# Permanent Income Shocks, Target Wealth, and the Wealth Gap

**Tullio Jappelli * and Luigi Pistaferri ****

**January 2023**

## Abstract

We test the key implication of the buffer stock model, namely that *any revision in permanent income leads to a proportionate revision in target wealth*. We use panel data on the amount of wealth held for precautionary purposes available in the 2002-2016 SHIW. Using the covariance restrictions that the model imposes on the joint behaviour of income and target wealth, we find that households indeed revise approximately one-for-one their target wealth in response to permanent income shocks. We consider variants of the baseline model and explore heterogeneity of responses across age, education, occupation and financial wealth distributions. We also find that people do change the pace of asset accumulation, closing the gap between actual and target wealth. Simulations of a standard buffer-stock model suggest that the adjustment rate observed in the data is in the ballpark of what a buffer-stock model would predict for realistic parameter values.

JEL Classifications: D12, D14, E21

Keywords: Buffer Stock Model; Target Wealth; Wealth Gap; Permanent Income Shocks; Panel Data

Jappelli acknowledges financial support from the Italian Ministry of University and Research (2017 PRIN Grant). We thank three anonymous referees, excellent research assistance from Calvin Yue He and Max Rong, and seminar participants at Essex, Venice, Padua and Naples for useful comments.

* University of Naples Federico II, CSEF and CEPR. Email: tullio.jappelli@unina.it.
** Stanford University, SIEPR, NBER and CEPR. E-mail: pista@stanford.edu.

## 1. Introduction

In the past three decades the buffer stock model has become one of the leading models for explaining saving behavior, and a vast body of evidence has confirmed many of its theoretical tenets. Several papers - using reduced form approaches, structural estimation, quasi-experimental evidence, and direct survey evidence - provide empirical tests of the model and show that building precautionary assets represent a significant determinant of household wealth accumulation decisions. Other papers focus on the model's implication of a concave consumption function, leading to the prediction that the marginal propensity to consume is decreasing in the level of cash-on-hand. Still others have extended the model to consider liquid and illiquid assets.[1]

One of the key theoretical implications of the buffer stock model is that consumers' decisions balance two opposite forces. The first is prudence, which leads consumers to save for precautionary reasons; the second is impatience, which instead leads consumers to defer savings. As a result of these opposite forces, consumers choose to maintain a "target" level of wealth that is proportional to permanent income. This implies that, other things being equal, *any revision in permanent income (due to job promotions or demotions, health shocks, etc.) leads to a proportionate revision in target wealth*. The intuition is simple: to insure a higher level of consumption against future income shocks, people need to scale up their precautionary assets, and *vice versa*. To our knowledge, this key implication of the model has not been tested in previous empirical literature.

To estimate the effect of revisions to permanent income on revisions of target wealth, one needs operational measures of both. We rely on survey data eliciting the amount of wealth held for precautionary purposes, which we interpret as target wealth in a buffer stock model. To measure the impact of revisions in permanent income, we use the covariance restrictions that the model imposes on the joint behaviour of income and target wealth. Using Italian panel data from 2002 to 2016, we find that households indeed revise approximately one-for-one their target wealth in response to permanent shocks. We consider variants of the baseline model, explore heterogeneity

[1] Carroll (2020) provides a rigorous treatment of the model. Carroll and Kimball (2007) and Jappelli and Pistaferri (2017) survey the empirical evidence on precautionary savings.

of responses across the age, education, occupation, and cash-on-hand distributions, and confirm this basic finding.

While our main finding supports the buffer stock model, suggesting that people understand what they should do in response to a shock, a different question is whether people *actually* adjust their stock of wealth when it is off target. This is a key issue, as in many household surveys (including the US Survey of Consumer Finances, SCF) people typically report that they are unprepared to meet even small financial emergencies. A second exercise we conduct is thus to check whether the change in actual cash-on-hand is negatively correlated with the "wealth gap", the deviation of cash-on-hand from target wealth. We find that households adjust in the right direction, closing about 1/10 of the gap between actual and target wealth every year. To check whether this adjustment is consistent with what a buffer-stock consumer would do, we simulate a standard buffer-stock model and run in simulated data the same adjustment regression we run in the actual data. This exercise reveals that the adjustment rate observed in the data is in the ballpark of what a buffer-stock model would predict for realistic parameter values. In the data and in the simulations, we also find that convergence to the target is faster when consumers are below target than when they are above it, a feature that is consistent with the concavity of the consumption function in the buffer stock model. All in all, results from the two parts of the paper provide support not only for the steady state implications of the buffer stock model, but also for the adjustment to target wealth.

The rest of the paper is as follows. In Section 2 we review the literature on the strength of the precautionary motive for saving, while Section 3 describes the main implication of the buffer stock model we test. Section 4 describes the data and Section 5 discusses the empirical findings for the relationship between target wealth and permanent income. Section 6 reports regressions for the adjustment to target wealth and compares the results with simulated data of a standard buffer-stock model. Section 7 concludes.

## 2. The strength of precautionary saving

Tests of the validity of the buffer stock model rely on assessing the strength of precautionary saving. A first research strategy is to estimate the degree of prudence from the consumption Euler equation.[2] A second strategy uses estimation-by-simulation methods to match empirical and theoretical moments of the consumption and wealth distributions under precautionary saving. Using this approach, Gourinchas and Parker (2002) conclude that wealth is accumulated early in life for precautionary reasons, while households older than 40 save mostly for retirement and bequests. Cagetti (2003) and Carroll (1997) confirm these broad findings. In a third approach, researchers estimate reduced form regressions for wealth relying on proxies for income risk, such as occupational dummies (Skinner, 1988; Fuchs-Schündeln and Schündeln, 2005) or the subjective variance of future income changes (Guiso, Jappelli and Terlizzese, 1992).

A fourth approach, which we follow in this paper, evaluates the importance of precautionary saving using survey questions that elicit the importance of various motives for saving.[3] The SCF in the US and the Survey of Household Income and Wealth (SHIW) in Italy ask individuals about their target wealth, namely how much they think that they should have in savings to face income risk and other emergencies. The evidence in favor of the model is mixed. Kennickell and Lusardi (2004) report that the bulk of the distribution of target wealth in the US is between $5,000 and $10,000. Fulford (2015) shows that elicited target wealth is much lower than predicted by standard modelling assumptions, and that perceived income uncertainty does not affect target wealth (while it should). Jappelli, Padula, and Pistaferri (2008) test the proposition that people with a below-target wealth expect to save, while those with above target expect to dissave, and reject this implication of the buffer stock model.

In this paper we use the same set of questions to test another implication at the heart of the buffer stock model, namely whether people revise target wealth proportionally to permanent

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[2] See e.g., Dynan (1993), Bertola, Guiso, and Pistaferri (2005), Fagereng, Guiso, and Pistaferri (2017) and Christelis et al. (2020).

[3] A related literature uses subjective expectations and direct survey questions to measure households' marginal propensity to consume (Shapiro and Slemrod, 1995, 2009; Sahm et al., 2015; Jappelli and Pistaferri, 2014; 2020; and Christelis et al., 2019).

income shocks. Our key insight is that direct survey evidence is most useful with genuine panel data, while cross-sectional inference is plagued by bias arising from unobserved heterogeneity correlated with preference and individual income risk.

## 3. Target wealth and the wealth gap

There are two versions of the buffer stock model in the literature. Both emphasize the interaction between liquidity constraints and precautionary saving. One version considers the possibility that a prudent and impatient consumer may face explicit credit constraints (Deaton, 1991); another features the same type of consumer but allows for the possibility of income falling to zero and so generating a "natural" borrowing constraint (Carroll, 1997). The two versions of the model deliver similar implications, and hence we treat them interchangeably. One important implication of the model is that that there exists a unique and stable value of target wealth as a ratio to permanent income, such that, if actual wealth is greater than the target, impatience outweighs prudence, and wealth falls, while if wealth is below the target, the precautionary saving motive outweighs impatience, and the consumer accumulates wealth.[4] This theoretical mechanism is precisely the focus of our paper.

Let's assume that the utility function is isoelastic, that the interest rate is constant and that preferences and the parameters of the income generating process are stable over time. In particular (expressed in log terms), income is the sum of permanent income $P_{it}$ and an i.i.d. transitory shock:[5]

$$\ln Y_{it} = \ln P_{it} + \varepsilon_{it} \tag{1}$$

Following the buffer-stock literature (Carroll, 1997; Carroll and Samwick, 1997), assume that the permanent component follows a random walk process:

[4] A second important implication is that consumption is an increasing and concave function of cash-on-hand.

[5] To avoid cluttering, in this section we leave any controlling for demographics implicit.

$$\ln P_{it} = \ln P_{it-1} + \zeta_{it} \quad (2)$$

where $\zeta_{it}$ is an i.i.d. revision in permanent income.

Denote target wealth by $W_{it}^*$,[6] and define the ratio $x^* = \frac{W_{it}^*}{P_{it}}$ as the "unique and stable value of the ratio of target wealth to permanent income" (Carroll, 1997). There are two broad sources of heterogeneity in $x^*$. The first is preferences, that is, more patient and more risk averse individuals tend to accumulate more wealth to protect against unforeseen events and have a higher $x^*$. The second is the income generating process. In particular, higher income risk requires more precautionary saving and therefore a higher $x^*$. Carroll (2020) proves these results in the general case and provides analytical solutions in some special cases.[7] Assuming that these sources of income and preference heterogeneity are stable over time for a given individual, they can be adequately captured by a fixed effect, and hence in a cross-section of individuals indexed by *i* we can express the $x^*$ ratio as:

$$\frac{W_{it}^*}{P_{it}} = \tilde{\theta}_i$$

And, after taking logs,

$$\ln W_{it}^* = \ln P_{it} + \theta_i, \quad (3)$$

[6] This is a (gross) wealth concept, i.e., inclusive of the contribution of income.

[7] For example, if the period utility function is isoelastic and the only source of uncertainty in income is a positive probability of (permanent) job displacement, Carroll (2020) shows that $x^*$ is approximately equal to:

$$x^* = \frac{W_t^*}{P_t} \approx \frac{1}{[(\gamma - r) + \delta(1 + \gamma/\pi)(1 - \gamma/\pi\,\omega)]},$$

where $\gamma$ is the growth rate of income, *r* the interest rate, $\delta$ the rate of time preference, $\pi$ the probability of falling into permanent unemployment, and $\omega$ the amount by which prudence exceeds the logarithmic benchmark. The expression shows that an increase in the growth rate of labor income, a reduction in the interest rate (equivalent to an increase in human wealth), and a reduction in the probability of unemployment reduce target wealth relative to permanent income. More impatient people have lower target wealth. On the other hand, an increase in prudence reduces the denominator and therefore is associated with higher target wealth.

where $\theta_i = \ln \tilde{\theta}_i$ is the the difference between log target wealth and log permanent income.

The central prediction of equation (3) is that in steady-state *any revision in permanent income leads to a proportionate revision in target wealth*, holding individual effects constant. To exemplify, suppose that people receive a permanent and positive income shock (a job promotion). This leads to a revision in consumption, which will be permanently higher. To protect and insure this higher level of consumption from future income shocks, the optimal plan requires now a higher level of target wealth. Symmetrically, if people receive a negative permanent income shock, consumption and the required target wealth will be permanently lower.

Consider now a version of (3) that is amenable to estimation:

$$\ln W_{it}^{*} = \alpha + \beta \ln P_{it} + \theta_i + v_{it} \tag{4}$$

where $v_{it}$ is an i.i.d. error term capturing classical measurement error in reported target wealth. The buffer stock model suggests that the ratio between target wealth and permanent income is an individual-specific constant. This implies that, controlling for an individual fixed effect, target wealth and permanent income move one-to-one, so that $\beta = 1$. This test, which to the best of our knowledge has never been implemented, is a simple way to validate the steady-state solution of the buffer stock model.

Cross-sectional data are inappropriate for testing (4), since the fixed effect is related to individual preferences and income risk, which are likely correlated with permanent income. For instance, if people with high $\theta_i$ have higher unobserved taste for saving, and if taste for saving and hard work (and hence permanent income) are correlated, people with high values of $\theta_i$ report high target wealth and are also likely to have high permanent income. This renders the OLS estimate of $\beta$ biased and inconsistent. In this example, the relation between target wealth and permanent income will be overstated. Most of the papers in the literature that rely on cross-sectional data on elicited target wealth suffer implicitly from this bias.

With panel data one can test whether individuals who have experienced a *change* in their permanent income also report a *change* in their target wealth, as opposed to testing whether (in a cross-section) high-permanent income individuals report higher target wealth, an association that may be related to risk-aversion or patience affecting both in the same direction. In particular, with panel data one can eliminate the bias by differencing the relationship (4), and hence estimate:

$$\Delta \ln W_{it}^{*} = \beta \Delta \ln P_{it} + \Delta v_{it} \tag{5}$$

Note that a test of the hypothesis $\beta = 1$ is a joint test of a particular version of the buffer stock model, featuring a constant interest rate, a specific income process, as well as homothetic and stable preferences. It is under these assumptions that one can conveniently capture all sources of heterogeneity in an individual fixed effect and difference it out in panel data. However, it is possible that changes in socio-economic circumstances may shift such parameters. In our regressions we control for age, family size, and other socio-economic characteristics in the attempt to minimize this possibility. Moreover, we consider a specification in which individual heterogeneity (the term $\theta$ in equation (4)) is subject to stochastic variation over the life cycle. Finally, our test would continue to be valid even when preference and income parameters change as long as such changes were embedded in the respondents' reported target wealth.

The test we propose in equation (5) requires empirical counterparts of target wealth and permanent income for several years. We use direct survey evidence on target wealth, relying on a question available between 2002 and 2016 in the SHIW, described below. However, permanent income is unobserved. Our main empirical approach is to use the covariance restrictions that equation (5) and the stochastic structure of the income process (equations (1)-(2)) impose on the data to estimate $\beta$ as well as the parameters of the joint distribution of income and target wealth. The main advantage of this approach is that it isolates the source of variation in income that is theoretically relevant for a test of the buffer-stock model. On the other hand, the test is based on the assumption that income follows the process described in equations (1) and (2).

## 4. The data

We use six waves of the Italian SHIW, a biannual representative sample of the Italian population. Each wave includes about 8,000 households. The surveys provide detailed information on demographic variables, income, consumption, wealth (broken down into real assets and various components of financial assets and debt). Consumption and income are yearly flows, while wealth is an end-of-year stock. The survey has also a rotating panel component: each year close to 50% of the sample is composed of households interviewed in the previous wave, while 50% represents new interviews.

In 2002, 2004, 2010, 2012, 2014, 2016, the SHIW has a direct question on target wealth for precautionary reasons,[8] which we take as a proxy of 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 wording of the question is the same in the six surveys, but the way the question is introduced is abridged in 2014 and 2016 (see Online Appendix B.1 for a description of the question in the various years). Since the 2014 and 2016 formulation might reduce attention to the question, in robustness checks we explore the stability of the results limiting the analysis to the period 2002-12. The way the survey question is framed and phrased aims to pin down a steady-state concept, rather than a period-specific one. Indeed, the question is introduced on very general terms ("*People save in various ways…*"), without reference to any current-period events, and (after providing respondents with a list of potential triggers for precautionary savings), people are asked about "*how much*" they would *"need to have in savings to meet"* the unexpected events. We thus interpret answers to this question as referring to the amount of wealth that people would hold in steady state,

[8] The question is patterned after a similar question in the SCF, described in Kennickell and Lusardi (2004). In the SHIW the question was not asked in 2006 and 2008 due to revisions in the special modules of the questionnaire.

not how much they need in a particular year (e.g., in the survey year), and we maintain this interpretation throughout the paper.

However, there might still be some ambiguity in the way the question is interpreted. Some people may interpret it as a stock, i.e., the total wealth they need to hold (including motives other than precautionary wealth). Others may interpret it as a flow, i.e., as the additional wealth they need to hold for precautionary reasons. The availability of panel data (and hence the focus on *changes* in target wealth) is key for our test to remain valid. In fact, reported target wealth may include not only precautionary wealth but also life-cycle wealth and bequests, which in general also responds to permanent income shocks. For reasonably persistent shocks to income, one should expect retirement wealth and wealth held for a bequest motive to be built up or decumulated slowly over time. Hence, as long as respondents are internally consistent over time in how they interpret what the question is asking, we can isolate and therefore identify the effect of *changes* in permanent income on *changes* in target wealth.

Table 1 reports sample statistics for the whole 2002-2016 sample (46,569 households) and for the panel sample (25,707 households). To make sure that the question on target wealth (our empirical proxy for $W^*$ in Section 2) is answered by the same person, our panel sample selects households where the household head does not change;[9] moreover, to reduce the impact of outliers we drop households reporting values of $W^*$ in the top 2.5% of the distribution. Given the rotating structure of the panel, 20% of the households are interviewed five or six times, 44% three of four times, and 36% only in two consecutive waves.

The sample mean of target wealth (deflated using the CPI) is 35,667 euro, slightly higher than the corresponding values in the panel sample (34,923 euro). The median is actually the same in the two samples (20,030 euro). The sample mean of the target wealth-income ratio ($W^*/Y$) is 1.84 (and the median 0.91), showing that precautionary wealth is potentially quite important for Italian households.[10] Statistics for the panel sample are similar.

[9] Households where the head changes are treated as new households.

[10] For comparison, in the SCF the bulk of the distribution of target wealth is considerably lower (between 1 and 2 months' worth of income). Note that $(W^*/Y) \leq x^* = (W^*/P)$ due to the presence of a transitory income component.

There are essentially no differences between the two samples in terms of gender, family size and marital status. Years of education, income, non-durable consumption and financial wealth are 4 to 8 percentage points higher in the panel sample, as should be expected given panel attrition and our requirements to focus only on households with a stable demographic structure. In keeping with the buffer stock model, cash-on-hand is defined as resources that are liquid and available to face emergencies, that is financial assets (transaction accounts, CDs, bonds, mutual funds, investment accounts, stocks, and loans to relatives and coops) plus monthly disposable income (net of capital income). The mean of cash-on-hand is 29,688 euro (the median is 9,014). The wealth gap (the difference between actual and target wealth) shows that two third of respondents are below target and report a negative wealth gap.

The Online Appendix provides further information about the survey questions: Figure B.1 plots the empirical distribution of target wealth for the various SHIW waves; Figure B.2 plots the mean and median target wealth against time; Table B.1 reports descriptive statistics for the entire sample and the panel sample, separately for the earlier and later periods examined (2002-2012 and 2014-16, respectively).

The descriptive statistics show a smooth decline of our measure of target wealth over time. One possible explanation for the declining importance of target wealth is the development of credit and insurance market opportunities following Italy joining the euro area in 2000 (Jappelli and Pistaferri, 2011). Before the introduction of the euro, the Italian mortgage and consumer credit markets were severely limited by regulation, judicial inefficiency and limited enforcement. The process of European financial integration and the associated fall in interest rates increased considerably households' incentives and ability to borrow. Moreover, financial integration spurred increasing competitive pressure, further reducing the cost of debt and increasing the supply of loans. All these developments are likely to be associated to a reduced need for precautionary balances, and therefore with the declining patterns of target wealth visible in Figure B.2.[11]

[11] From an econometric point of view, the declining trend in target wealth is not a concern. As we show in the next section, our parameters are identified from the covariance of growth rates, and therefore our procedure does not hinge on the "level" of target wealth or permanent income, but on their co-movements over time across individuals (i.e., on a longitudinal setting).

In Section 5 we will check if people adjust their target wealth in response to permanent income shocks, and in Section 6 if those who are off target actually attempt to close the gap by increasing or reducing cash-on-hand over time.

## 5. The relationship between target wealth and permanent income

We estimate the parameters of interest using the covariance restrictions that the buffer-stock model imposes on the joint behavior of target wealth and income. Consider the process for log income of equations (1)-(2), add demographic controls, and take first differences to yield:

$$\Delta \ln Y_{it} = \Delta Z'_{it}\gamma^{y} + \zeta_{it} + \Delta\varepsilon_{it} \tag{6}$$

The buffer-stock model of Section 3 predicts that the log of target wealth and permanent income move one-to-one, i.e., that in the regression (3), augmented for observable characteristics:

$$\ln W^{*}_{it} = Z'_{it}\gamma^{w^*} + \beta \ln P_{it} + \theta_i + v_{it}$$

the coefficient $\beta = 1$. First differencing eliminates the fixed effect $\theta_i$ and (using equation (2)) yields:

$$\Delta \ln W^{*}_{it} = \Delta Z'_{it}\gamma^{w^*} + \beta\zeta_{it} + \Delta v_{it} \tag{7}$$

Longitudinal data on target wealth and income can be used to estimate $\beta$ (and other parameters of interest) by GMM, using moment restrictions imposed by the model on the unobservable components of income growth $\left(g^{y}_{it}\right)$ and target wealth growth $\left(g^{w^*}_{it}\right)$. These components are estimated using the residuals of regressions (6) and (7):

$$g^{y}_{it} = \Delta \ln W_{it} - \Delta Z'_{it}\hat{\gamma}^{y} = \zeta_{it} + \Delta\varepsilon_{it} \tag{8}$$

$$g^{w^*}_{it} = \Delta \ln W^{*}_{it} - \Delta Z'_{it}\hat{\gamma}^{w^*} = \beta\zeta_{it} + \Delta v_{it} \tag{9}$$

We obtain these residuals running regressions for $\Delta \ln Y_{it}$ and $\Delta \ln W_{it}^{*}$, respectively, on the first difference of age, age squared, family size, marital status, and year dummies. We assume that the demographic changes are predictable, but acknowledge that some of the income shocks could represent unpredictable demographic shocks. Our income variable is the sum of net of tax labor income (both dependent employment and self-employment) and transfers. We exclude capital income because potentially correlated with target wealth. In robustness analysis we focus on a sample that excludes the self-employed, who might have a different income process; we also examine sensitivity of estimates by stratifying on other socioeconomic characteristics.

We use the following five moment restrictions to identify the four parameters of interest:

$$E\left(\left(g_{it}^{y}\right)^{2}\right) = \sigma_{\zeta}^{2} + 2\sigma_{\varepsilon}^{2} \tag{10.1}$$

$$E\left(g_{it}^{y} g_{it-1}^{y}\right) = -\sigma_{\varepsilon}^{2} \tag{10.2}$$

$$E\left(g_{it}^{y} g_{it}^{w^{*}}\right) = \beta\sigma_{\zeta}^{2} \tag{10.3}$$

$$E\left(\left(g_{it}^{w^{*}}\right)^{2}\right) = \beta^{2}\sigma_{\zeta}^{2} + 2\sigma_{v}^{2} \tag{10.4}$$

$$E\left(g_{it}^{w^{*}} g_{it-1}^{w^{*}}\right) = -\sigma_{v}^{2} \tag{10.5}$$

In estimation we account for the fact that the data, instead of being available every year as in the model above, are spaced two years apart (and for 2010, six years apart).[12] Moreover, since estimation involves higher moments that are more likely to be influenced by extreme values, we also estimate the model winsorizing the top and bottom 0.5% of the distributions of $g^{y}$ and $g^{w^{*}}$. In a robustness check, we show that the results are similar when using unwinsorized residuals.

We compute our GMM estimates using as a weighting matrix $\Sigma = diag(\Omega^{-1})$, where $\Omega^{-1}$ is the GMM optimal weighting matrix (the inverse of the variance-covariance matrix of the moments used in estimation). We do this to avoid the small sample bias associated with using the

[12] The structure of equations (10.1)-(10.5) assumes that $E\left(g_{it}^{w^{*}} g_{it-s}^{y}\right) = E\left(g_{it}^{w^{*}} g_{it+s}^{y}\right)$. This is a testable assumption which we do not reject (for $s = \{1,2\}$) with a p-value of 59%. Another implicit assumption is the absence of "advance information" about future changes in income. We follow Blundell, Pistaferri and Preston (2004) and test for "advance information" by testing whether $E\left(g_{it}^{w^{*}} g_{it+s}^{y}\right) = 0$ for all $s > 0$ (in our case, $s = \{1 \dots 4\}$). The test that these covariances are all jointly zero test has a p-value of 12%, so again we fail to reject the null.

optimal weighting matrix, see Altonji and Segal (1996). The GMM standard errors are adjusted accordingly.

The GMM results are reported in Table 2. The estimate of $\beta$ is 0.83 and we do not reject the null hypothesis that $\beta$=1 at the 1% level. Hence, our results are statistically consistent with the prediction of the buffer-stock model that reported target wealth adjusts approximately one-for-one in response to permanent income innovations. As for the other parameters of the model, the variance of permanent income shocks ($\sigma_\zeta^2$) and that of transitory income shocks ($\sigma_\varepsilon^2$) are precisely estimated and broadly comparable to previous estimates obtained using the SHIW (Jappelli and Pistaferri, 2006) and with evidence from the US (Carroll and Samwick, 1997; Gourinchas and Parker, 2002). Finally, the estimate of unobserved heterogeneity in target wealth ($\sigma_\eta^2$) reflects sources of heterogeneity not captured by the set of rather parsimonious demographic variables we include in the regression, measurement error, as well as the fact that target wealth – as any measure of wealth – has a much larger cross-sectional variance than flow variables such as income and consumption.[13]

In columns (2) and (3) we provide two important extensions. First, we allow changes in target wealth to be affected also by transitory income shocks (with parameter $\kappa$). We thus rewrite equation (9) as:

$$g_{it}^{w^*} = \beta\zeta_{it} + \kappa\Delta\varepsilon_{it} + \Delta v_{it}$$

This specification changes moment conditions (10.3) and (10.4) to:

$$E\left(g_{it}^{y} g_{it}^{w^*}\right) = \beta\sigma_\zeta^2 + 2\kappa\sigma_\varepsilon^2$$
$$E\left(\left(g_{it}^{w^*}\right)^2\right) = \beta^2\sigma_\zeta^2 + 2\sigma_v^2 + 2\kappa^2\sigma_\varepsilon^2$$

[13] A general test of GMM misspecification in an overidentified model is based on Newey (1985), and consists of testing whether the difference between actual and theoretical moments (i.e., the moments in equations (10.1)-(10.5)) is close to zero, accounting for sampling variability and the use of a non-optimal weighting matrix (as in our case). This test (distributed $\chi_1^2$) has a large p-value (94%), because the differences between actual and predicted moments (evaluated at the estimated parameters) is actually quite small.

and adds an extra moment condition:

$$E\left(g_{it}^{w^*} g_{it-1}^{y}\right) = -\kappa\sigma_{\varepsilon}^{2},$$

resulting in an exactly identified model. The results, reported in column (2), show that the estimate of $\kappa$ is small and statistically insignificant, while the response to permanent changes in income continues to be large. In fact, we don't reject the null $\beta = 1$ at the 1 percent level, although the confidence interval is now larger than in column (1). Hence, consistently with the predictions of the standard version of the buffer-stock model, consumers appear to adjust target wealth to changes in permanent income but not to transitory fluctuations in their income.

So far we have assumed that the unobserved heterogeneity term $\theta_i$ in equation (4) is literally fixed over time, so that it can be differenced out in panel data. In a second extension we propose a more flexible specification, assuming that the unobserved heterogeneity term is fixed in expectation, but it is occasionally subject to unanticipated innovations. Hence, we write unobserved heterogeneity as evolving stochastically according to a random walk process:

$$\theta_{it} = \theta_{it+1} + \psi_{it}$$

Equation (9) now becomes:

$$g_{it}^{w^*} = \beta\zeta_{it} + \Delta v_{it} + \psi_{it}$$

This alternative specification changes moment condition (10.4), which becomes: $E\left(\left(g_{it}^{w^*}\right)^2\right) = \beta^2\sigma_{\zeta}^2 + 2\sigma_{v}^2 + \sigma_{\psi}^2$, giving again an exactly identified model. The results of this specification are reported in column (3) of Table 2. The estimate of $\beta$ is lower (0.73) than in the baseline model, and more precisely estimated, so that the hypothesis that $\beta = 1$ is now rejected at the 5% level (but not at the 1%).[14] The estimate of the variance of preference shocks ($\sigma_\psi^2$) is sizable and precisely estimated.

To explore possible sources of heterogeneity and misspecification of the relation between target wealth and permanent income shocks, we present additional robustness results, organized in two tables. In Table 3 we explore various sources of possible heterogeneous response of target wealth to permanent income shocks by splitting the sample according to some key socio-economic characteristics (age, wealth, education, and occupation).

Previous studies suggest that the young are more likely to exhibit buffer stock behavior.[15] In column (1) of Table 3 we repeat the estimation of the baseline model focusing on a sample of young household (where the head is 45 or less), while column (2) focuses on older households (where the head is more than 45 years old). We also experimented changing the age cutoff slightly (to 40 or 50), with similar results. The estimated variances of transitory and permanent shocks are higher in the sample of young households. The estimate of $\beta$ is also higher among the young, but for both young and older households we cannot reject the null that $\beta = 1$.

In columns (3)-(4) we consider heterogeneity by financial wealth. Cash-poor consumers, who face potential liquidity constraints, might be more reluctant to increase their target wealth in response to positive income shocks. We classify as "poor" (or potentially liquidity constrained) households with financial wealth below two-months' income (as in Zeldes, 1989), and as "rich" those with financial wealth below above that threshold. We find that the point estimate of $\beta$ is actually higher for the poor than for the rich (1.1 vs. 0.7). The hypothesis $\beta = 1$ is not rejected for the poor but has a borderline p-value for the rich households.

The split by education (columns (5)-(6)) reproduces similar findings: low-educated households appear to adjust their target wealth more in sink with changes in their permanent income than high-educated households do. The final two columns (7) and (8) consider occupation.

[14] If the permanent component of income is not a random walk but an AR(1) process with a high AR coefficient, the response of changes in target wealth to changes in income could be lower than predicted by the random walk case. This may be a potential explanation for the estimate of $\beta$ being lower than 1.

[15] As argued by Carroll (1997), "a finite horizon version of the [buffer-stock] model […] with age/income profiles roughly calibrated to U. S. household-level data […] generates buffer-stock saving behavior over most of the working lifetime until roughly age 45 or 50, and behavior that resembles the standard LC/PIH model only for roughly the period between age 50 and retirement" (Carroll, 1997, p. 3).

The self-employed might have a different and more volatile income process. This is indeed the case judging from the estimates of the variances of transitory and permanent income shocks (about twice as high for the self-employed). The estimate of $\beta$ in the sample of employees is similar to the baseline; for the smaller group of households where the head is self-employed, the estimate is imprecise.

In Table 4 we check robustness to various forms of misspecification and consider three experiments: (a) restricting the sample to the 2010-16 waves (when the target wealth variable is available on a continuous basis); (b) restricting the sample to the 2002-2012 waves, dropping years in which the question on target wealth was asked in slightly different form; and (c) considering a sample where income growth and target wealth growth are not winsorized. In all cases, the results remain qualitatively similar.

## 6. Convergence to the target

A test of the hypothesis $\beta$=1 does not rely on information on the amount of wealth that people *currently* hold, which is affected by past income and other shocks, but only on information about the amount of wealth that people target. The finding that $\beta$=1 suggests that reported target wealth moves in lockstep with revisions to permanent income, but not necessarily that people adjust their actual wealth to target. Furthermore, some respondents may provide answers "as if" they behaved according to a buffer stock model, even though they have difficulty identifying what their ratio of target wealth to permanent income is, or may actually follow a different model. To shed light on this issue, in this section we check whether people with current wealth away from the target attempt to close the wealth gap in the following periods.[16]

To pave the way for the formal regression analysis, Figure 1 plots the change in cash-on-hand – that is, the wealth adjustment $(\ln W_{it} - \ln W_{it-}\ ) \equiv \ln \frac{W_{it}}{W_{it-1}}$ – against the lagged wealth

[16] Parker and Souleles (2019) perform a qualitatively similar check between reported and actual MPCs, comparing the "revealed preference" approach (in which inference is based on actual data) with the "reported response" approach, which consists of asking people to report their choices. They find that households reporting that they "mostly spent" their economic stimulus payments in 2008, had indeed spent twice as much as those reporting that they used their payments "mostly to save or pay down debt".

gap $(\ln W_{it-1} - \ln W^*_{it-}\ ) \equiv \ln \frac{W_{it-1}}{W^*_{it-1}}$. The graph shows a negative correlation between these two variables, suggesting that there is indeed adjustment towards the target. It also shows asymmetric behaviour: adjustment is faster when wealth falls short of target than when consumers have accumulated wealth in excess of their target.

To test the relation in a formal regression, we add demographic controls and an error term and consider:

$$\ln \frac{W_{it}}{W_{it-1}} = \alpha + \lambda \ln \frac{W_{it-1}}{W^*_{it-1}} + \Delta Z'_{it} \gamma^{\Delta w} + e_{it} \quad (11)$$

In Appendix A.1. we show that this equation approximates the relationship linking the growth in the wealth-to-permanent income ratio to the lagged wealth gap ratio. The error term of the approximation is the innovation to permanent income, which is by assumption orthogonal to lagged realization of the wealth gap ratio, implying that OLS estimates of (11) are unbiased and consistent.

A negative $\lambda$ coefficient signals convergence towards target wealth. Since the regression differences out individual effects, this is reminiscent of the convergence criteria of growth regressions: each individual has a different steady-state target wealth, and each converges to its own steady state. Furthermore, the magnitude of $\lambda$ measures the speed of convergence. For instance, $\lambda = -0.5$ means that half of the percentage wealth gap at time *t*-1 is filled between periods *t*-1 and *t*.

Note that on the right-hand-side of equation (11) the two terms of the wealth gap can be affected by the history of income shocks. Actual wealth will be lower (higher) if there has been a string of recent negative (positive) shocks. Target wealth depends on the persistence of the income process and its riskiness, and it is possible that the history of income shocks may have led consumers to revise their expectations. However, if respondents embed this history in their reports of target wealth, our test should remain valid.

We report estimates of equation (11) in Table 5, controlling for changes in age, age squared, marital status, and family size. In column (1) the estimated convergence coefficient is -0.208, and statistically different from zero at the 1% level. While this represents evidence of convergence towards the target, the adjustment is not immediate. Indeed, the estimate implies that, on average, it takes about 10 years to close the gap between actual and target wealth (absent additional shocks).[17]

In the other regressions of Table 5 we provide sample splits by age, education, occupation, and financial wealth with the aim of exploring potential sources of heterogeneity in adjusting to the target wealth. In particular, in columns (2) and (3) of Table 5 we stratify the sample by age (young vs older households). In columns (4) and (5) we consider heterogeneity in the adjustment to target wealth by education and in columns (6) and (7) by occupation. Finally, in columns (8) and (9) we split the sample by financial wealth (less or more than two months' income). We find some interesting differences across groups (e.g., adjustment is faster for high-education households and for the self-employed and lower for young households, possibly because they have longer horizons and more time to adjust to target), but overall there is remarkably limited heterogeneity in the adjustment elasticity across these groups, as the estimated $\lambda$ coefficients in the OLS regressions vary between -0.162 and -0.282, implying that it takes between 7.1 and 12.3 years to close the gap between actual and target wealth.[18]

In Table 6 we consider sensitivity of our estimates to some specification checks. A concern in the OLS estimation of equation (11) is that $\ln W_{it-1}$ appears on both sides of the regression, which may lead to biased estimates if $\ln W_{it-1}$ is measured with error.[19] To address this issue, we run an IV regression using the second lag of $\ln\left(\frac{W_{it}}{W_{it}^*}\right)$ as an instrument. In column (1) of Table 6 we find that the adjustment coefficient is reduced ($\lambda = -0.14$) but remains statistically different

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[17] Since the data are biannual, the adjustment is (0.208/2) on an annual basis. Hence, absent other shocks it would take approximately 1/(0.208/2)=9.6 years to entirely close the gap.

[18] In our previous work (Jappelli, Padula and Pistaferri, 2001) we tested a similar prediction of the buffer-stock model, namely that when the wealth-to-permanent income ratio is below the target, consumers should save more, and when the wealth-to-permanent income ratio is above target, they should increase consumption. Using IV regressions, we found little support for this prediction. The test in Table 5 is much more powerful than in our previous work, as we do not need to construct a proxy estimate of permanent income, can use longitudinal data to control for unobserved heterogeneity potentially correlated with permanent income, and have access to data from six SHIW waves (as opposed to two).

[19] One can show that if $\ln \widetilde{W}_{it} = \ln W_{it} + \xi_{it}$, so that $\xi_{it}$ is a classical measurement error, the OLS estimation of $\lambda$ in equation (11) is inconsistent: $plim\ \hat{\lambda}_{OLS} = \lambda - (1+\lambda)\frac{var(\xi_{it})}{var(\ln \tilde{\ }_{it})}\frac{var(\ln \tilde{\ }_{it})}{var(\ln \tilde{\ }_{it} - \ln W_{it}^*)}$. Hence, OLS suggests faster convergence than in reality.

from zero, despite the fact that these regressions only use half of the original sample since IV construction requires at least three panel observations (the first-stage F-statistics is also large, F=1360).

In column (2) of Table 6 we consider an alternative definition of cash-on-hand that adds valuables (jewels), on the ground that they can be easily liquidated for consumption smoothing purposes, and subtracts fixed expenses (rents), since these are harder to adjust in the short-run. Both variables are measured in the SHIW over our sample period. The results are similar to the baseline (an adjustment coefficient of -0.196).

While our baseline estimate (-0.208) may suggest a relatively slow adjustment rate, consider that even in a frictionless buffer-stock model adjustment to the target may take time, since it requires deviating from a smooth intertemporal consumption path, which is costly from a utility point of view. To assess if the estimated adjustment rate to target is consistent with the model, in Appendix A.2 we present a simulation of a standard buffer-stock model. We set the variances of income shocks to the values estimated in the baseline specification of Table 2 ($\sigma_{\zeta}^{2}$=0.021 and $\sigma_{\varepsilon}^{2}$=0.056, respectively) and impose an exogenous borrowing constraint as in Deaton (1991). We then consider a range for the remaining three key parameters of the model: the coefficient of relative risk aversion, the interest rate, and the intertemporal discount rate. Finally, we use the realizations of cash-on-hand from the model (a combination of random income draws and optimal saving choices) and the model-predicted target wealth values to run the same regression (11) we estimate in the actual data. As far as we know, our paper is the first to discuss (and present evidence for) speed of adjustment to target in the context of a buffer-stock model.

Table 7 shows that, for realistic combinations of the parameters, the speed of adjustment predicted by the model is not far from the one observed in the data. For example, with a 1% interest rate,[20] a coefficient of relative risk aversion of 2.5, and a discount factor of 0.92, the speed of adjustment would be -0.225, not far from the baseline estimated -0.208. While this exercise is not designed to pin down any structural parameter (since $\lambda$ is a complicated function of all the parameters of the model), it shows that realistic combinations of the structural parameters of the

[20] In the 2002-16 period covered by our data, the average real return on Italian T-bills was 0.7%.

model can replicate the speed of adjustment observed in the data, despite the simplicity of the setting.

As suggested by Figure 1, the estimated average adjustment rate to the target ($\lambda = -0.208$) may mask some important heterogeneity. One important form of heterogeneity is whether consumer adjust faster if the wealth gap is positive (i.e., if they have accumulated wealth in excess of target) vs. negative (if their wealth falls short of target). To test this prediction, we consider an extension of equation (11) in which we interact the lagged wealth gap with dummies for positive and negative wealth gaps:

$$\ln\frac{W_{it}}{W_{it-1}} = \alpha + \lambda^{below}\left(\ln\frac{W_{it-1}}{W^*_{it-1}}\right)\mathbf{1}\left\{\left(\ln\frac{W_{it-1}}{W^*_{it-1}}\right) \le 0\right\} + \lambda^{above}\left(\ln\frac{W_{it-1}}{W^*_{it-1}}\right)\mathbf{1}\left\{\ln\frac{W_{it-1}}{W^*_{it-1}} > 0\right\} + \Delta Z'_{it}\gamma^{\Delta w} + e_{it} \quad (12)$$

In column (3) of Table 6 we present estimates of this regression. We find that households with wealth below target adjust faster ($\lambda^{below}$=-0.286) than those above target ($\lambda^{above}$=-0.108). One explanation is directly related to the concavity of the consumption function: the utility cost of having too little wealth when a bad shock happens is higher than the utility cost of having too much wealth when the same shock happens, and hence there are greater incentives (consumption smoothing benefits) to adjust when wealth is below target (see also Figure Ia in Carroll, 1997).

To compare the actual adjustment with that predicted by the buffer stock model, in the last two columns of Table 7 we replicate regression (12) in our simulated buffer-stock economy and find that realistic values of the parameters generate remarkably similar adjustment coefficients to those observed in the data (particularly in the last three rows of the table), providing further support for the buffer stock model.

To summarize, the results offers support to the hypothesis that people adjust their wealth towards their precautionary target. Simulation of a standard buffer stock model with realistic parameter values produces adjustment of comparable speed. Remarkably, the data replicate one important asymmetry predicted by the model: people who are below target adjust at a faster rate than those who are above it. The result may be explained by bad realizations of shocks to permanent income generating larger utility losses when there is too little wealth than when there is too much, and from the risk of not having an adequate buffer to prevent consumption to fall in case of negative shocks. This is a direct consequence of the concavity of the consumption function induced by precautionary behavior.

## 6. Conclusions

One of the most important implications of the buffer stock model of saving is that consumers choose to maintain a target level of wealth that is proportional to permanent income. This implies that, other things being equal, any revision in permanent income leads to a proportionate revision in target wealth. While many papers provide evidence on the importance of precautionary saving, this key implication of the model has thus far not been directly tested. In this paper, we rely on panel data on the desired amount of wealth for precautionary purposes (which we interpret as target wealth in a buffer stock model) and income to propose such test.

We estimate the relation between target wealth and permanent income by GMM, exploiting the covariance restrictions on the joint behaviour of income and target wealth in the buffer stock model. We find that households indeed revise proportionally (if not fully so) their target wealth in response to permanent shocks. This result appears robust to various checks on sample definitions and regression specifications. In the last part of the paper, we leverage our longitudinal data to check whether people *actually* adjust their wealth when they are off target. Our point estimate implies that, on average, it takes about ten years to close the gap between actual wealth and target wealth (absent additional shocks). The adjustment is slower when we attempt to correct for measurement error in cash-on-hand with IV regressions.

All in all, the results suggest that people seem to understand that they should accumulate a buffer stock to guard against permanent changes in their incomes, and that in practice they do attempt to close the gap at a speed that is similar, for realistic parameter values, to that obtained in formal simulation of a standard buffer stock model. The concavity of the consumption function implies also that adjustment should be asymmetric: being below target is more costly, in utility terms, from being above it, and hence consumers should attempt to close the gap faster when their wealth falls short of target. This prediction is remarkably borne out in the data. Putting together the evidence from the two parts of the paper (which exploit different implications of the buffer-stock model and use different empirical strategies and data), this paper finds thus strong evidence supporting the buffer-stock model.

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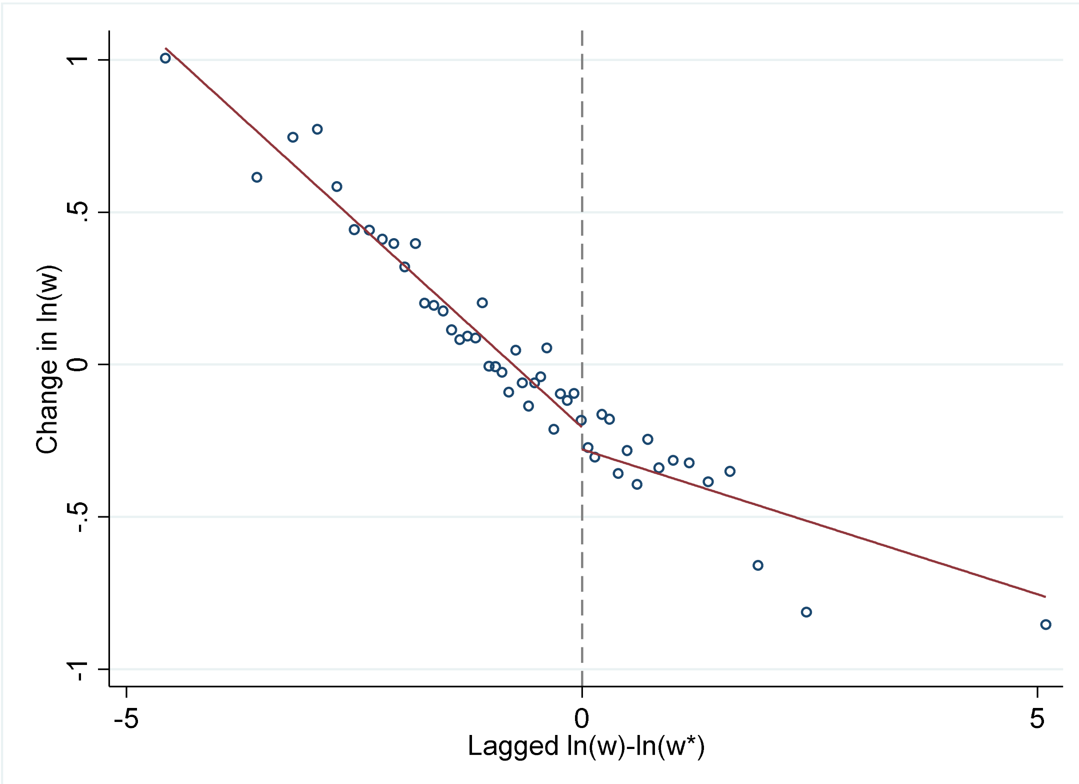
**Figure 1: Adjustment to Target Wealth**




*Note.* The figure plots the change in actual wealth against the lagged wealth gap (binscatter over 50 quantiles, with solid lines obtained from regressions run separately for values of the running variable above and below 0). Actual wealth ($W$) is defined as financial wealth plus monthly income. The wealth gap is the difference between actual wealth and target wealth ($W^*$).

## Table 1. Descriptive Statistics

| | Total sample | | | Panel sample | | |
|---|---|---|---|---|---|---|
| | Mean | Median | Std. Dev. | Mean | Median | Std. Dev. |
| Target wealth ($W^*$) | 35,667 | 20,030 | 44,009 | 34,923 | 20,030 | 42,751 |
| Consumption | 24,848 | 21,265 | 15,178 | 25,441 | 21,859 | 15,271 |
| Income ($Y$) | 25,791 | 20,943 | 20,426 | 26,303 | 21,586 | 19,437 |
| Cash-on-hand ($W$) | 29,688 | 9,014 | 93,180 | 31,914 | 9,709 | 98,646 |
| Wealth gap: $(W - W^*)$ | -5,979 | -5,623 | 96,499 | -3,010 | -4,940 | 100,936 |
| $\mathbf{1}\{(W - W^*) < 0\}$ | 0.67 | 1.00 | 0.47 | 0.66 | 1.00 | 0.47 |
| $W^*/Y$ | 1.84 | 0.91 | 11.03 | 1.75 | 0.89 | 6.94 |
| Years of education | 9.20 | 8.00 | 4.58 | 9.47 | 8.00 | 4.57 |
| Age | 59.14 | 60.00 | 15.85 | 60.02 | 60 | 15.09 |
| Male | 0.56 | 1.00 | 0.50 | 0.56 | 1.00 | 0.50 |
| Family size | 2.45 | 2.00 | 1.27 | 2.48 | 2.00 | 1.27 |
| Married | 0.60 | 1.00 | 0.49 | 0.62 | 1.00 | 0.49 |
| Observations | | 46,569 | | | 25,707 | |

*Note*. Consumption is non-durable consumption. Income is the sum of labor income (from employment and self-employment) and transfers.

## Table 2. GMM Results

| | Baseline | Adding transitory income shocks | Adding preference shocks |
|---|---|---|---|
| | (1) | (2) | (3) |
| $\sigma_\zeta^2$ | 0.021 | 0.022 | 0.023 |
| | (0.002)*** | (0.002)*** | (0.002)*** |
| $\sigma_\varepsilon^2$ | 0.056 | 0.055 | 0.054 |
| | (0.003)*** | (0.003)*** | (0.003)*** |
| $\sigma_\eta^2$ | 1.074 | 1.080 | 0.797 |
| | (0.021)*** | (0.021)*** | (0.034)*** |
| $\beta$ | 0.834 | 0.600 | 0.726 |
| | (0.137)*** | (0.185)*** | (0.120)*** |
| $\lambda$ | | 0.096 | |
| | | (0.089) | |
| $\sigma_\psi^2$ | | | 0.268 |
| | | | (0.026)*** |
| $N$ | 16,847 | 16,847 | 16,847 |
| P-val. test $\beta$=1 | 0.224 | 0.030 | 0.022 |

*Notes*: The table reports estimates of the parameters determining the relationship between the growth of target wealth and the stochastic income process. Observations on (residual) target wealth and earnings growth are winsorized at the top and bottom 0.5%. Column (1) uses the baseline model. Column (2) adds a transitory income shock. Column (3) adds the preferences shock. Columns (4) and (5) estimate the baseline specification for a sample of young households (aged 45 or less) and older households (aged more than 45), respectively. Standard errors are reported in parenthesis. ***, **, and * indicate statistical significance at the 1%, 5% and 10% confidence level, respectively.

## Table 3. GMM Results for Different Socio-Economic Groups

| | Age ≤ 45 | Age > 45 | Poor | Rich | Low education | High education | Non self-employed | Self-employed |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $\sigma_{\zeta}^{2}$ | 0.024 | 0.019 | 0.021 | 0.021 | 0.019 | 0.035 | 0.018 | 0.041 |
| | (0.011)** | (0.002)*** | (0.006)*** | (0.002)*** | (0.003)*** | (0.007)*** | (0.002)*** | (0.012)*** |
| $\sigma_{\varepsilon}^{2}$ | 0.087 | 0.052 | 0.080 | 0.045 | 0.059 | 0.035 | 0.051 | 0.115 |
| | (0.014)*** | (0.003)*** | (0.008)*** | (0.003)*** | (0.004)*** | (0.008)*** | (0.003)*** | (0.016)*** |
| $\sigma_{\eta}^{2}$ | 1.040 | 1.077 | 1.240 | 0.989 | 1.094 | 0.917 | 1.080 | 0.996 |
| | (0.053)*** | (0.227)*** | (0.041)*** | (0.024)*** | (0.023)*** | (0.051)*** | (0.022)*** | (0.069)*** |
| $\beta$ | 1.067 | 0.866 | 1.140 | 0.714 | 0.909 | 0.555 | 0.965 | 0.404 |
| | (0.557)* | (0.157)*** | (0.380)*** | (0.130)*** | (0.169)*** | (0.179)*** | (0.167)*** | (0.246) |
| $N$ | 2,692 | 14,155 | 5,652 | 11,195 | 14,903 | 1,944 | 15,336 | 1,511 |
| P-val. test $\beta$=1 | 0.905 | 0.393 | 0.713 | 0.027 | 0.589 | 0.013 | 0.836 | 0.015 |

*Notes*: The table reports estimates of the parameters determining the relationship between the growth of target wealth and the stochastic income process. Observations on (residual) target wealth and earnings growth are winsorized at the top and bottom 0.5%. Columns (1) an (2) estimate the baseline specification for poor and rich households (with financial wealth less or more than 2 months income); column (3) and (4) for low and high education (up to junior high school, over junior high school); and columns (5) and (6) for occupation. Standard errors are reported in parenthesis. ***, **, and * indicate statistical significance at the 1%, 5% and 10% confidence level, respectively.

## Table 4. GMM Robustness Results

| | Year $\geq$ 2010 | Year $\leq$ 2012 | No winsorization |
|---|---|---|---|
| | (1) | (2) | (3) |
| $\sigma_{\zeta}^2$ | 0.022 | 0.010 | 0.026 |
| | (0.003)*** | (0.004)*** | (0.004)*** |
| $\sigma_e^2$ | 0.053 | 0.075 | 0.067 |
| | (0.004)*** | (0.006)*** | (0.005)*** |
| $\sigma_{\eta}^2$ | 0.973 | 1.198 | 1.018 |
| | (0.023)*** | (0.037)*** | (0.021)*** |
| $\beta$ | 1.004 | 1.668 | 0.667 |
| | (0.189)*** | (0.645)*** | (0.130)*** |
| $N$ | 11,719 | 9,285 | 16,732 |
| P-value test $\beta$=1 | 0.982 | 0.301 | 0.011 |

*Notes*: The table reports estimates of the parameters determining the relationship between the growth of target wealth and the stochastic income process using the baseline model. Column (1) includes only observations in 2010-16; column (2) includes only observations in 2002-2012. In Columns (1)-(2) observations on (residual) target wealth and earnings growth are winsorized at the top and bottom 0.5%. In Column (3) observations are not winsorized. Standard errors are reported in parenthesis. ***, **, and * indicate statistical significance at the 1%, 5% and 10% confidence level, respectively.

**Table 5. Adjustment to Target Wealth:**

**Baseline and Sample Splits by Age, Education, Occupation, and Wealth**

| | Baseline | Age ≤ 45 | Age > 45 | No College | College | Employees | Self-Employed | Poor | Rich |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Lagged wealth gap | -0.208 | -0.162 | -0.217 | -0.208 | -0.254 | -0.206 | -0.236 | -0.281 | -0.282 |
| | (0.008)*** | (0.012)*** | (0.009)*** | (0.006)*** | (0.021)*** | (0.007)*** | (0.023)*** | (0.011)*** | (0.009)*** |
| Age | -0.055 | -0.102 | -0.010 | -0.128 | 0.039 | -0.063 | -0.018 | -0.046 | -0.085 |
| | (0.038) | (0.086) | (0.056) | (0.038)*** | (0.072) | (0.039) | (0.077) | (0.056) | (0.043)** |
| Age sq./100 | 0.027 | -0.026 | -0.002 | 0.031 | 0.070 | 0.032 | -0.001 | -0.091 | 0.032 |
| | (0.008)*** | (0.078) | (0.012) | (0.009)*** | (0.033)** | (0.009)*** | (0.051) | (0.019)*** | (0.014)** |
| Family size | 0.160 | 0.125 | 0.177 | 0.166 | 0.100 | 0.157 | 0.172 | 0.178 | 0.122 |
| | (0.016)*** | (0.051)** | (0.023)*** | (0.018)*** | (0.060)* | (0.020)*** | (0.055)*** | (0.025)*** | (0.020)*** |
| Married | 0.146 | 0.236 | 0.119 | 0.125 | 0.282 | 0.149 | 0.144 | 0.152 | 0.125 |
| | (0.072)** | (0.111)** | (0.069)* | (0.067)* | (0.137)** | (0.058)** | (0.195) | (0.096) | (0.058)** |
| *N* | 16,644 | 2,630 | 14,014 | 14,711 | 1,933 | 15,138 | 1,506 | 5,587 | 11,057 |

*Note*. Demographic variables are in first differences. All regressions also include year dummies. The lagged wealth gap is $\ln\left(\frac{W_{it-1}}{W^*_{it-1}}\right)$. Column (1) reports the baseline specification. Columns (2) and (3) estimate the baseline specification for a sample of young households (aged 45 or less) and older households (aged more than 45); columns (4) and (5) for low and high education (up to junior high school, over junior high school); columns (6) and (7) for a sample of employees and self-employed; and columns (8) and (9) for poor and rich households (with financial wealth less or more than 2 months income). ***, **, and * indicate statistical significance at the 1%, 5% and 10% confidence level, respectively. Block bootstrap standard errors (clustered at the household level) are reported in parenthesis.

**Table 6. Adjustment to Target Wealth:**
**IV, Revised Cash-on-hand, and Asymmetric Behavior**

| | IV | Revised cash-on-hand | Gap below/ above target |
|---|---|---|---|
| | (1) | (2) | (3) |
| Lagged wealth gap | -0.135 | -0.196 | |
| | (0.023)*** | (0.009)*** | |
| Age | -0.093 | -0.023 | -0.057 |
| | (0.055)* | (0.036) | (0.038) |
| Age sq./100 | -0.005 | 0.013 | 0.030 |
| | (0.015) | (0.011) | (0.008)*** |
| Family size | 0.170 | 0.146 | 0.160 |
| | (0.027)*** | (0.015)*** | (0.017)*** |
| Married | 0.166 | 0.182 | 0.153 |
| | (0.077)** | (0.059)*** | (0.072)** |
| Lagged wealth gap > 0 | | | -0.108 |
| | | | (0.015)*** |
| Lagged wealth gap ≤ 0 | | | -0.286 |
| | | | (0.008)*** |
| *N* | 7,879 | 16,575 | 16,644 |

*Note*. Demographic variables are in first differences. All regressions also include year dummies. The lagged wealth gap is $\ln\left(\frac{W_{it-1}}{W^*_{it-1}}\right)$. In the Instrumental Variable (IV) regression of column (1), the instrument is the second lag of the wealth gap. In column (2) we use a revised definition of cash-on-hand: we include valuables, subtract rents and include transitory income components (severance payments, insurance reimbursements, scholarships, non-recurrent gifts). Column (3) distinguishes between positive and negative wealth gaps, as in equation (12). ***, **, and * indicate statistical significance at the 1%, 5% and 10% confidence level, respectively. Block bootstrap standard errors (clustered at the household level) are reported in parenthesis.

**Table 7. Estimated Adjustment to Target Wealth for Different Parameter Values**

| $r$ | $\gamma$ | $(1+\delta)^{-1}$ | $\lambda$ (Implied years to close the gap) | $\lambda^{below}$ (Implied years to close the gap) | $\lambda^{above}$ (Implied years to close the gap) |
|---|---|---|---|---|---|
| 1.03 | 2 | 0.92 | -0.259 | -0.309 | -0.228 |
| | | | (7.72) | (6.47) | (8.77) |
| 1.01 | 2 | 0.94 | -0.249 | -0.296 | -0.220 |
| | | | (8.02) | (6.76) | (9.08) |
| 1.03 | 1.5 | 0.94 | -0.241 | -0.306 | -0.203 |
| | | | (8.31) | (6.53) | (9.84) |
| 1.03 | 2.5 | 0.90 | -0.240 | -0.297 | -0.201 |
| | | | (8.35) | (6.73) | (9.95) |
| 1.01 | 2.5 | 0.92 | -0.225 | -0.281 | -0.187 |
| | | | (8.89) | (7.12) | (10.71) |
| 1.01 | 3 | 0.90 | -0.187 | -0.234 | -0.148 |
| | | | (10.70) | (8.54) | (13.48) |
| 1.04 | 2.5 | 0.90 | -0.165 | -0.233 | -0.119 |
| | | | (12.10) | (8.57) | (16.74) |
| 1.04 | 2 | 0.92 | -0.158 | -0.231 | -0.109 |
| | | | (12.65) | (8.64) | (18.35) |
| Data | | | -0.208 | -0.286 | -0.108 |
| | | | (9.62) | (6.99) | (18.52) |

*Note*. See Appendix A2 for details. $\lambda$ is the coefficient of a regression of $\ln\left(\frac{W_{it}}{W_{it-2}}\right)$ on $\ln\left(\frac{W_{it-2}}{W^*_{it-2}}\right)$ using data generated from simulating a buffer stock model for *N*=20,000 agents. The "implied years to close the gap" is computed as $1/(\lambda/2)$. In the last two columns we use again simulated data and obtain estimates of $\lambda^{below}$ and $\lambda^{above}$ as coefficients of a regression of $\ln\left(\frac{W_{it}}{W_{it-2}}\right)$ on $\ln\left(\frac{W_{it-2}}{W^*_{it-2}}\right)\mathbf{1}\{\ln\left(\frac{W_{it-2}}{W^*_{it-2}}\right) \leq 0\}$ and $\ln\left(\frac{W_{it-2}}{W^*_{it-2}}\right)\mathbf{1}\{\ln\left(\frac{W_{it-2}}{W^*_{it-2}}\right) > 0\}$, respectively, with the "implied years to close the gap" computed accordingly. The last row ("Data") reports the coefficients estimated in the baseline wealth adjustment regression of column (1) of Table 5, and of the regression in column (3) of Table 6, distinguishing between adjustment below and above target.

## Appendix

### A.1. The wealth adjustment equation (11)

Here we show that equation (11) is an approximation of the relationship linking the growth in the wealth-to-permanent income ratio to the lagged wealth gap ratio. In particular, write the adjustment equation in terms of quantities normalized in relation to permanent income:

$$x_{it} - x_{it-1} = \lambda(x_{it-1} - x_{it-1}^{*})$$

where $x = W/P$ is the (gross) wealth-to-permanent income ratio, and $x^{*} = W^{*}/P$ is its target (gross) wealth equivalent. Using these definitions, the adjustment equation can be rewritten as:

$$\frac{W_{it}}{P_{it}} - \frac{W_{it-1}}{P_{it-1}} = \lambda\left(\frac{W_{it-1}}{P_{it-1}} - \frac{W_{it-1}^{*}}{P_{it-1}}\right)$$

Multiplying both sides by $P_{it-1}/W_{it-1}$ yields:

$$\frac{W_{it}}{W_{it-1}}\frac{P_{it-1}}{P_{it}} - 1 = \lambda\left(1 - \frac{W_{it-1}^{*}}{W_{it-1}}\right)$$

and, rearranging terms:

$$1 + g_{w_t} = (1 + g_{P_t})(1 - \lambda g_{w_{t-1}^{*},w_{t-1}})$$

where $g_{w_t}$ and $g_{P_t}$ are the current growth rates of wealth and permanent income, respectively, and $g_{w_{t-1}^{*},w_{t-1}} = \frac{W_{t-1}^{*} - W_{t-1}}{W_{t-1}}$ is the lagged gap between target and actual wealth (normalized by actual wealth). Taking logs on both sides, and using the log approximations $\ln(1 \pm a) \approx \pm a$, we obtain:

$$\ln W_{it} - \ln W_{it-1} \approx \lambda(\ln W_{it-1} - \ln W^*_{it-1}) + \zeta_{it}$$

which is equation (11) (without demographic controls). Note that the error term of this approximation is the innovation to permanent income, which is by assumption orthogonal to lagged realization of the wealth gap ratio. Hence, an OLS regression of $(\ln W_{it} - \ln W_{it-1})$ on $(\ln W_{it-1} - \ln W^*_{it-1})$ recovers an unbiased estimate of the adjustment coefficient $\lambda$.

The advantage of using this approximation is that we do not need an estimate of permanent income and can rely only on observable variables (actual and target wealth).

**A2. Simulations of a Buffer Stock Model**

We consider a standard version of the Buffer Stock model in which life cycle consumers solve:

$$\max E_t \sum_{t=0}^{T} (1+\delta)^{-t} \frac{C_t^{1-\gamma}}{1-\gamma}$$

s.t. $A_{t+1} = (1+r)A_t + Y_{t+1} - C_{t+1}$ for all $t$. We omit the subscript $i$ for simplicity. The (log) income process contains both a transitory i.i.d. component $\varepsilon_{it}$ and a permanent, random walk component as in equations (1)-(2):

$$\ln Y_t = \ln P_t + \varepsilon_t \quad (1)$$

$$\ln P_t = \ln P_{t-1} + \zeta_t \quad (2)$$

where $\zeta_t$ is the i.i.d. revision in permanent income. We follow the Deaton's (1991) version of the buffer stock model and impose an explicit borrowing constraint such that $A_t \geq 0$ for all $t$. Deaton (1991), Ludvigson and Michaelides (2001), and Luengo-Prado and Sørensen (2004) describe the nature of the solution. In particular, one can reformulate the model in terms of cash-on-hand, $W_t =$

$(1+r)A_{t-1}+Y_t$, rewriting the budget and borrowing constraints as $W_{t+1}=(1+r)(W_t-C_t)+Y_{t+1}$ and $C_t \leq W_t$ for all $t$, respectively. The Euler equation associated with this problem is:

$$u'(C_t)=\max\left\{u'(W_t),\frac{1+r}{1+\delta}E_t u'(C_{t+1})\right\}$$

After normalizing all variables by the level of permanent income to eliminate non-stationarity, the Euler equation can be solved numerically by backward induction (in the last period $C_T=W_T$) to obtain a "consumption" function, i.e., the consumption/permanent income ratio as a function of the cash-on-hand/permanent income ratio, or $c_t(x_t)$.

We simulate the behavior of $N$=20,000 consumers over $T$=150 periods (allowing 50 burn-in periods). Consumers are born with zero assets and leave no bequests since there is no uncertainty about the time horizon. We choose the variances of permanent and transitory income shocks as in the baseline specification of Table 2 ($\sigma_\zeta^2$=0.021 and $\sigma_\varepsilon^2$=0.056, respectively).

In Table 7, we experiment for a range of values for: (a) the coefficient of relative risk aversion ($\gamma=1.5$ to $\gamma$=3), (b) the interest rate ($r$=0.01 to $r$=0.04); (c) and the intertemporal discount rate ($\frac{1}{1+\delta}=0.9$ to $\frac{1}{1+\delta}=0.94$). In all cases, the consumer is "impatient" in the sense implied by the buffer-stock model (since $\frac{1+r}{1+\delta}<1$) and prudent (since $\gamma>0$).

Our simulations produce, for each consumer and period, a sequence of income and asset choices (and hence cash-on-hand $W$). The model also produces a value for target wealth $W^*$. We can thus estimate in the simulated data the same adjustment regression we estimate in the data (excluding the contribution of observable characteristics), including the fact that our data are biannual:

$$\ln\left(\frac{W_{it}}{W_{it-2}}\right)=\alpha+\lambda\ln\left(\frac{W_{it-2}}{W_{it-2}^*}\right)+e_{it}$$

The objective is to compare the value of $\lambda$ estimated in the simulated data with that estimated in the actual data. Table 7 reports the estimated $\lambda$ and the implied years to close the gap between actual and target wealth (obtained as $-1/(\lambda/2)$).

In the data (last row of Table 7) , the baseline estimate of $\lambda = -0.208$ (with a 95% confidence interval (-0.224, -0.193)), so that it takes about 9.6 years to close the gap (with a 95% confidence interval (8.88, 10.32), computed using the delta method). While this exercise cannot pin down the combination of the three parameters $(r, \gamma, (1+\delta)^{-1})$ that would replicate exactly the adjustment we observe in the data, it shows that realistic combinations of the three parameters would achieve that. For example, Carroll (2010) considers values for the interest rate ranging from 2% to 6%; relative risk aversion between 1 and 4; and discount rates between 0.9 and 0.98, in the ballpark of the values used in the table above.

In the last two columns of Table 7, we use the simulated data to run a version of the equation above but distinguishing between adjustment when consumers are below the target and when they are above:

$$\ln\frac{W_{it}}{W_{it-2}} = \alpha + \lambda^{below}\left(\ln\frac{W_{it-2}}{W_{it-2}^{*}}\right)\mathbf{1}\left\{\left(\ln\frac{W_{it-2}}{W_{it-2}^{*}}\right) \leq 0\right\} + \lambda^{above}\left(\ln\frac{W_{it-2}}{W_{it-2}^{*}}\right)\mathbf{1}\left\{\left(\ln\frac{W_{it-2}}{W_{it-2}^{*}}\right) > 0\right\} + e_{it}$$

The last two columns in Table 7 report the estimates of $\lambda^{below}$ and $\lambda^{above}$ obtained in the simulated data and (in parenthesis) the implied years it would take to fill the gap between actual and target wealth.

# Online Appendix

# Permanent Income Shocks, Target Wealth, and the Wealth Gap

**Tullio Jappelli and Luigi Pistaferri**

# Online Appendix B

## B.1. Target Wealth Questions in the 2002-2016 SHIW

The wording of the questions we use to measure target wealth change across the various SHIW waves. In 2002, 2004, 2010, the question is as follows:

> *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?*

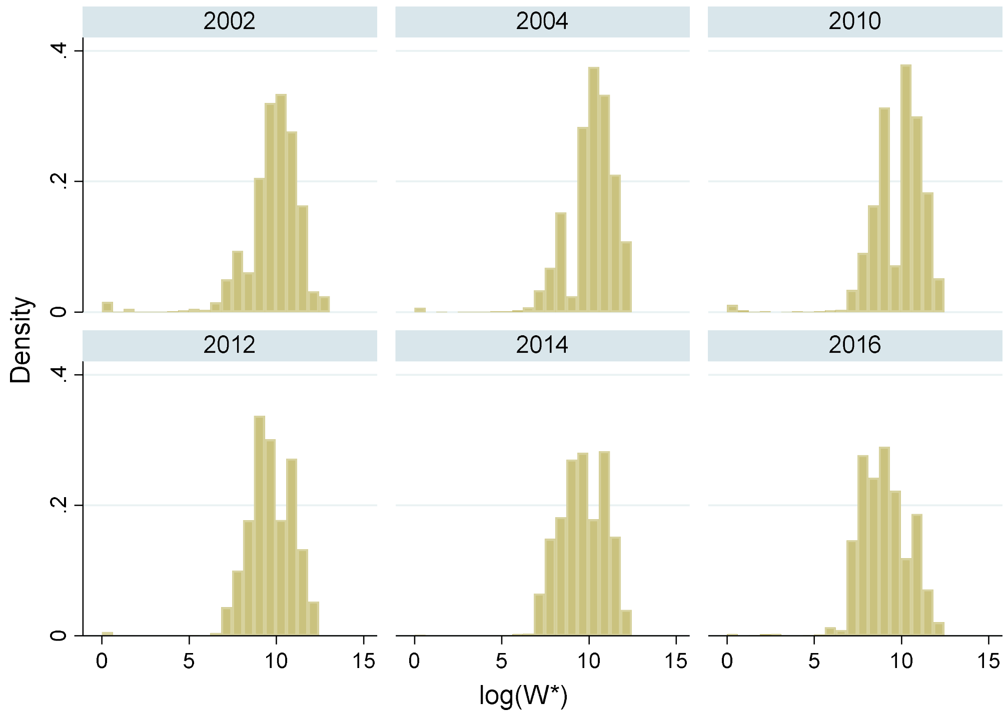
In 2012, the wording is:

> *People save in various ways (depositing money in a bank, buying financial assets, property, or other assets) and for different reasons. One 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?*

Finally, in the last two waves (2014 and 2016) the wording is:

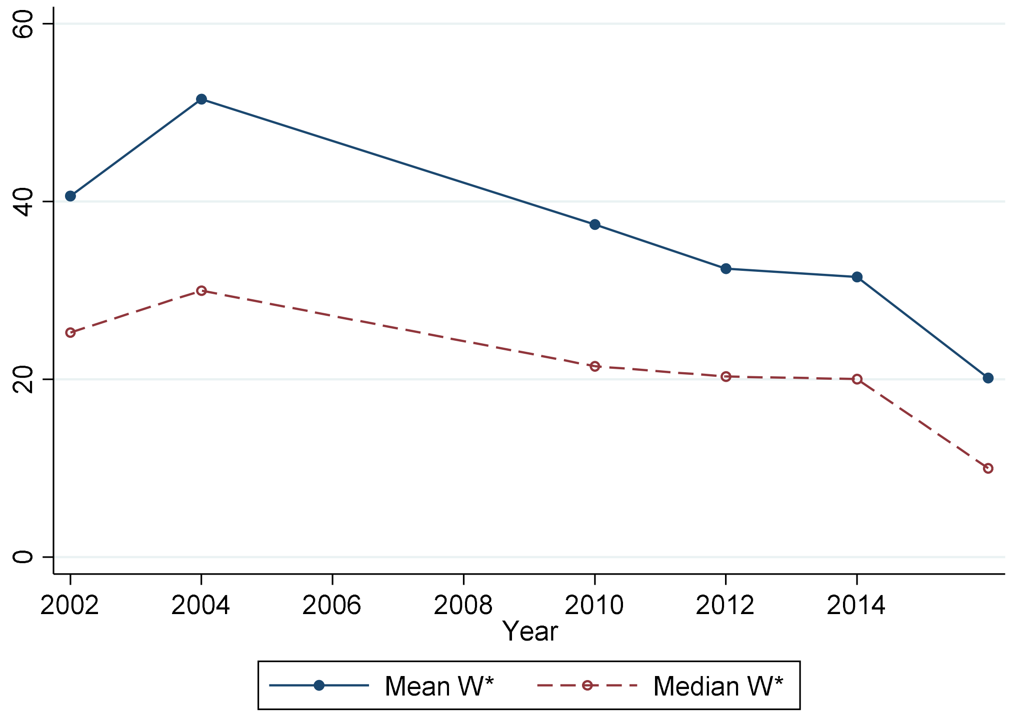
> *About how much do you think you and your family need to have in savings to meet unexpected events, such as health problems or other emergencies?*

**Figure B.1: The Distribution of Target Wealth**




*Note.* The figure plots the cross-sectional distribution of the log of target wealth from 2002 to 2016.

**Figure B.2: Mean and median target wealth, 2002-2016**




Note. The figure plots average and median target wealth from 2002 to 2016 (in thousands euro).

## Table B.1: Descriptive statistics

| 2002-2012 | Total sample | | | Panel sample | | |
|---|---|---|---|---|---|---|
| | Mean | Median | SD | Mean | Median | SD |
| Target wealth ($W^*$) | 40,413.32 | 21,479.96 | 47,533.66 | 38,857.41 | 21,479.96 | 45,841.52 |
| Consumption | 25,868.45 | 22,124.36 | 15,680.63 | 26,419.88 | 22,876.16 | 15,588.66 |
| Income ($Y$) | 26,609.26 | 21,586.5 | 21,264.31 | 26,959.09 | 22,339.16 | 19,686.29 |
| Cash-on-hand ($W$) | 29,220.39 | 9,554.32 | 83,836.68 | 31,536.31 | 10,484.16 | 89,130.91 |
| Wealth gap: $(W - W^*)$ | -11,192.93 | -8,153.42 | 89,416.26 | -7,321.1 | -6,848.22 | 93,269.37 |
| $\mathbf{1}\{(W - W^*) < 0\}$ | 0.70 | 1 | 0.46 | 0.68 | 1 | 0.46 |
| $W^*/Y$ | 2.08 | 1.03 | 12.91 | 1.92 | 1 | 7.11 |
| Years of education | 9.01 | 8 | 4.59 | 9.29 | 8 | 4.58 |
| Age | 57.95 | 58 | 15.79 | 59.07 | 59 | 15.01 |
| Male | 0.58 | 1 | 0.49 | 0.58 | 1 | 0.49 |
| Family size | 2.53 | 2 | 1.27 | 2.54 | 2 | 1.28 |
| Married | 0.63 | 1 | 0.48 | 0.64 | 1 | 0.48 |
| Observations | | 31,144 | | | 17,257 | |

| 2014-2016 | Total sample | | | Panel sample | | |
|---|---|---|---|---|---|---|
| | Mean | Median | SD | Mean | Median | SD |
| Target wealth ($W^*$) | 26,084 | 10,015 | 33,884 | 26,889 | 15,000 | 34,242 |
| Consumption | 22,789 | 19,300 | 13,882 | 23,441 | 20,000 | 14,397 |
| Income ($Y$) | 24,139 | 19,530 | 18,509 | 24,963 | 20,129 | 18,850 |
| Cash-on-hand ($W$) | 30,633 | 8,106 | 109,640 | 32,685 | 8,410 | 115,673 |
| Wealth gap: $(W - W^*)$ | 4,548 | -2,509 | 108,653 | 5,796 | -2,350 | 114,518 |
| $\mathbf{1}\{(W - W^*) < 0\}$ | 0.61 | 1 | 0.49 | 0.61 | 1 | 0.49 |
| $W^*/Y$ | 1.35 | 0.66 | 5.39 | 1.4 | 0.67 | 6.56 |
| Years of education | 9.57 | 8 | 4.54 | 9.83 | 8 | 4.55 |
| Age | 61.54 | 62 | 15.69 | 61.96 | 63 | 15.07 |
| Male | 0.52 | 1 | 0.50 | 0.52 | 1 | 0.50 |
| Family size | 2.3 | 2 | 1.24 | 2.36 | 2 | 1.24 |
| Married | 0.55 | 1 | 0.5 | 0.58 | 1 | 0.49 |
| Observations | | 15,425 | | | 8,450 | |

*Note*. Consumption is non-durable consumption. Income is the sum of labor income (from employment and self-employment) and transfers.