themselves from bad income draws. The estimates also imply reasonable values of the coefficient of relative risk aversion.

However, the results also suggest that earnings uncertainty, i.e., the source of uncertainty most frequently studied in the theoretical literature, fails to explain a large fraction of saving and wealth accumulation. Our results imply that earnings uncertainty is not, at least in the context of the Italian economy, a viable explanation for the empirical failure of the permanent income hypothesis.

One possible interpretation of our results is that we fail to find a large effect of precautionary saving because households are informally linked by risk-sharing arrangements. Since our evidence suggests that precautionary saving is only slightly higher for single income earners than for households with two or more income earners, this interpretation must imply that risk sharing takes place through networks that pool income risks from different households, rather than within the same household. In the present paper we have not tested for this effect, but we regard it as an interesting topic for future research.

Finally, we wish to stress that the results of this paper do not cast doubts on the importance of precautionary saving *per se*. Survey respondents, in Italy and elsewhere, consistently indicate that saving for emergencies is one of the main reasons for saving. Future empirical studies may reveal that, beside earnings uncertainty, other important types of risk, such as health and mortality risks, are important determinants of saving.

Appendix

This appendix provides a description of the survey and details of the data set, variable definitions, and sources of the survey employed in this study. The construction of permanent earnings is described in the second part of this appendix.

A.1. The 1989 Survey of Household Income and Wealth (SHIW)

The Bank of Italy first sponsored a survey of consumer finances and characteristics in 1965. The survey was conducted regularly each year from 1965 to 1984. In 1987 it was decided to double the sample size (to roughly 8,000 households) and to conduct the survey every two years. Surveys are conducted in the first two months of each year, and the variables refer to the previous year. We refer to the 1989 SHIW as the one conducted at the beginning of 1990.

Until 1987 the surveys were conducted as a series of independent cross-sections. In that year it was decided to change the design of the survey. The 1989 survey includes two groups of households:

1. The first is a random sample of households interviewed also at the beginning of 1988 (the panel component); this sample includes 1,208 households.
2. The second is a random sample of households interviewed for the first time at the beginning of 1990; it includes 7,066 households.

The overall sample design is such that the SHIW is representative of the Italian population. The 1989 SHIW covers 8,274 households (25,150 individuals and 13,864 income recipients), randomly selected from 294 Italian cities. Here we briefly summarize the sample design. The sample selection is made on the basis of a two-stage (towns and households) stratified sampling procedure. In the first stage, all the Italian metropolitan areas and towns are divided in strata. Towns with more than 40,000 inhabitants and a random sample of all towns with less than 40,000 inhabitants (there are more than 9,000 in Italy) are selected. In the second stage, households are drawn by a random sampling procedure from the list of all resident households in a given city. Probability selection is enforced at all stages of sampling. Table A.1 compares the population and sample means of selected demographic variables.

Interviews are conducted by a specialized agency with professional interviewers. The interviews are preceded by extensive trainings and several meetings with Bank of Italy representatives who instruct the interviewers. The latter are given no discretion in the choice of households and families to be interviewed. Interviews take place in person, by visiting the residence of the household.

The unit of observation is the family, which is defined to include all persons residing together in the same dwelling who are related by blood, marriage, or adoption; individuals having 'partners or other common-law relationships' are treated as families. Families include one-person units as well as units of two or more persons. Thus, the definition of the household is similar to that adopted by the 1983–86 Survey of Consumer Finances [Avery and Kennickell (1988)].

The survey takes place in the months of January and February. Balance sheets items are reported as of December 31 of the preceding year, while income is reported for the previous calendar year. The standard errors of the sample estimates of the consumption, income, and net worth variables as a percentage of the sample averages in the 1989 Survey are 1.57, 1.30, and 3.00, respectively.

The questions about uncertainty were asked for the first time in the 1989 SHIW to all households. The tests for the persistence of earnings reported in section 6 use instead only the 1,208 observations relative to the panel component of the 1989 Survey.

Because of its sample design and its collection of detailed wealth statistics, the 1989 SHIW is similar to the 1983–86 Survey of Consumer Finances (SCF),

Table A.1
Population and sample means of selected variables in the 1989 SHIW.[a]

Variable	Population (1)	1989 SHIW (2)
Males	48.6	48.7
Females	51.4	51.3
Age < 24	32.7	32.9
Age 25–44	28.6	28.8
Age 45–64	24.1	26.1
Age > 65	14.5	12.3
City size < 20.000	46.8	44.7
City size 20.000–40.000	13.1	12.4
City size 40.000–1 million	28.8	29.6
City size > 1 million	11.2	13.3
North	44.3	46.5
Centre	19.1	18.9
South	36.6	34.7

[a]Data sources: 1989 SHIW and Annuario Statistico Italiano (ISTAT, Rome, 1989). The numbers in column 2 are based on the entire sample of 8,274 households.

Table A.2
Means and standard deviations of income and wealth in the 1983 SCF and in the 1989 SHIW.[a]

	1989 SHIW	1983 SCF
Disposable income		
Mean (μ_y)	35.5	25.7
Standard deviation (σ_y)	29.4	29.0
σ_y/μ_y	0.83	1.13
Net worth		
Mean (μ_w)	173.2	71.6
Standard deviation (σ_w)	307.4	166.5
σ_w/μ_w	1.77	2.32

[a]Data sources: For Italy the statistics refer to the sample of 8,274 households of the 1989 SHIW. The numbers are in millions of 1989 lire. For the U.S. we have used the 1983 SCF and selected the sample of 3,692 households (excluding the sample of high-income respondents). Numbers for the U.S. are in 1982 thousand dollars.

which is representative of the U.S. population [Avery and Kennickell (1988, pp. 30–31)]. We provide a comparison of the income variance and distribution of the 1989 SHIW and the 1983–86 SCF. Table A.2 indicates that for both disposable income and net worth the ratio of the standard deviation to the sample mean is lower in Italy than in the U.S. Table A.3 reports the distribution of income in the two surveys. The share of aggregate family income received by the highest decile is 33 percent in the U.S. and 25.2 percent in Italy. That received by the lowest decile is 1 percent in the U.S. and 2.7 percent in Italy.

Table A.3

Share of family income by income deciles: a comparison between the 1983 SCF and the 1989 SHIW.[a, b]

	1989 SHIW			1983 SCF
	Average income	% of families	% of income	% of income
Income decile	(1)	(2)	(3)	(4)
Lowest	13.5	25.8	2.7	1
Second	22.2	15.7	4.3	3
Third	28.0	12.4	5.5	4
Fourth	33.9	10.3	6.5	5
Fifth	39.8	8.8	7.7	7
Sixth	45.4	7.7	9.1	8
Seventh	52.9	6.6	10.8	10
Eighth	62.5	5.6	12.7	13
Ninth	78.1	4.5	15.7	16
Highest	125.9	2.8	25.2	33

[a] In millions of 1989 lire.

[b] Data sources: the numbers in columns 1, 2, and 3 are based on the sample of 8, 274 households of the 1989 SHIW. The source for the income distribution in the U.S. is Avery et al. (1984, table 2, p. 681).

A.2. Variables definition

Inflation uncertainty Question: On this table we have indicated some classes of inflation. We are interested in knowing your opinion about inflation twelve months from now. Suppose now that you have 100 points to be distributed between these intervals (a table is shown to the person interviewed). Are there intervals which you definitely exclude ? Assign zero points to these intervals. How many points do you assign to each of the remaining intervals ?

For this and the following variable the intervals of the table shown to the person interviewed are the same. The intervals are: >25, 20–25, 15–20, 13–15, 10–13, 8–10, 7–8, 6–7, 5–6, 3–5, 0–3, <0 percent. In case it is less than zero, the person is asked: How much less than zero ? How many points would you assign to this class ?

Earnings uncertainty Question: We are also interested in knowing your opinion about labor earnings or pensions twelve months from now. Suppose now that you have 100 points to be distributed between these intervals (a table is shown to the person interviewed). Are there intervals which you definitely exclude ? Assign zero points to these intervals. How many points do you assign to each of the remaining intervals ?

Age of the head of the household Question: Where were you born and in which year? In the wealth regressions we choose the following spline function for age:

$$
\begin{array}{lll}
Age^{(1)} = Age \text{ if } Age \le 24, & Age^{(1)} = 24 \text{ otherwise},\\
Age^{(2)} = \text{Min}(Age\text{-}24, 10) \text{ if } Age > 24, & Age^{(2)} = 0 \text{ otherwise},\\
Age^{(3)} = \text{Min}(Age\text{-}34, 10) \text{ if } Age > 34, & Age^{(3)} = 0 \text{ otherwise},\\
Age^{(4)} = \text{Min}(Age\text{-}44, 10) \text{ if } Age > 44, & Age^{(4)} = 0 \text{ otherwise},\\
Age^{(5)} = \text{Min}(Age\text{-}54, 10) \text{ if } Age > 54, & Age^{(5)} = 0 \text{ otherwise},\\
Age^{(6)} = Age\text{-}64 \text{ if } Age > 64, & Age^{(6)} = 0 \text{ otherwise}.
\end{array}
$$

Head of the household If the person who would usually be considered the head of the household (i.e., the husband or the father) has migrated or works abroad, the head of the household is the person who is responsible of the economic activity of the family.

Household size Question: Total number of persons in the family. Persons include head, spouse (whether married or not married), children, other relatives, and nonrelatives living in the household.

Education of the head of the household Question: Education of household head. Response: (5) no education, (6) completed elementary school (5 years), (7) completed second grade (8 years), (8) completed high school (13 years), (9) completed college degree (17 to 19 years), (0) post-graduate education (more than 20 years of education). The variable has been recoded according to the values given in parentheses. For the highest class we have assumed a value of 20 years of education.

Marital status of the head of the household Question: Marital status of household head. Responses: (1) Married (includes couples living together), (2) never married, (3) separated and divorced, (4) widowed.

Occupation of the head of the household Question: Main occupation of household head. Responses: (1) operative and laborer, (2) clerical, (3) precision craft, (4) professional, (5) manager, (6) entrepreneur, (7) self-employed, (8) other.

Sector of occupation of the head of the household Question: Main sector of occupation of household head. Responses: (1) agricultural, (2) and (3) industry, (4) public administration, (5)–(7) services.

Region of the country Question: residence of the household. Responses: North (Piemonte, Valle D'Aosta, Liguria, Lombardia, Trentino, Friuli, Veneto, Emilia-Romagna), Centre (Marche, Umbria, Toscana, Lazio), South (Abruzzi, Molise, Campania, Basilicata, Puglia, Calabria, Sicilia, Sardegna).

Labor earnings of household Question: How much did you earn from your labor activity net of all taxes and contributions in 1989 ? This question is asked to each member of the household, whether it is employed or self-employed. The variable used in the estimation is the sum of net of taxes labor earnings of the household. The variable refers to the year 1989.

Consumption of household Sum of the expenditures on nondurable consumption items (food consumption, entertainment, education, clothes, medical expenses, housing repairs and additions). Durable consumption (vehicles, furnitures and appliances, art objects) is not included in the definition of consumption. The variable refers to the year 1989.

Household net worth Sum of household's liquid assets (checking accounts, saving accounts, money market accounts, certificates of deposits), financial assets (stocks, government bonds, other bonds), property and business, net of household liabilities (debt owed on credit cards, on car loans, other forms of consumer debt, and mortgages on houses, properties, and additions). The variable is measured at the end of 1989.

A.3. The construction of permanent earnings

We estimate permanent earnings on a sample of 5,347 households, excluding households whose head is not in the labor force or older than 65. To compute permanent earnings we proceed as follows. Denote by $Y(\tau)$ the earnings of a household of age τ. We assume that permanent earnings of this household at age τ can be expressed as

$$Y(\tau) = Z\beta + \phi(\tau),$$

where Z is a vector of household (or head) characteristics and $\phi(.)$ is a quadratic function of age. We estimate this regression proxying Z with age, education, gender, martial status, occupation, regional location, family size, and number of income earners. To account for heteroskedasticity, we estimate the equation by Generalized Least Squares, using as weights the residuals from a first-stage OLS regression. The final estimates are reported in table A.4.

Assuming that the maximum age at which people work is 65 years, the estimated permanent earnings at age τ_0 is

$$Y_p(\tau_0) = (65 - \tau_0 + 1)^{-1} \sum_{\tau=\tau_0}^{65} [Zb + f(\tau)] \left(\frac{1+n}{1+r}\right)^{(\tau-\tau_0)},$$

where b and f indicate, respectively, the estimated coefficients of β and ϕ

Table A.4

Earnings function estimates, dependent variable: total household earnings.[a]

Variable	Coefficient (1)	t-statistics (2)	Variables' means (3)
Demographics			
Education	0.524	5.62	9.800
Education squared	0.003	0.64	115.66
Age	0.246	3.03	43.03
Age squared	− 0.002	− 2.42	1953.7
Male	1.449	3.27	0.905
Married	2.851	6.93	0.847
Family size	0.387	2.98	3.436
Number of children	0.517	2.73	1.457
Number of income earners	10.120	35.70	1.671
Occupation			
Operative and laborer	− 5.165	− 11.62	0.322
Clerical	− 3.568	6.82	0.299
Precision craft	2.120	2.50	0.083
Professional	12.39	6.75	0.028
Manager	5.983	5.79	0.065
Entrepreneur	18.456	7.32	0.016
Other	− 6.130	− 3.72	0.001
Sector			
Agriculture	− 3.485	6.81	0.053
Industry	− 0.476	1.14	0.254
Services	0.223	0.63	0.446
Regional location			
North	2.425	6.03	0.400
South	− 1.628	− 4.36	0.385
Constant	− 1.868	0.98	1.000
Adjusted R^2	0.344		
Standard error (%)	5.830		
Dependent variable mean	31.388		
Observations	5,347		

[a]The sample of 5,347 observations is obtained excluding households with zero earnings and households where the head is not in the labor force or older than 65. The dependent variable is expressed in millions of 1989 lire. The following attributes are excluded from the regression: self-employed, residents in the Centre, employed in the public sector.

reported in table A.4. The parameters n and r represent, respectively, the rate of growth of productivity and the rate of interest. Assuming that $r = n$, the expression reduces to

$$Y_p(\tau_0) = Zb + (65 - \tau_0 + 1)^{-1} \sum_{\tau=\tau_0}^{65} f(\tau).$$

The second term in this expression can be computed using the fact that, by the mean value theorem, there exists a $\tau^*(\tau_0)$ such that

$$f[\tau^*(\tau_0)] = (65 - \tau_0 + 1)^{-1} \sum_{\tau=\tau_0}^{65} f(\tau).$$

Having determined the value of $\tau^*(\tau_0)$ as a function of the estimated coefficients and of τ_0, permanent earnings are then computed as

$$Y_p(\tau_0) = Zb + f[\tau^*(\tau_0)].$$

Human wealth is computed as the product of permanent earnings and the age of the household to retirement. Transitory earnings are defined as the difference of permanent and current earnings.

A.4. Tape and sources

Information about the SHIW can be found in: 'Housing Assets in the Bank of Italy's Survey of Household Income and Wealth' by Luigi Cannari and Giovanni D'Alessio, published in: C. Dagum and M. Zenga, eds., *Income and Wealth Distribution, Inequality and Poverty* (Springer Verlag, Berlin, 1990). The main source of information is an Italian publication of the Bank of Italy: 'I bilanci delle famiglie italiane nell'anno 1989', *Supplement to the Statistical Bulletin* no. 26 (Bank of Italy, Rome, Oct. 1991). The tape, questionnaire, reference material, and description of the 1989 SHIW may be requested by writing to: Research Department, Bank of Italy, Via Nazionale 91, 00186 Rome, Italy.

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