A Direct Test of the Buffer-Stock Model of Saving*

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Abstract

Recent models with liquidity constraints and impatience emphasize that consumers use savings to buffer income fluctuations. When wealth is below an optimal target, consumers try to increase their buffer stock of wealth by saving more, while, if wealth is above target, they increase consumption. This important implication of the buffer stock model of saving has not been subject to direct empirical testing. We derive from the model an appropriate theoretical restriction and test it using data on working-age individuals drawn from the 2002 and 2004 Italian Surveys of Household Income and Wealth. One of the most appealing features of the survey is that respondents report the amount of wealth held for precautionary purposes, which we interpret as target wealth in a buffer stock model. The test results do not support buffer stock behavior, even among population groups that are more likely, a priori, to display such behavior. The saving behavior of young households is instead consistent with models in which impatience, relative to prudence, is not as high as in buffer stock models (JEL: D91).

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1 Introduction

Recent intertemporal consumption models emphasize the role of savings as a buffer stock against income fluctuations. Deaton (1991) and Carroll (1992, 1997) have solved sophisticated versions of such models. Although the specific details of the models differ, emphasizing liquidity constraints or the probability of low income realizations, they share similar predictions. In both models, consumers have a unique and stable wealth to permanent income ratio (what we term the target wealth-income ratio). This implies that people who have received negative income shocks, and whose wealth is consequently below target, intend to be "savers", and thus increase their stock of wealth. People who have received positive shocks, and whose wealth is therefore above target, intend to be "dissavers", and will therefore increase current consumption and run down their stock of wealth.

This key implication of the buffer-stock saving model has not been subject to empirical scrutiny because target wealth is unobservable. Current evidence of buffer-stock behavior is based on two model's implications: that consumption tracks income closely, and that precautionary saving represents an important reason for wealth accumulation. Several simulations of intertemporal consumption models predict consumption-income tracking in the early part of the life-cycle (Attanasio, Banks, Meghir, and Weber, 1999; Laibson, Repetto and Tobacman, 1998; Gourinchas and Parker, 2002; Cagetti, 2003). Empirical evidence on the importance of precautionary saving is mostly based on reduced form regressions of net worth or financial assets on proxies for income risk. Some studies report that precautionary wealth represents a small portion of total wealth, e.g. Guiso, Jappelli and Terlizzese (1992), and Hurst, Kennickel, Lusardi and Torralba (2005); others find a large impact of income risk, Carroll and Samwick (1997), and Gruber and Yelowitz (1999). These studies differ in many respects, such as the definition of wealth, the measure of risk, and institutional features. But even findings of large effects of income risk on saving are not conclusive evidence of buffer stock behavior, because life-cycle models with income risk also provide an important role for precautionary saving, see Hubbard, Skinner, and Zeldes

(1995). In short, the literature still lacks a convincing test of the buffer-stock model.

In this paper we use a survey question on precautionary wealth available in the 2002 and 2004 Bank of Italy Surveys on Household Income and Wealth (SHIW) to propose a direct test of buffer stock behavior. The question asks people how much savings they think they need for future emergencies, and is similar to a question contained in the 1995 and 1998 Surveys of Consumer Finances described in Kennickell and Lusardi (2004). We interpret this question as providing information on target wealth in a buffer-stock model, and test the proposition that people with wealth-income ratio below target expect to save, while those with wealth-income ratio above target expect to dissave.

We show that the main testable implication of the buffer stock model is that the covariance between the wealth gap (the difference between actual and target wealth) and consumption is (strongly) positive. Although we focus on Carroll's version of the buffer stock model, the test applies equally well to Deaton's case. In Carroll, buffer stock behavior emerges from the tension between impatience, prudence, and the chance of zero earnings. Impatient individuals would like to anticipate consumption, but the chance of zero future earnings generates a demand for wealth. In Deaton, the tension is between impatience, prudence, and liquidity constraints, but the insights are similar, and buffer stock behavior emerges again as the optimal policy.

Since we study a specific implication of buffer stock behavior, our test can be used to check whether or not buffer stock behavior is rejected by the data, but cannot be directly interpreted as suggesting alternative consumption theories. The final part of the paper therefore uses estimates of the age-wealth profile obtained with Italian repeated cross-sectional data to provide further evidence on the validity of the buffer-stock model. Realistic versions of this model with finite horizons and declining income after retirement limit considerably the age-range of buffer stock behavior. Carroll (1997) shows that buffer stock behavior emerges until roughly age 50, and that afterwards people start to accumulate wealth steadily to prepare for retirement. In other words, one should expect the individual wealth-income ratio to be stationary at young ages if consumers behave according to the buffer stock model.

Other models of intertemporal choice deliver different predictions about the correlation between income and consumption and the age-wealth profile during the life-cycle. In the standard life-cycle model without uncertainty, the individual wealth-income ratio is not stationary because consumers save each year until retirement. Hubbard, Skinner and Zeldes (1995) use numerical methods to analyze the properties of a more sophisticated life-cycle model with life uncertainty and income risk; their simulations report, on average, substantial accumulation even at young age. Laibson, Repetto and Tobacman (1998), Attanasio, Banks, Meghir, and Weber (1999), Gourinchas and Parker (2002) and Cagetti (2003) provide structural estimates of stochastic dynamic models of consumption, matching theoretical and observed statistics for US households, and find a close association between income and consumption in the early part of the life-cycle, and therefore little wealth accumulation in young age, and more substantial wealth accumulation near retirement.

The rest of the paper is organized as follows. Section 2 reviews the buffer stock saving model, presents the empirical test, based on the stationarity of the target wealth-to-income ratio, and computes the test statistics on data simulated from a realistic parametrization of the model. Section 3 describes the survey question on target wealth, and compares it with a similar question asked in the Survey of Consumer Finances.

The test results are presented in Section 4. Our findings suggest absence of significant correlation between the wealth gap and consumption and are thus inconsistent with the buffer stock model, regardless of the particular definition of wealth used (real or financial). We perform several robustness checks. First, we explore if buffer-stock behavior emerges in some population groups that, a priori, are more likely to follow the buffer stock model: the self-employed, the young, those who face higher income risk. Second, using direct information on the individual rate of time preference, we check if buffer stock behavior emerges among people who report to be impatient. Finally, using the panel section of the 2002-2004 survey, we check the robustness of the results to the presence of unobserved heterogeneity and when consumption, cash-on-hand, and target wealth are measured with error.

Section 5 provides further evidence on the validity of the model, exploring whether the wealth-income ratio of young consumers is stationary, as suggested by the buffer stock model. Section 6 summarizes our findings.

2 Deriving testable implications of buffer stock behavior

We take as our point of departure Carroll's (1992) buffer-stock saving model to derive testable predictions and explain our empirical strategy. Consumers have finite horizons and choose consumption to maximize the following objective function:

$$E_0 \sum_{t=0}^{T} \beta^t u(C_t)$$

where β is the subjective discount factor, the instantaneous utility function is isoelastic, $u(C_t) = C_t^{1-\rho} / (1-\rho)$, and $\rho > 0$ is the coefficient of relative risk aversion. The dynamic budget constraint is:

$$W_{t+1} = R[W_t - C_t + Y_t]$$

where $R = 1 + r$ is the constant interest rate factor, and W_t, Y_t, and C_t are, respectively, non-human wealth, labor income, and consumption at time t. Labor income shifts due to transitory and permanent shocks, assumed to be log-normally distributed, i.e.,

$$Y_{t+1} = P_{t+1} V_{t+1} \quad (1)$$

$$P_{t+1} = G P_t N_{t+1} \quad (2)$$

where G is the growth rate of income, P_{t+1} is permanent income, and V_{t+1} and N_{t+1} are i.i.d. shocks with mean equal to 1. The model also assumes that in each period there is a small chance $p > 0$ that transitory income is zero. The Bellman equation of the problem is:

$$
\begin{aligned}
V_t(W_t, P_t) &= \max_{C_t}\{u(C_t) + \beta E_t V_{t+1}(W_{t+1}, P_{t+1})\} \qquad (3)\\
s.t. \quad P_{t+1} &= G P_t N_{t+1}\\
W_{t+1} &= R[W_t - C_t + Y_t]
\end{aligned}
$$

To exploit the homogeneity of the instantaneous utility function, let's define cash-on-hand, X_t, as non-human wealth plus income ($X_t = W_t + Y_t$), and write (3) as:

$$
\begin{aligned}
v_t(x_t) &= \max_{c_t}\{u(c_t) + \beta E_t G^{1-\rho} N_{t+1}^{1-\rho} v_{t+1}(x_{t+1})\} \qquad (4)\\
& \quad s.t.\\
x_{t+1} &= R[x_t - c_t]\frac{1}{GN_{t+1}} + V_{t+1} \qquad (5)
\end{aligned}
$$

where $x_t = \frac{W_t + Y_t}{P_t}$, $c_t = \frac{C_t}{P_t}$ and $v_t(x_t) = V_t(W_t, Y_t)/P_t^{1-\rho}$.

Carroll (2004) shows that for specific ranges of parameter values, the problem has a solution (i.e., the functional defined in 4 has a fixed point), optimal consumption is an increasing and concave function of cash-on-hand, and the marginal propensity to consume out of cash-on-hand is bounded from above and from below. Furthermore, there exists a unique and stable cash-on-hand-to-permanent income ratio x^* such that, "if actual cash-on-hand is greater than the target, impatience will outweigh prudence, and wealth will fall, while if cash-on-hand is below the target, the precautionary saving motive will outweigh impatience and the consumer will try to build wealth back up toward to target" (Carroll, 2001, p. 33).[1] In our notation, if $(x_t - x^*) < 0$, then the cash-on-hand to permanent income ratio grows in expectation. If instead $(x_t - x^*) > 0$, x_t falls (again, in expectation). Using cross-sectional data, we test this key implication of the model.

[1] Carroll (2004) shows also that, at the target, expected consumption growth is less than expected permanent income growth; and that expected consumption growth is declining in cash-on-hand.

At any given point in time, households differ in their value of the wealth gap $(x_t - x^*)$. A first source of heterogeneity concerns preferences and the parameters of the income generating process, which set different values of x^* for each individual. Income shocks are a second source of heterogeneity: even if two identical consumers have the same preferences and the same income generating process - and therefore the same x^* - they receive different income shocks and have therefore different x_t and wealth gaps.[2]

Thus in a cross-section, the implication we test is that:

$$COV(x_{ht} - x_h^*, E_{ht}(x_{ht+1} - x_{ht})) < 0 \tag{6}$$

where $COV(.,.)$ is a population covariance and h is a household index. This notation makes explicit that $E_{ht}(x_{ht+1} - x_{ht})$ is the time t expectation of household h's next period change in cash-on-hand, and the covariance is taken with respect to the cross-sectional distribution of the wealth gap and of expected asset accumulation.

To test this restriction one needs to observe x_h^*, x_{ht} and $E_{ht}(x_{ht+1})$. As we shall see, we have data on actual wealth and on a proxy of target wealth, but not on the expected value of the change in cash-on-hand. To evaluate $E_{ht}(x_{t+1})$, let's take the expectation as of time t of (5) for household h, and recall that $E_{ht}(N_{t+1}) = 1$, $E_{ht}(V_{t+1}) = 1$, and $VAR_{ht}(\ln N_{t+1}) = \sigma_N^2$:

$$\begin{aligned} E_{ht}(x_{ht+1}) &= R[x_{ht} - c_{ht}] \times E_{ht}\left(\frac{1}{GN_{t+1}}\right) + E_{ht}V_{ht+1} \\ &\approx \frac{R}{G}[x_{ht} - c_{ht}] \times e^{\sigma_N^2} + 1 \end{aligned} \tag{7}$$

where the second equality follows from a second order Taylor expansion of $\frac{1}{N_{ht+1}}$ around the mean of N_{ht+1}.

Substituting (7) in (6) and defining $\gamma = e^{\sigma_N^2}$, we can restate (6) in terms of observable variables as:[3]

[2] These are not the only possible sources of heterogeneity. In Section 2.2 we use simulation analysis to explore the effect of heterogeneity in income risk, income growth, and interest rates.

[3] Equation (8) is the relevant condition only if $COV(x_{ht} - x_h^*, x_{ht}) > 0$. Since this holds in the data, it is the only case we examine.

$$\theta = \frac{COV(x_{ht} - x_h^*, c_{ht})}{COV(x_{ht} - x_h^*, x_{ht})} > \left(1 - \frac{G}{R\gamma}\right) \tag{8}$$

The right-hand-side of the inequality (8) is positive, because $\sigma_N > 0$ implies $\gamma > 1$, while the condition $G < R$ guarantees a finite present discounted value of income. According to the model, the left-hand-side θ (which from now on we term the covariance ratio) should therefore be positive.[4] Intuitively, people above target have a relatively high consumption to permanent income ratio (and vice versa).

2.1 Test interpretation

The proposed test has an instrumental-variable interpretation. Dropping the time subscripts, the sample analog of the left-hand-side of the inequality (8) is:

$$\widehat{\theta} = \frac{cov(x_h - x_h^*, c_h)}{cov(x_h - x_h^*, x_h)} = \frac{\sum_{h=1}^{H}((x_h - x_h^*) - \overline{(x_h - x_h^*)})(c_h - \overline{c_h})}{\sum_{h=1}^{H}((x_h - x_h^*) - \overline{(x_h - x_h^*)})(x_h - \overline{x_h})}$$

where $cov(.,.)$ is a sample covariance and a bar over a variable denotes its cross-sectional mean. The same expression can be obtained from the regression:

$$c_h = \eta + \theta x_h + u_h \tag{9}$$

using the wealth gap $(x_h - x_h^*)$ as an instrument. The advantage of the regression framework is that it naturally delivers standard errors which allow us to conduct statistical inference on the value of θ.

2.2 The simulated covariance ratio

The buffer-stock model suggests that θ should be (strictly) positive (see 8), but it does not tell us how large it should be to be consistent with the model's assumptions.

[4] The lower bound for the covariance ratio, $\left(1 - \frac{G}{R\gamma}\right)$, rises with income uncertainty σ_N and falls with the productivity growth factor G. Its numerical value depends on some of the model's assumptions. If one sets R to 1.04, G to 1.03, and σ_N to 0.1, as in Carroll (2004), the lower bound is 0.019.

To answer this question, we simulate the model for an economy populated by heterogeneous consumers. In the simulated model, there are two sources of heterogeneity. Each individual has a different discount factor, uniformly distributed between 0.86 and 0.96. This guarantees that each consumer has different target wealth. Secondly, although in the baseline scenario the income process is the same, in each period consumers are hit by different realizations of the shocks.

We set the other models' parameters following Carroll's (2004) baseline scenario. The growth factor $G = 1.03$, the interest rate factor $R = 1.04$, the coefficient of relative risk aversion $\rho = 2$, the standard deviation of permanent and transitory income shocks is 0.1, and the probability of unemployment is 0.005. Such parametrization guarantees a stationary cash-on-hand-to-permanent income ratio x^*, and that consumers exhibit buffer stock behavior.

We assume that consumers start with zero wealth, and simulate the model for 100 periods and 1,000 consumers. We then compute, for each consumer, target wealth as the ratio between cash-on-hand and permanent income such that $E_{ht}(x_{ht+1}) = x_{ht}$. In Figure 1 we plot the cross-sectional distribution of target wealth against the intertemporal discount rate β for the 1,000 buffer stock consumers of our simulations. The figure highlights the positive association of target wealth and the discount factor: x_h^* increases from about 1.2 for impatient individuals (low β) to 1.45 for more patient consumers (high β).

Based on the different values of x_h^* and different realizations of x_{ht} and c_{ht}, we compute in each of the 100 periods the cross-sectional covariance ratios, and summarize its distribution by the median value. For the baseline experiment we find a simulated $\theta = 0.62$.

It is important to check that the simulated θ does not depend heavily on the specific parametrization of the model. Therefore we simulate the covariance ratio under a wide range of alternative parameter assumptions. Each parametrization satisfy the conditions for buffer stock behavior. As discussed in Carroll (2004) this requires that the interest factor is larger than the growth factor and that consumers are sufficiently impatient.

Table 1 reports the simulated θ for different parameter values and sources of individual heterogeneity. Each parametrization is obtained from the baseline case by varying one parameter at the time, highlighting the effect on the simulated covariance ratio. Lowering the growth factor to 1.025 lowers the simulated covariance ratio slightly to 0.61, while raising it to 1.035 increases the ratio to 0.64. Raising the interest rate factor from 1.035 and to 1.045 does not change the covariance ratio appreciably, while raising the coefficient of risk aversion to 4 reduces the covariance ratio to 0.45. Changing the income process has a large impact on the ratio. For instance, lowering the standard deviation of permanent income shock to 0.04 raises the covariance ratio to 0.66, while raising the standard deviation to 0.14 produces a ratio of 0.52. Finally, the simulated θ increases to 0.70 when the probability of unemployment is lowered to 0.1 percent. In all cases, the simulated value of θ ranges between 0.45 and 0.7.

We also compute the simulated covariance ratio under different assumptions about the source of heterogeneity in the model. We consider cases in which the growth rates of income are uniformly distributed between 2.5 and 3.5 percent (obtaining $\theta = 0.63$), interest rates factors between 3.5 to 4.5 percent ($\theta = 0.62$), coefficient of relative risk aversion between 1.5 and 4 ($\theta = 0.51$), standard deviation of permanent and transitory income shocks between 4 and 14 percent ($\theta = 0.56$ and $\theta = 0.60$, respectively), and the probability of zero income between 0.1 and 1 percent ($\theta = 0.59$).

Finally, we compute the simulated covariance ratio choosing parameter values that are meant to fit some of the features of the Italian economy. In the past two decade the productivity growth rates of Italian workers in the age group (20-50) has been 1.5 percent, and the real interest rate 2.5 percent; accordingly, we set $G = 1.015$ and $R = 1.025$. Jappelli and Pistaferri (2006) estimate the income process (1)-(2) using the same data used in this paper and find standard deviations of permanent and transitory income shocks of 0.16 and 0.28, respectively. Even for such parameterization, we find a simulated θ equal to 0.46.

On the whole, the lesson we draw from these experiments is that in a realistically calibrated buffer stock model the covariance ratio is likely to be in the $0.5 - 0.6$ range, and unlikely to fall below 0.4 or to exceed 0.7. Any empirical estimate of θ that is statistically significantly away from this range would therefore be hard to reconcile with buffer stock behavior.

3 Data

To implement the empirical test of the buffer stock model, we use the 2002 and 2004 Italian Surveys of Household Income and Wealth (SHIW). SHIW is a biannual representative sample of the Italian population conducted by the Bank of Italy.[5] In each year, the sample includes about 8,000 households and 24,000 individuals. Details on questionnaire, sample design, response rates, results and comparison of survey data with macroeconomic data are given in Biancotti et al. (2004) and Faiella et al. (2006).[6]

For our purposes, the SHIW has several advantages. It has data on wealth, income, consumption, and detailed demographic characteristics of the household. Net financial assets measure the liquid portion of wealth, and are the sum of transaction accounts, government bonds, CDs, corporate bonds, retirement accounts, life insurance, and stocks, less household debt (mortgage loans, consumer credit and other personal loans). Total assets are the sum of net financial assets and real assets (real estate, unincorporated business holdings, valuables and art objects). The SHIW also includes a rotating panel component: in each year, about 45 percent of the households are also interviewed two years later. We will later use the panel section of the SHIW to recover individual-level variables available only in the 2000 survey and to assess

[5] In the buffer stock model, the marginal propensity to consume is high because consumers are impatient. Carroll (2001) interprets the excess sensitivity of consumption found by Campbell and Mankiw (1991) and Jappelli and Pagano (1989) in time series data for several OECD countries, and in Italy in particular, as dependent on the prevalence of impatient households. He argues that in these countries there are "more households who are impatient and consequently inhabit the portion of the consumption function where the MPC is high, whether they are formally constrained or not" (Carroll, 2001). Italy, therefore, provides a good testing ground for the buffer-stock model.

[6] The SHIW started in 1977, but data on consumption have been collected only since 1984.

the robustness of our results in the presence of fixed effects.

Most importantly for the present study, the 2002 and 2004 SHIW have a direct question on precautionary wealth, which we use to proxy target wealth in the buffer stock model: "People save in various ways (depositing money in a bank account, buying financial assets, property, or other assets) and for different reasons. A first reason is to prepare for a planned event, such as the purchase of a house, children's education, etc. Another reason is to protect against contingencies, such as uncertainty about future earnings or unexpected outlays (owing to health problems or other emergencies). About how much do you think you and your family need to have in savings to meet such unexpected events?" The question is patterned after a similar question in the Survey of Consumer Finances (SCF), described in Kennickell and Lusardi (2004).[7]

Table 2 reports sample means and quartiles of target wealth for various sample groups, pooling data for 2002 and 2004. The median value of target wealth is 25,000 euro, while the mean is 55,137. Interestingly, these values are considerably higher than in the U.S., where Kennickell and Lusardi (2004) report that the bulk of the distribution of target wealth is between \$5,000 and \$10,000. Target wealth is higher among high-school and college graduates, self-employed, households with multiple income recipients, and households living in the North. Between 2002 and 2004 median target wealth increases by 13 percent.

The median ratio of target wealth to total wealth is 0.31, and 3.32 if wealth includes only financial assets. These numbers are higher than in Kennickell and Lusardi (2004), who report 0.08 and 0.2 respectively. This shows that in Italy precautionary wealth potentially accounts for a larger portion of wealth, possibly due to higher income risk and/or lower degree of development of financial and insurance markets. The Italian data also indicate that in 75 percent of the cases financial wealth is below target, and in 28 percent of cases total wealth is below target. Comparable figures

[7] The SCF question is: "About how much do you think you and your family need to have in savings for unanticipated emergencies and other unexpected things that may come up?". As in the SCF, the question is asked in the wealth and saving section of the questionnaire. The question has been extensively tested in the SCF with focus groups.

for Kennickell and Lusardi (2004) are 48 and 17 percent, respectively.

In the empirical application we measure consumption as non durable expenditures.[8] We define cash-on-hand as $Y + W_f + \lambda W_r$, where Y is household disposable income, W_f and W_r are, respectively, net financial assets and real assets, and $0 \leq \lambda \leq 1$ measures the portion of real assets that can be used in the current period to finance consumption. We focus on a sample where buffer stock behavior is more likely to emerge, selecting households with heads aged between 20 and 50. The resulting sample consists of 5,911 observations (2,953 for 2002 and 2,958 for 2004).

In keeping with the model's notation, consumption, target wealth, cash-on-hand and the wealth gap are all normalized by an estimate of permanent income, that is, income during the working life purged from transitory components. The permanent component of income is estimated by the fitted value of a regression of household non-financial income on age, education, dummies for occupation, region of residence, head gender, number of earners, and a year dummy. The results are very similar if one estimates the permanent income using the full set of sample years between 1984 and 2004, with interaction terms allowing for the year effects to differ across education and occupation, and relying on total household income instead of household non financial-income.

We therefore opt for a simple and straightforward definition. In Section 4.5 we adopt a different strategy, relying on time-averages of income obtained using the panel component of the survey. The advantage is that this measure is potentially closer to the income stochastic process assumed in Section 2. The drawback is that the number of observations is considerably reduced. In practice, the results appear to be very similar.

Figure 2 plots the histogram of the ratio of target wealth to permanent income. The median ratio represents slightly more than one year of income, and the bulk of the distribution is between 2 months and six years. Table 3 reports sample statistics for various population groups. The ratio of target wealth to permanent income is higher

[8] Results are unchanged if one defines consumption as the sum of non durable and durable expenditures, see Section 4.5.

for single earners households and for households where the head has not completed high-school, but overall it is quite stable across different population groups.

4 Testing the buffer stock model

In this section we estimate the covariance ratio θ and compare it with the simulated values from Section 2.2, showing that realistic values of the parameters of the buffer stock model provide a range of θ between 0.4 and 0.7. Furthermore, we test whether θ is higher among households that can be expected to exhibit stronger buffer stock behavior. We focus on households facing high income risk (such as the self-employed) and impatient consumers (using a direct survey question on the rate of time preference). Finally, we check robustness of our results to measurement error, different definitions of income and consumption, and unobserved heterogeneity.

4.1 Baseline estimates

The first row of Table 4 displays baseline estimates for the whole sample on the pooled 2002-2004 sample.[9] They are obtained regressing consumption on cash-on-hand, using the wealth gap as an instrument. In the first column, we set $\lambda = 1$ and cash-on-hand is just $Y + W_f + W_r$, on the assumption that households can use all assets to buffer income shocks. The point estimate of θ is 0.011, much lower than the values consistent with buffer stock behavior. Since the estimate has a small standard error, we formally reject the hypothesis that θ equals any one of the simulated values of Section 2.1. In the other columns we use different definitions of wealth, obtained setting $\lambda = \{0.75, 0.50, 0.25\}$, because transaction costs, illiquidity, and indivisibilities may allow consumers to use only a portion of their real assets as a buffer. We find that $\widehat{\theta}$ ranges from 0.012 to 0.015, always much below the range of admissible values for the simulated covariance ratio, and therefore failing to support the model.

[9] We obtain practically identical results in the two separate years 2002 and 2004.

4.2 Group estimates

Even if our baseline results do not support it, the buffer-stock model might still characterize the behavior of some population groups that face high income volatility or are more impatient. We are particularly interested in testing the buffer-stock behavior for groups that, a priori or based on previous evidence, are more likely to exhibit such behavior. The self-employed clearly face greater income risk than employees. If the incomes of households with multiple earners are not perfectly correlated, single income households face more risk than households where both spouses work. The young might face more income uncertainty, or be more impatient than the middle-aged because they don't yet perceive the need to accumulate for old age. In Italian regions with better functioning credit and insurance markets (the North and the Centre), employment shocks and other risks are more likely to be insured. And in the case of education, we have hard evidence with the same dataset that the two groups face different income risks.

To check if buffer stock behavior characterizes some population groups, in Table 4 we present estimates of θ distinguishing between relatively younger and older households (age less or greater 40), single and multiple earners, employees and self-employed, and region of residence. In the first column $\widehat{\theta}$ never exceeds 0.015, confirming the full sample estimates for each of the group considered. Interestingly, the pattern of coefficients is at variance with priori hypotheses on buffer stock behavior. The estimated coefficient is lower among the young, the self-employed and single earners, and in each case the coefficients are precisely estimated and we can therefore reject the hypothesis that they are equal in the two groups. The estimates for different definitions of cash-on-hand do not change the pattern of results.

Recent work on the extent of precautionary motive for saving has focussed on business owners. Business owners and entrepreneurs face higher income risk, but their wealth holdings are also higher than average. Hurst et al. (2005) provide evidence that tests of precautionary saving are considerably affected by the treatment of entrepreneurs. In the total sample, they find a strong, positive relation between wealth and permanent income shocks, as in Carroll and Samwick (1987). But the result is almost entirely due to business owners: when these are excluded from the sample, there is hardly evidence for precautionary saving. Table 4 reports $\widehat{\theta}$ distinguishing by entrepreneurship, defined as positive business wealth. The results are again at variance with the buffer stock model for both groups, as $\widehat{\theta}$ is uniformly lower than the threshold value for business owners and non-owners. However, in this case the relative size of the coefficients agrees with expectations, as $\widehat{\theta}$ is generally higher for business wealth owners (except when $\lambda = 1$).

Comparison of different population groups with different income generating process is potentially interesting, because in this case we can rely on our previous work using Italian microeconomic data to estimate the same income process postulated in the buffer stock model and specified in Section 2. Jappelli and Pistaferri (2006) estimate that the standard deviation of permanent income shocks is 0.17 for the less well educated, and 0.14 for those with at least a high school degree. Setting the interest rate factor at 1.025, the growth factor at 1.015 one obtains a simulated $\theta = 0.45$ for the less well educated and $\theta = 0.52$ for households with higher education.[10] The last two sets of results in Table 4 report the estimated θ for different education groups. As in the simulations, we find a lower value of $\widehat{\theta}$ in the group with lower education, but the point estimates are far away from the simulated values, which range from 0.9 to .3 percent. Different definitions of cash-on-hand do not change appreciably the pattern of results.

4.3 Impatience

The rate of time preference is a critical parameter of models of intertemporal choice, but microeconomic data seldom allow to pin down particular features of this and other preference parameters. The 2000 SHIW attempts at providing data on time preference through a lottery question. Frederick, Loewenstein, and O'Donoghue (2002) survey theoretical and empirical research on time preferences, and classify the vari-

[10] Carroll and Samwick (1997) using U.S. data also find that the less well educated face higher standard deviation of permanent income shocks.

ous methods by elicitation methodology (choice, matching, rating or pricing), type of instrument used to elicit preferences (field versus experiment), and time frame (less than one day to many years). They report that a widely used way to elicit the rate of time preference is through survey questions asking the respondent to report how much he or she is willing the pay to receive a lottery winnings today instead of later in time. The 2000 SHIW has precisely such question: "Suppose that you win 5,000 euro, payable for certain in a year's time. What is the *maximum amount* that you are willing to pay to have the 5,000 euro immediately?".

The question is asked only to half of the sample (household heads born in odd-numbered years), and about 15 percent don't answer it. The 2000 data can be merged with 2002 and 2004 data using the panel component of SHIW (1,749 households are interviewed in 2000, 2002 and 2004). After merging the data, and considering that we select individuals less than 50 years old in 2002, we are left with 498 valid observations with data on both target wealth and time preference. On average, to cash the lottery one year in advance, respondents are willing to pay 150 euro, implying a quite standard rate of time preference of 3 percent a year. Several studies use questions similar to this, as documented in Frederick, Loewenstein, and O'Donoghue (2002), who also reviews pros and cons of various methods for eliciting time preference.[11]

We therefore split the sample according to whether the rate of time preference is above or below 3 percent. Table 5 reports the estimated θ in the two sub-samples. It is important to keep in mind that the sample in this case is highly selected, and that we have relatively few observations. Buffer stock behavior is rejected in both groups, as $\widehat{\theta}$ ranges between 1.3 and 1.9 percent. Interestingly, the $\widehat{\theta}$ for the high impatience group is higher for all measures of cash-on-hand (except $\lambda = 0.25$).

[11] Frederick, Loewenstein, and O'Donoghue (2002) emphasize that measurement of time preference can be affected by confounding factors, such as uncertainty, intertemporal arbitrage and consumption smoothing.

4.4 Panel estimates

In Section 2.1 we stress that the covariance ratio θ can be obtained by the cross-sectional regression $c_h = \eta + \theta x_h + u_h$. Any valid estimation of such equation requires instruments that are correlated with x but uncorrelated with c, except through their effect on x. Indeed, our framework posits that the wealth gap $(x_h - x_h^*)$ provides such instrument. In the buffer stock model, the only reasons why the wealth gap might differ across consumers are the history of household-specific shocks, and the parameters determining target wealth (risk aversion, rate of time preference relative to the interest rate, growth rate of income, and standard deviation of permanent income shocks).

In practice, however, one cannot rule out that there is some systematic relationship between the error term in consumption and what people report about their target wealth. As an example, suppose that some households are patient and have larger target wealth than others, and that it takes them longer to reach their target wealth than impatient consumers. Then during the transition period following an income shock one would observe that households with large negative values of the wealth gap (the patient ones) consume less. More generally, any omitted variable might lead to biased estimates of θ.

To address the potential source of bias arising from unobserved heterogeneity, we can rely on the panel section of the SHIW. A total of 4,408 households were interviewed in both the 2002 and 2004 surveys, providing data on all the relevant variables in two time periods. Excluding households where the head is older than 50 years, results in a two-year panel of 1,087 households for a total of 2,174 observations.

Table 6 reports first difference IV estimates of equation 9. In the total sample the estimated $\widehat{\theta}$ is 0.007 - even lower than in the cross-sectional estimates - and precisely estimated. The other cells of the table report $\widehat{\theta}$ for the same groups as in Table 4. Overall, the panel results are even less favorable to the buffer-stock model, suggesting that if any bias exists it cannot explain rejection of the model obtained in the absence of unobserved heterogeneity correlated with the instrument.

4.5 Measurement error

In our baseline estimates of Table 4 we estimate a covariance ratio of 0.012, to be contrasted with a simulated value of 0.62. Can measurement error account for such a large difference between the theoretical benchmark and empirical estimates? To explore the robustness of our findings in the presence of measurement error, suppose that consumption, cash-on-hand and target wealth are all measured with error:

$$\begin{aligned}
\widetilde{c}_h &= c_h + \varepsilon_h^c \\
\widetilde{x}_h &= x_h + \varepsilon_h^x \\
\widetilde{x}_h^* &= x_h^* + \varepsilon_h^{x^*}
\end{aligned}$$

where tilded variables are observed, untilded are true, unobserved values, and ε_h^k is a measurement error in variable k having mean zero. Under the assumptions that the errors are uncorrelated with each other and with true consumption, cash-on-hand and target wealth, one can show that the probability limit of our IV estimator of θ is:

$$\theta(\nu, \xi) = p \lim \widehat{\theta} = \theta \left(\frac{1 - \nu - \xi}{1 - \xi} \right) < \theta$$

where ν is the percent variation in measured cash-on-hand explained by measurement error, and $\xi = \frac{\sigma_{\widetilde{x}\widetilde{x}^*}}{\sigma_{\widetilde{x}}^2}$. The expression shows that in the presence of measurement error our estimator can be indeed downward biased. Thus, one could reject the buffer stock model even when the model is true, at least in principle.

To establish how large should measurement error be in order to reconcile our results with the buffer stock model, we plot the probability limit of $\widehat{\theta}$ as a function of ν and compare it with $\widehat{\theta}$. As long as the probability limit of $\widehat{\theta}$ is larger than estimated $\widehat{\theta}$, measurement error cannot account for the model rejection. To compute the probability limit of $\widehat{\theta}$ we set θ to its baseline simulated value (0.62), and note that

ξ can be computed as the slope coefficient in the OLS regression of target wealth on cash-on-hand, which we find to be 0.0349.

In Figure 3 we plot the estimated covariance ratio (the horizontal line $\widehat{\theta} = 0.012$) and the probability limit of $\widehat{\theta}$ against measurement error ν. The figure shows that only for very large values of ν the probability limit of $\widehat{\theta}$ falls below $\widehat{\theta}$: that is, measurement error leads to false rejection of the buffer stock model only if $\nu > 0.95$. In other words, only extremely large measurement error in wealth can possibly make $\widehat{\theta} = 0.012$ consistent with buffer stock behavior. Since the reliability index of income and wealth in the SHIW exceeds 80 percent (Biancotti et al. 2004), it is extremely unlikely that measurement error invalidates our test, regardless of the definitions of wealth and sample split.[12]

4.6 Further sensitivity checks

Our measure of permanent income, which we use to normalize cash-on-hand, consumption, and target wealth, is obtained through cross-sectional regressions, and may not be purged from transitory components. In Table 7 we report the estimated covariance ratio using an alternative measure, obtained averaging household disposable income (net of financial income) over time. Averaging should remove income components that are purely transitory and mean-reverting. This measure can only be computed for the panel section of the SHIW. Accordingly, we report estimates using the panel section of the last three surveys (2000, 2002 and 2004). The results are similar to the baseline estimates, although θ is less precisely estimated due to the reduced number of observations.

All our tests have been conducted defining consumption as non-durable expenditure. SHIW has also data on expenditures on durable goods, and therefore we can use total expenditure as an alternative measure of consumption. The results are, however, very similar. We perform two final sensitivity checks, excluding financial income

[12] Biancotti, D'Alessio and Neri (2004) give extensive account of the quality of the main variables in SHIW. Exploiting the panel section of the survey, they compute the reliability index for a broad range of variables. The index is the fraction of total variability of the measured characteristic accounted by its true variability.

from the definition of income and excluding financial income or housing wealth from total wealth. As shown in the last two rows of Table 7, the results barely change.

5 The wealth-income ratio of young households

The version of the buffer stock model that we analyze is one with impatient consumers, uncertainty about future earnings, and no borrowing constraints. If such consumers are sufficiently prudent and expect their earnings to grow over time, they will never borrow and keep their consumption within their current incomes, thus inducing "tracking" between consumption and income. In other versions of the buffer stock model, impatient consumers would like to borrow but are prevented to do so because of credit market imperfections, as in Deaton (1991). The implications for the behavior of consumption and wealth are similar, however, and "consumption is smoothed, not over the whole life-cycle, but over much shorter periods of a few years at a time" (Deaton, 2005). In the literature, this is often referred to as "high-frequency" smoothing of income, as opposed to the "low-frequency" or "life-cycle frequency" smoothing that was postulated by Modigliani and Brumberg.

Tracking of income and consumption and buffer stock behavior stand in sharp contrast with one of the most important implications of the Life-Cycle Hypothesis, according to which young people save for post-retirement expenditures, and accumulate wealth up to retirement. In the certainty version the model, the wealth-income ratio increases during the working span, target wealth-income ratio is reached at retirement age, and the consumption and income profiles are completely detached. If income is expected to increase over the working life, consumers borrow early in life, and start accumulating wealth only when debt is repaid, which might be even after several years of work, depending on preferences and the growth rate of individual incomes (Hubbard and Judd, 1986).

In a more sophisticated version of the life-cycle model with income risk and life uncertainty, Hubbard, Skinner and Zeldes (1995) show that sufficiently patient consumers save even earlier in life. In these life-cycle models with income risk, uncertainty generates a demand for precautionary saving during the working span. But, as noted by Modigliani (1986), accumulated assets can serve the double purpose of providing resources for retirement and as a buffer against unexpected emergencies.

Gourinchas and Parker (2002) results fall in between these two polar cases. They estimate that the behavior of young consumers exhibits buffer stock behavior, at least in the U.S. These consumers would like to borrow but cannot, or are too prudent to borrow. One way or another, their consumption tracks income closely and the wealth-income ratio is approximately constant. Once consumers reach middle-age, however, they follow the standard life-cycle model and the wealth-income ratio increases until retirement. Carroll's (1997) simulations of age profile of the wealth-income ratio is indeed consistent with these findings. Similar tracking of income and consumption arises in models with hyperbolic discounting, see Laibson, Repetto and Tobacman (1998).[13] The age profile of the wealth-income ratio of young and middle-aged consumers provides therefore a useful avenue to distinguish different classes of models of intertemporal choice.

In the previous section we establish that Italian wealth data are at variance with the buffer stock model. Even though we select a sample where buffer stock behavior is most likely to arise (individuals aged 20 to 50, or individuals with relatively high rates of time preference), we do not find evidence that deviations of wealth from target are offset by changes in consumption. What then explains the saving decisions of young households? Here we attempt to discriminate between different saving models providing evidence on the saving behavior of young consumers and estimating their age-wealth profiles.

A single cross-section is not suitable to the purpose of estimating age-profiles, since in a given year age is perfectly collinear with year of birth (Shorrocks, 1975). The individuals interviewed in any cross-section belong to generations that differ in productivity, mortality, preferences, and economic environment. For instance,

[13]The composition of wealth, however, differs between models with exponential and hyperbolic discounting, because hyperbolic consumers hold a smaller share of assets in liquid form, see Angeletos et al. (2001).

someone who entered the labor force in the sixties experienced different productivity growth and might even have different preferences than an individual born in the eighties and just now entering the labor force. Thus, a finding that the wealth-income ratio changes with age in a cross-section may tell very little about households' behavior.

With panel data or repeated cross-sectional data one, can recover age effects under suitable identification assumptions. Panel data allow the econometrician to track individual wealth trajectories over time. When long panels with wealth data are not available, repeated cross-sectional data can partly overcome their absence. Although the same individual is only observed once, a sample from the same cohort is observed in a later survey, so that one can track the wealth not of the same individual, but of a representative sample of individuals of the same cohort.

We use income and wealth data from seven SHIW surveys (1989, 1991, 1993, 1995, 1998, 2000 and 2002), a total of almost 60,000 households.[14] Income is defined as household disposable income, net of financial income. To account for the fact that some of the wealth is illiquid and cannot be used for precautionary purposes, we use two definitions of wealth, total assets and net financial assets.

We use the repeated cross-sections to sort the data by the year of birth of the head of the household. The first cohort includes all households whose head was born in 1939 (50 years old in 1989, the first year of the sample). The second includes those born in 1940, and so on up to the last cohort, which includes those born in 1980 (22 years old in 2002, the last year). As with other survey data, the wealth distribution is skewed. We report only results for the average wealth-income ratio; results for the median ratio are similar and are not reported for brevity.

The left graphs in Figure 4 offers important insights into the process of wealth accumulation of young Italian households. To make the graphs more readable, we plot only the wealth-income ratio and the financial wealth-income ratio of four selected

[14]In the SHIW households are defined to include all persons residing in the same dwelling who are related by blood, marriage or adoption. Individuals selected as "partners or other common-law relationships" are also treated as families.

cohorts. The numbers in the graph refer to the year of birth, extending from 50 (individuals born in 1950) to 65 (individuals born in 1965). Except for the youngest and the oldest generations, each cohort is observed at seven different points in times, one for each cross-section. As said, the cross-sections run from 1989 to 2002. Thus, each generation is observed for 13 years with each line being broken (for instance, cohort 60 is sampled 7 times from age 29 in 1989 to age 42 in 2002). Both ratios are potentially affected by age, cohort and time effects.[15]

To estimate the age profile of the wealth-income ratio, one can proceed as Deaton and Paxson (1994), regressing the wealth-income ratio on age dummies, cohort dummies, and restricted year dummies, summing to zero and orthogonal to a time trend. An alternative identification assumption is to express the ratio as a function of age dummies and unrestricted time dummies (eliminating cohorts effects). This alternative decomposition delivers, qualitative similar results, e.g., an increasing wealth-income ratio. Both normalizations rule out time-age or time-cohort interaction terms

The wealth-income equation is estimated on 203 age/year/cohort cells. Given the structure of our sample, the regressors include 28 age dummies (from age 22 to age 50), 41 cohort dummies (from 1939 to 1980), a set of restricted time dummies, and a constant term. Under the assumptions described above, the estimated age dummies can be interpreted as an individual age-wealth profile, purged from cohort effects.

The right-hand-side of Figure 4 plots the estimated age dummies, separately for the total wealth and financial wealth-income ratios. Both ratios increase with age. Between age 20 and 50 there is a six-fold increase in the wealth-income ratio (from 1 to 6), and a three-fold increase in the financial wealth-income ratio (from 0.4 to 1.2).

Since wealth accumulation may depend also on other characteristics (household size and composition, rules governing retirement, education, gender, region of residence) we estimate an extended specification on the repeated cross-sectional data. We also exclude households with heads less than 30 years old, to account for the fact

[15] Two macroeconomic episodes characterize our sample period. The economy went into a recession in 1991-93. Afterwards the economy began a mild recovery, with the growth rate picking up in 2000, and falling in 2002.

that young working adults with independent living arrangements tend to be wealthier than average, affecting the age-wealth profile. In both cases the qualitative results of increasing age-wealth profile in Figure 4 is unchanged. Overall, the evidence suggests that models in which consumption and income of young households track each other closely are not an adequate description of the behavior of Italian households. Rather, consumers start saving early in life, and accumulate assets at the rate of around 15 percent of their income, or euro 5,000 euro per year.

6 Conclusions

Intertemporal models with liquidity constraints, income risk, and impatience emphasize that consumers use savings to buffer income fluctuations. These models deliver a stationary distribution of the ratio of target wealth to permanent income. When actual wealth, relative to income, is below the optimal target, consumers try to increase their saving. When wealth is above target, they increase consumption. This important implication of the buffer stock model has not been subject to direct empirical testing.

We derive from the model an appropriate theoretical restriction and test it using data drawn from the 2002 and 2004 Italian Surveys of Household Income and Wealth. One of the most appealing features of these surveys is that people report the amount of wealth held for precautionary purposes, which we interpret as target wealth in the buffer stock model. The test results do not support buffer stock behavior, even among population groups that are more likely, a priori, to display such behavior (the young and the self-employed). Unobserved heterogeneity and measurement error in target wealth or consumption are unlikely to explain the model's failure.

Our test rejects the buffer stock model, but cannot be interpreted as suggesting that alternative consumption theories are valid. In the final part of the paper we therefore use estimates of the age-wealth profile obtained with Italian repeated cross-sectional data to provide further evidence on the validity of the buffer-stock model. Indeed, the model predicts that the consumption tracks income closely and the wealth-income ratio is approximately constant, at least for young consumers. Instead, we find that the wealth-income ratio (both real and financial) of young Italian households increases substantially with age, providing further indirect evidence against buffer stock behavior. Overall, the saving behavior of young households is consistent with models in which impatience, relative to prudence, is not as high as in buffer stock models.

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Table 1
The Simulated Covariance Ratio

Growth factor	Covariance ratio θ	Interest rate factor	Covariance ratio θ
$G = 1.025$	0.605	$R = 1.035$	0.632
$G = 1.035$	0.641	$R = 1.045$	0.616
$G = [1.025, 1.035]$	0.629	$R = [1.035, 1.045]$	0.617
Probability of zero income		Relative risk aversion	
$p = 0.001$	0.704	$\rho = 1.5$	0.669
$p = 0.01$	0.572	$\rho = 4$	0.452
$p = [0.001,0.01]$	0.594	$\rho = [1.5, 4]$	0.513
S.d. of permanent shocks		S.d. of transitory shocks	
$\sigma_N = 0.04$	0.663	$\sigma_V = 0.04$	0.691
$\sigma_N = 0.14$	0.524	$\sigma_V = 0.14$	0.586
$\sigma_N = [0.04,0.14]$	0.561	$\sigma_V = [0.04,0.14]$	0.596

Note. The table reports the median simulated covariance ratio under alternative parameterization of a buffer stock economy populated by 1,000 individuals. In the baseline experiment $G = 1.03$, $R = 1.04$, $\rho = 2$, $\sigma_N = 0.1$, $\sigma_V = 0.1$, and $p = 0.005$ and β ranges from 0.86 to 0.96. The median simulated ratio in the baseline case is $\theta = 0.623$.

Table 2
Selected Statistics for Target Wealth

	Mean	*First quartile*	*Median*	*Third quartile*	*Number of observations*
Age<40	53,421	10,000	25,000	50,000	2,860
Age≥40	57,022	10,000	28,285.92	52,000	3,051
Self-employed	69,350	15,000	47,143	94,286	1,078
Employee	51,967	10,000	25,000	50,000	4,833
Single earner	49,864	9,429	23,572	50,000	2,683
Multiple earners	60,302	10,000	28,286	60,000	3,228
North-Center	61,316	11,314	28,286	66,000	3,977
South	40,857	50,000	18,857	47,143	1,934
Entrepreneurs	69,399	14,143	40,000	94,286	1,209
Non-entrepreneurs	51,651	9,429	25,000	50,000	4,702
Low education	48,232	9,429	25,000	50,000	2,665
High education	61,447	10,000	28,286	60,000	3,246
Total sample	55,137	10,000	25,000	50,000	5,911

Note. The table reports sample statistics of self-reported target wealth computed using the pooled 2002 and 2004 SHIW. Sample statistics are estimated using population weights.

Table 3
Selected Statistics for the Ratio of Target Wealth to Permanent Income

	Mean	*First quartile*	*Median*	*Third quartile*	*Number of observations*
Age<40	2.485	0.412	1.143	2.626	2,860
Age≥40	2.384	0.446	1.178	2.626	3,051
Self-employed	2.368	0.496	1.324	2.614	1,078
Employee	2.452	0.419	1.127	2.664	4,833
Single earner	2.869	0.496	1.324	2.946	2,683
Multiple earners	2.014	0.395	1.019	2.161	3,228
North-Center	2.417	0.487	1.219	2.682	3,977
South	2.484	0.322	1.011	2.582	1,934
Entrepreneurs	2.432	0.499	1.307	2.710	1,209
Non-entrepreneurs	2.438	0.417	1.132	2.579	4,702
Low education	2.509	0.452	1.200	2.778	2,665
High education	2.374	0.417	1.110	2.483	3,246
Total sample	2.437	0.430	1.164	2.626	5,911

Note. The table reports sample statistics for the ratio of target wealth to permanent income using the pooled 2002 and 2004 SHIW. Permanent income is estimated by the fitted value of a regression of household non-financial income on age, education, dummies for occupation, region of residence, head gender and number of earners in the household and year dummies. Sample statistics are estimated using population weights.

Table 4
Testing Buffer-Stock Behavior: Baseline Regression and Group Estimates

	$Y + W_r + W_f$	$Y + 0.75W_r + W_f$	$Y + 0.5W_r + W_f$	$Y + 0.25W_r + W_f$	*Number of observations*
Total sample	0.012	0.015	0.017	0.015	5,911
	(0.000)	(0.001)	(0.001)	(0.001)	
Age<40	0.012	0.014	0.016	0.010	2,860
	(0.001)	(0.001)	(0.001)	(0.003)	
Age≥40	0.012	0.015	0.018	0.017	3,051
	(0.001)	(0.001)	(0.001)	(0.002)	
Self-employed	0.008	0.010	0.013	0.015	1,078
	(0.001)	(0.001)	(0.001)	(0.002)	
Employee	0.017	0.020	0.022	0.017	4,833
	(0.001)	(0.001)	(0.001)	(0.002)	
Single earner	0.013	0.015	0.017	0.014	2,683
	(0.001)	(0.001)	(0.001)	(0.002)	
Multiple earners	0.012	0.015	0.020	0.023	3,228
	(0.001)	(0.001)	(0.001)	(0.002)	
North-Center	0.013	0.016	0.020	0.023	3,977
	(0.000)	(0.001)	(0.001)	(0.002)	
South	0.011	0.012	0.013	0.008	1,934
	(0.001)	(0.001)	(0.002)	(0.002)	
Entrepreneurs	0.009	0.011	0.014	0.015	1,209
	(0.001)	(0.001)	(0.001)	(0.002)	
Non-entrepreneurs	0.016	0.019	0.021	0.016	4,702
	(0.001)	(0.001)	(0.001)	(0.002)	
Low education	0.009	0.011	0.013	0.009	2,665
	(0.001)	(0.001)	(0.002)	(0.003)	
High education	0.014	0.017	0.020	0.018	3,246
	(0.001)	(0.001)	(0.001)	(0.001)	

Note. The sample is based on the pooled 2002 and 2004 SHIW. W_r and W_f are, respectively, real and financial wealth, and Y is disposable income. Standard errors are reported in parentheses.

Table 5
Sample Splits by Rate of Time Preference

	$Y + W_r + W_f$	$Y + 0.75W_r + W_f$	$Y + 0.5W_r + W_f$	$Y + 0.25W_r + W_f$	*Number of observations*
High impatience	0.011	0.014	0.020	0.025	188
	(0.001)	(0.002)	(0.003)	(0.006)	
Low impatience	0.012	0.014	0.017	0.011	609
	(0.001)	(0.002)	(0.003)	(0.006)	

Note. The sample slits are based on a question in the 2000 SHIW asking the respondent to report how much he or she is willing the pay to receive a lottery winnings today instead of later in time. "High" and "Low impatience" refer to values of the reported rate of time preference greater or lower than 3%. Observations for 2000 are then merged with data from 2002 and 2004, and estimation is performed on the resulting pooled data. W_r and W_f are, respectively, real and financial wealth, and Y is disposable income. Standard errors are reported in parentheses. Standard errors are reported in parentheses.

Table 6
Panel Estimates

	$Y + W_r + W_f$	$Y + 0.75W_r + W_f$	$Y + 0.5W_r + W_f$	$Y + 0.25W_r + W_f$	*Number of observations*
Total sample	0.007	0.008	0.008	0.006	2,174
	(0.001)	(0.002)	(0.002)	(0.003)	
Age<40	0.009	0.012	0.016	0.019	978
	(0.002)	(0.004)	(0.006)	(0.010)	
Age≥40	0.005	0.005	0.004	0.001	1,196
	(0.002)	(0.002)	(0.003)	(0.003)	
Self-employed	0.006	0.008	0.009	0.008	410
	(0.002)	(0.003)	(0.004)	(0.005)	
Employee	0.005	0.005	0.005	0.004	1,764
	(0.002)	(0.002)	(0.003)	(0.003)	
Single earner	0.001	0.001	0.002	0.002	897
	(0.003)	(0.003)	(0.004)	(0.004)	
Multiple earners	0.011	0.014	0.017	0.016	1,277
	(0.001)	(0.002)	(0.003)	(0.004)	
North-Center	0.007	0.008	0.007	-0.001	1,478
	(0.002)	(0.002)	(0.003)	(0.005)	
South	0.008	0.009	0.009	0.008	696
	(0.002)	(0.003)	(0.003)	(0.004)	
Entrepreneurs	0.007	0.008	0.006	-0.001	468
	(0.002)	(0.003)	(0.004)	(0.005)	
Non-entrepreneurs	0.004	0.004	0.004	0.003	1,706
	(0.002)	(0.002)	(0.003)	(0.003)	

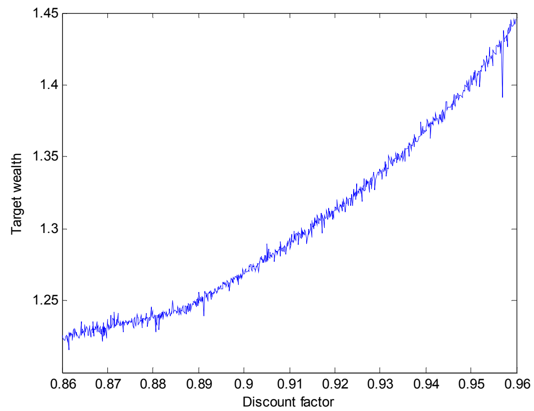
Note. The table first differences IV estimates of the covariance ratio. The sample is the panel section of the 2002 and 2004 SHIW. W_r and W_f are, respectively, real and financial wealth, and Y is disposable income. Standard errors are reported in parentheses.

Table 7
Further Sensitivity Checks

	$Y + W_r + W_f$	$Y + 0.75W_r + W_f$	$Y + 0.5W_r + W_f$	$Y + 0.25W_r + W_f$	*Number of observations*
Permanent income estimated as 2000-2004 average	-0.001 (0.001)	-0.003 (0.001)	-0.004 (0.001)	-0.006 (0.002)	1,601
Consumption includes durables	0.014 (0.001)	0.016 (0.001)	0.019 (0.001)	0.017 (0.002)	5,911
Cash-on-hand excludes financial income	0.012 (0.000)	0.015 (0.001)	0.017 (0.001)	0.015 (0.001)	5,911
Cash-on-hand excludes housing wealth	0.003 (0.001)	0.002 (0.001)	-0.000 (0.002)	-0.005 (0.002)	5,911

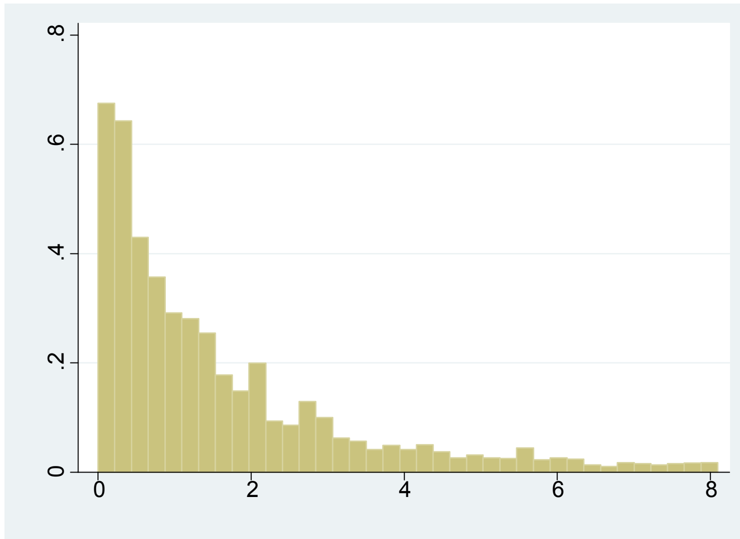
Note. W_r and W_f are, respectively, real and financial wealth, and Y is disposable income. Standard errors are reported in parentheses.

Figure 1: The simulated cross-sectional distribution of target wealth



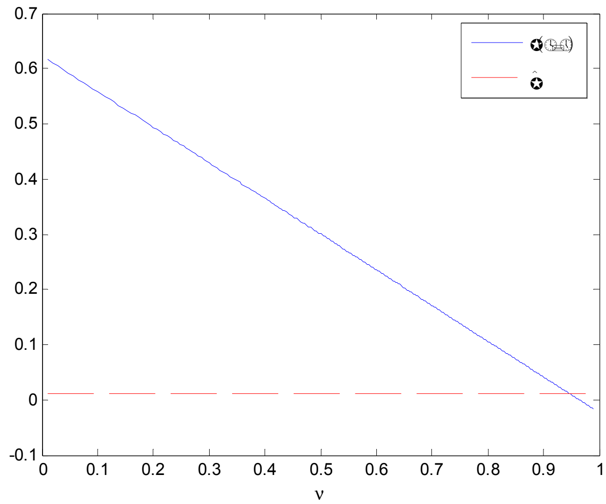
Note. The figure plots the cross-sectional distribution of the ratio of target wealth to permanent income (x^*) as a function of the discount factor β for 1,000 consumers. The target wealth ratios are obtained simulating the buffer stock model using the baseline parameters $G = 1.03$, $R = 1.04$, $\rho = 2$, $\sigma_N = 0.1$, $\sigma_V = 0.1$, $p = 0.005$ and assuming that β is uniformly distributed between 0.86 and 0.96.

Figure 2: The Ratio of Target Wealth to Permanent Income



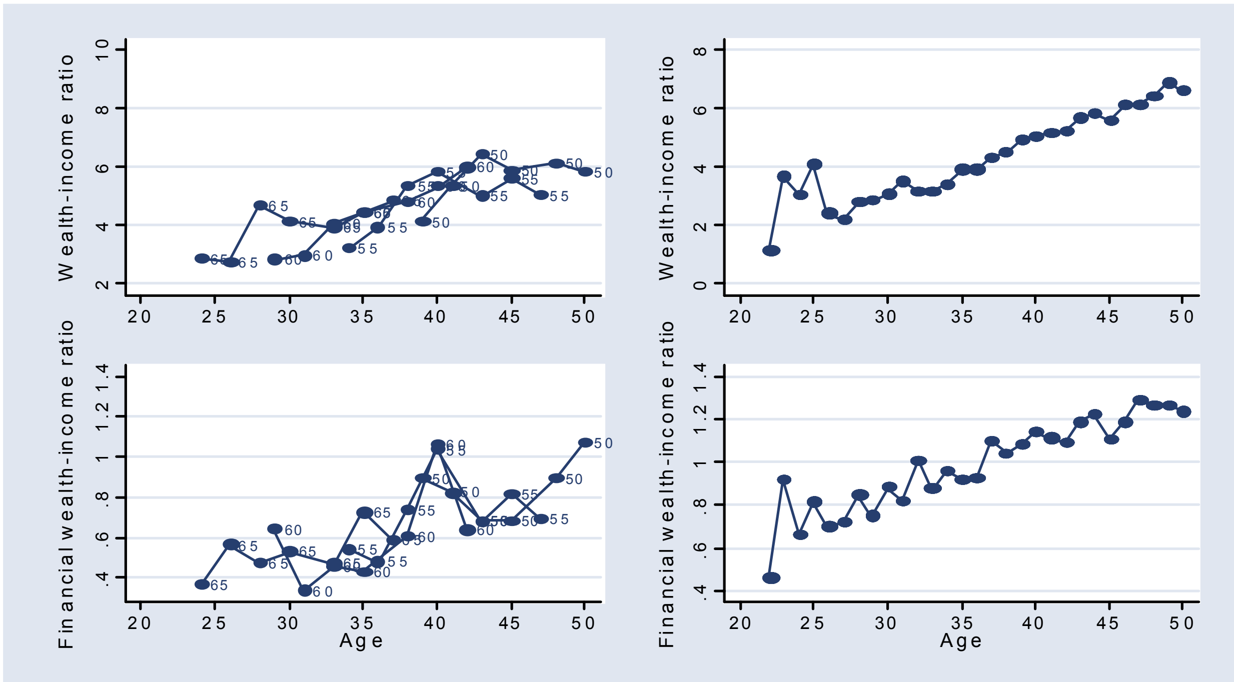
Note. The figure plots the sample distribution of the target wealth to permanent income using the pooled 2002 and 2004 SHIW. Permanent income is estimated by the fitted value of a regression of household non-financial income on age, education, dummies for occupation, region of residence, head gender, number of earners, and a year dummy.

Figure 3: The covariance ratio with measurement error



Note. The dotted line is the estimated covariance ratio ($\widehat{\theta} = 0.012$) obtained from the first regression in Table 4 with cash-on-hand defined as $Y + W_r + W_f$. The continuous line is the probability limit of $\widehat{\theta}$ as function of ν, the percent variation in measured cash-on-hand explained by measurement error. To compute the probability limit, we set θ equal to the baseline simulated value 0.623 and ξ equal to 0.0349.

Figure 4: The Age Profile of the Wealth-Income Ratio.



Note. The upper two graphs report the wealth-income ratio and the financial-wealth income ratio of selected cohorts using fourteen years of SHIW (1989-2002). The two graphs on the right report the age profiles of the two variables estimated with the repeated cross-sectional data. The age profiles are obtained by regressions of the wealth-income ratio on age dummies, cohort dummies, and restricted year dummies, summing to zero and orthogonal to a time trend.