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ABSTRACT

Consumption Growth, the Interest Rate, and Financial Literacy*

We study a model in which financial sophistication improves portfolio returns and therefore the incentive to substitute consumption intertemporally. The model delivers a Euler equation in which consumption growth is positively correlated with financial sophistication. We test the model's prediction using panel data on consumption and financial literacy from the Italian Survey of Household Income and Wealth (SHIW) and an appropriate instrumental variables procedure. We find that consumption growth is positively correlated with financial literacy. Under plausible assumptions, we provide estimates of the intertemporal elasticity of substitution that are in line with those in the literature (between 0.2 and 0.4). We complement our results with direct evidence on the link between financial literacy and return on saving.

JEL Classification: D8, E2, G1 and J24
Keywords: consumption growth, Euler equation and financial literacy

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1 Introduction

The permanent income hypothesis suggests that a crucial factor explaining the growth rate of consumption is the incentive to substitute consumption over time (Hall, 1978). The incentive depends on the expected interest rate and is measured by the elasticity of intertemporal substitution (EIS). EIS is an essential ingredient of macroeconomic models. For example, if elasticity is high, consumers respond to small reductions in the real interest rate by increasing current consumption. Therefore, an aggregate demand shock that increases the expected real interest rate might induce a significant reduction in consumption, offsetting the demand shock. Obtaining an estimate of EIS therefore is crucial for assessing the effectiveness of fiscal and monetary policies, and for assessing many other policy issues.

The most common approach to estimating EIS is the Euler equation for consumption, which can be applied to aggregate time series or household level data. However, estimating EIS is not straightforward. First, there is the problem of endogeneity of the interest rate, so the Euler equation is usually estimated by Instrumental Variables (IV) because the error term of the equation (consumption innovation) might be correlated with the interest rate. An early application is Hall (1988), which uses various measures of real interest rate and different sampling periods, and concludes that, at least for the U.S., the EIS is close to zero. Campbell (2003) also finds low values of EIS for the OECD countries.

Attanasio and Weber (1993) and Attanasio and Low (2004) point out that aggregation problems and the role of demographic and labor supply variables mean that EIS can be estimated properly only by using microeconomic data.

Empirical evidence based on micro data results in higher EIS values but given the limited cross-sectional variability of the interest rate these estimates are rather imprecise. Attanasio and Weber (1995) use data from the U.S. Consumer Expenditure Survey and obtain positive values for EIS, though they are small in absolute value (between 0.2 and 0.4) and rarely statistically different from zero. Zeldes (1989) uses the after-tax interest rate, subtracting the marginal tax rate on unearned income from the nominal interest rate, and finds an EIS of about 0.4 for a sample of high-wealth consumers. Shea (1994) finds higher values (between 1 and 2) using data from the Panel Study of Income Dynamics, but in both studies these numbers are imprecisely estimated.

In the present paper, building on Arrow's (1987) insight, we posit that financial literacy and financial sophistication allow consumers to access better investment opportunities. We derive a Euler equation that shows that the interest rate sensitivity of consumption growth depends on the incentives to acquire financial information, which can be interpreted as the return to financial literacy (or to financial sophistication). The model implies that the growth rate of consumption is higher for "high-information", "high-returns" individuals, i.e. individuals who have a greater incentive to save in the current period and to postpone consumption to later periods. From a methodological point of view, we show that the effect of the interest rate on the growth rate of consumption should take account of the incentive to acquire financial information as well as the effect of information on wealth accumulation. Failure to take account of this channel results in inconsistent estimates of the EIS, given the omission of an explanatory variable from the Euler equation. From an empirical point of view, we identify an important source of heterogeneity in interest rates that helps to pin down the interest rate effect on consumption growth.

For our empirical application we use Italian panel data with information on consumption and financial literacy. We recognize that financial literacy is an endogenous variable in the consumer optimization problem, and implement an IV approach using as instruments for financial literacy parents' educational background, and whether one has a degree in economics. The results indicate that financial literacy is positively associated with consumption growth, consistent with the model's prediction. Under plausible assumptions about the relation between financial literacy and the return to saving, we provide estimates of the EIS that are in line with available empirical studies (between 0.2 and 0.4). Splitting the sample by wealth indicators, we find that the correlation between financial literacy and consumption growth applies only to the sample of high-wealth households, which are less likely to face borrowing constraints and more likely to smooth consumption intertemporally. Our empirical strategy has some limitations, i.e. that in the absence of these additional assumptions we cannot disentangle the pure interest rate effect (the EIS) from the effect of financial literacy on the interest rate.

The remainder of the paper is organized as follows. Section 2 presents a model of financial literacy and wealth accumulation, where individuals face income uncertainty and must choose how much to consume and how much to invest in financial literacy in each period. Section 3 describes the data, our measure of consumption and the indicators of financial literacy. Section 4 discusses the econometric issues that arise in estimating the Euler equation for consumption and presents the empirical results. Section 5 complements our results with direct evidence on the link between financial literacy and the return to saving. Section 6 concludes.

2 The model

We integrate investment in financial literacy in a standard model of intertemporal choice. The model emphasizes that, like other forms of human capital, financial information can be accumulated, and that the decision to invest in financial literacy has costs and benefits. On the costs side, investing in financial literacy requires time and monetary resources. On the benefits side, financial literacy allows consumers to access better investment opportunities, thereby raising the return on each euro saved. To the best of our knowledge, Arrow (1987) was the first to propose, in a theoretical model, the idea that investors can increase the payoff from their financial portfolios by acquiring information on the rate of return. The assumption is consistent with many empirical studies showing that there is substantial dispersion in portfolio returns across households, and that portfolio performance is associated with financial sophistication and investors' experience (see for instance Calvet *et al.*, 2007). In Section 5 we discuss this literature in more detail.

We illustrate the role of financial literacy in a multi-period model with endogenous saving and investment in financial information.[1] More specifically, we consider an intertemporal model in which consumers live for T periods (from 0 to $T-1$) and die at the end of period $T-1$, so that they consume their entire wealth and income in the final period $T-1$. The return to saving is the interest rate factor R_{t+1}, which is paid at the beginning of each period on wealth transferred from period t to period $t+1$. We assume that the gross rate of return depends on the level of financial literacy according to:

$$R_{t+1} = f(\Phi_{t+1}) \tag{1}$$

Raising the stock of financial literacy allows consumers to access better investment opportunities and/or save on transaction costs and fees, so that $f'(\Phi_{t+1}) > 0$. It is also plausible, but not necessary for our argument, to assume $f''(\Phi_{t+1}) \leq 0$, that is either constant or decreasing returns to literacy. Each period, financial literacy can be acquired at a price p, depreciates at a rate δ and evolves according to:

$$\Phi_{t+1} = (1-\delta)\Phi_t + \phi_t$$

where ϕ_t is gross-investment in financial literacy. The initial stock of literacy Φ_0 is what people know about finance before entering the labor market. Therefore the initial stock is related to schooling decisions and parental background, neither of which we model explicitly. We assume that earnings y_t are uncertain, and denote wealth and consumption by A_t and c_t and the discount factor by β.

The value function of the optimization problem is:

$$V_0(A_0, \Phi_0) = \max_{\{c_t, \Phi_{t+1}\}} E_0 \sum_{t=0}^{T-1} \beta^t u(c_t)$$

where $u(c_t)$ is the period utility function. The value function satisfies the recursion:

$$V_t(A_t, \Phi_t) = \max_{\{c_t, \Phi_{t+1}\}} [u(c_t) + \beta E_t V_{t+1}(A_{t+1}, \Phi_{t+1})]$$

[1] In related work, Jappelli and Padula (2011) study the implication of a model with endogenous accumulation of financial information for the age-profiles of wealth and financial literacy in the presence of social security.

where:

$$A_{t+1} = f(\Phi_{t+1})\left[A_t + y_t - c_t - p\Phi_{t+1} + p(1-\delta)\Phi_t\right]$$

Appendix A shows that the Euler equation of the problem is:

$$u'(c_t) = \beta f(\Phi_{t+1}) E_t u'(c_{t+1}) \tag{2}$$

and that Φ_{t+1} evolves according to the following recursion:

$$[s_t f'(\Phi_{t+1}) - p f(\Phi_{t+1})] + p(1-\delta) = 0 \quad \text{for} \quad t \leq T-3 \tag{3}$$

$$p f(\Phi_{t+1}) - s_t f'(\Phi_{t+1}) = 0 \quad \text{for} \quad t = T-2 \tag{4}$$

where s_t is cash-on-hand and is defined as $s_t = [A_t + y_t - c_t - p\Phi_{t+1} + p(1-\delta)\Phi_t]$.

Equation (2) is the standard Euler equation for consumption, and states that the marginal rate of substitution between consumption in any two periods equals the interest rate factor, which in turn depends on the stock of financial literacy. Equation (3) states that in equilibrium the marginal return from financial literacy, $s_t f'(\Phi_{t+1})$ equals the cost of literacy, $p\,[f(\Phi_{t+1}) - (1-\delta)]$. Note also that in our model the interest rate is non-stochastic. However, the model can be easily extended to the case of stochastic returns, with the modification that the error term of the Euler equation includes also the covariance between the interest rate and consumption growth.

We can immediately verify that if the utility function is isoelastic, after taking logs, equation (2) can be written as:

$$\Delta \ln c_{t+1} = \sigma \ln \beta + \sigma \ln f(\Phi_{t+1}) + \epsilon_{t+1} \tag{5}$$

where σ is the elasticity of intertemporal substitution and ϵ_{t+1} is a composite error term which includes the conditional variance of consumption growth and innovation in consumption (the difference between realized and expected consumption, $c_{t+1} - E_t c_{t+1}$). The expression indicates that consumption growth is positively correlated with the stock of financial literacy, to an extent that depends on the elasticity of substitution σ.

Equation (5) provides the framework of our empirical analysis. The equation is an equilibrium condition because both $\Delta \ln c_{t+1}$ and Φ_{t+1} are endogenous variables. To make it operational we need to find instruments that are correlated with literacy but uncorrelated with the consumption innovation term of the Euler equation.

3 Data

Estimation of the Euler equation (5) requires panel data on consumption and data on financial literacy. The panel included in the 2006-10 Survey of Household Income and Wealth (SHIW) meets this requirement. It offers widely used indicators of financial literacy, an annual measure of non-durable consumption that is not affected by seasonality factors, and detailed demographic, income, and wealth data. The SHIW is a biannual survey of a representative sample of the Italian population conducted by the Bank of Italy covering about 8,000 households and 24,000 individuals. Details of the questionnaire, sample design, response rates and comparison of survey data with macroeconomic data are provided in Faiella *et al.* (2008), in Bartiloro *et al.* (2010), in Biancotti *et al.* (2012).

The SHIW includes a rotating panel component: in each survey, about 45% of the households are also interviewed two years later.[2] Most importantly for the present study, the 2008 and 2010 SHIW contains three core questions on financial literacy: interest rate compounding, portfolio diversification, and understanding of mortgage contracts (the wording of the questions is reported in Appendix B). The first two questions are the same questions as posed in the U.S. Health and Retirement Survey (HRS); together with a question on understanding the difference between nominal and real interest rates, they have become a standard tool to measure financial literacy (Lusardi and Mitchell, 2011). The question on understanding mortgage contracts is one of two questions posed in the 2009 National Finan-

[2]SHIW data are collected through personal interviews. Questions concerning the whole household (such as consumption and wealth) are addressed to the household head or the person most knowledgeable about the family's finances; wherever possible, questions about individual incomes are answered by the individual household member. The unit of observation is the family, which is defined as including all persons residing in the same dwelling who are related by blood, marriage, or adoption. Individuals described as "partners or other common-law relationships" are also treated as family.

cial Capability Survey (Lusardi, 2011). Therefore our indicators of financial literacy include three out of the five standard questions on financial literacy.[3]

Table 1 reports the distribution of the financial literacy indicators, merging 2008 and 2010 data. It is apparent that a considerable number of respondents have limited understanding of financial matters: 72.7 percent correctly answered the compound interest question, 64.8 percent gave right answers the mortgage question, but only 48.5 percent correctly answered the diversification question. Overall, there were only 32.8 percent of correct answers to all the questions. The pattern agrees with the evidence in Lusardi and Mitchell (2011), who use international data to show that financial illiteracy is widespread even in countries with well developed financial markets, such as Germany, the Netherlands, Sweden, Japan, Italy, New Zealand, and the United States. They report also that, in each of these countries, less well educated people, women, and older people are less well informed than the average. Table 1 also shows that financial literacy is strongly correlated with parental education, and with the individual having a college degree in economics; we use these background variables as an instrument for Φ_{t+1} in the Euler equation.

Our panel includes 4,345 households interviewed in 2006 and 2008, and 4,621 households interviewed in 2008 and 2010. Defining an "observation" as two years of data, this corresponds to 8,966 potential observations. We drop cases where the household head changed, and those with inconsistent data on age, gender or education, missing information on consumption or financial literacy, or where growth rate of consumption exceeds 100 percent (in absolute value). The final sample includes 8,743 observations (4,234 in 2006-08, 4,509 in 2008-10). Since in many cases we have only one observation per household, we test primarily if the cross-sectional variation in consumption growth is explained by the cross-sectional variation in financial literacy.

Table 2 reports descriptive statistics for the main variables used in the estimation. The

[3]Because these questions are parsimonious and have been used in numerous studies, Hastings *et al.* (2012) refer to the original HRS questions as "The Big Three" questions on financial literacy, and when combined with the NFCS questions, as the "Big Five" questions.

average yearly growth rate of consumption is 1.2 percent, but the average conceals considerable sample heterogeneity (the standard deviation of consumption growth is 0.276). The sample average of the financial literacy indicator is 1.86, which means that on average people gave the correct answer to less than two financial literacy questions. Our sample selection rules do not affect average income (9.97 before selection vs. 9.99 in Table 2), family size, fraction of household heads with a college degree in economics (1.2 percent), and the fraction of heads whose fathers and mothers have a college degree (2.3 and 0.8 percent, respectively). Average age is slightly lower in the selected sample in comparison with the original sample (58.01 vs. 60.01 years).

The main limitation of our dataset is that the panel is relatively short. Even though over long periods of time the forecast error in consumption growth should be zero on average, in the case of short panels it might not be. In some specifications therefore we augment the regression with regional dummies and group dummies to control, at least partly, for the effect of aggregate and group-specific shocks on the forecast error.

4 Empirical results

Our theoretical model delivers an equilibrium relation between consumption growth and financial literacy. However, it is important to stress that this is not a causal relation, because literacy and consumption are both endogenous variables, and are jointly determined in the optimization problem. Ordinary Least Squares (OLS) estimation of the Euler equation therefore will yield inconsistent estimates. To address the endogeneity problem, we rely on an IV strategy, using three background education variables as instruments for financial literacy: whether the respondent has a degree in economics and whether one of the respondent's parents has a college degree. As we shall see, the three instruments are strongly correlated with financial literacy. Our identification assumption is that the instruments are not correlated with the error term of the Euler equation, and in particular with heterogeneity in individual preferences. For instance, the assumption would be violated if parents' education is related to children's rate of time preferences.

Two previous studies use an IV approach to address the endogeneity between financial literacy and choice variables such as wealth, saving and portfolio composition. Christiansen *et al.* (2008) use a large register-based panel data set containing detailed information on Danish investors' educational attainment and financial and socioeconomic variables. The authors show that stockholding increases if individuals have completed an economics education program and if an economist becomes part of the household. To sort out the double causality between portfolio choice and the decision to become an economist, Christiansen *et al.* (2008) use better access to education due to the establishment of a new university, as an instrument for economics education. Behrman *et al.* (2010) use an IV approach to isolate the causal effects of financial literacy on wealth accumulation and wealth components in Chile, using as instruments school attendance and family background.[4] Other recent studies acknowledge the endogeneity of financial literacy with respect to saving decisions and point out that the incentives to invest in financial literacy can affect the relation between literacy and saving, see Delevande *et al.* (2008), Willis (2009), Calvet *et al.* (2009) and Lusardi *et al.* (2012).

As has become standard practice in the estimation of a Euler equation for consumption, we control for individual preferences using age and family size. The financial literacy variable is entered as the sum of the three indicators (thus it ranges from 0 to 3), or as three separate dummy variables. As the left-hand-side variable we use either the growth rate of non-durable consumption or the growth rate of total consumption (including the purchase of durable goods).

Note that we omit the conditional variance of consumption growth (which according

[4]Four instruments are factors indicative of where the respondents attended primary school, their age in 1981 when a national voucher program was implemented, and the macroeconomic conditions when they entered school and the labor market. The other instruments are indicators of family background (paternal and maternal education attainment, economic background in childhood, whether the respondent worked before the age of 15), and personality traits (risk aversion, positive and negative self esteem). Although the statistical tests suggest that the 11 instruments predict financial literacy, four coefficients are statistically different from zero in the first stage regression (economic background and enrollment rates during childhood).

to equation (5) appears in the error term). The omission is justified only if preferences are quadratic. In fact, if the utility function is isoelastic, households react to expected consumption risk by increasing the growth rate of consumption (lowering consumption in period t relative to period $t+1$) to an extent that depends on the degree of prudence. Empirically, it is difficult to find suitable proxies for consumption risk. The consequence of this omission is more serious in excess sensitivity tests, where the equation is augmented by expected income growth. Insofar as consumption risk is correlated with $E_{i,t}\Delta \ln y_{it+1}$, the latter proxies for the omitted effect of consumption risk, generating spurious evidence of excess sensitivity. In our context the omission of consumption risk is of less concern, because the main purpose of our analysis is to estimate the sensitivity of consumption growth with respect to financial literacy, not to perform an excess sensitivity test.[5]

4.1 Baseline results

Table 3 reports our baseline specification. The first stage regression displayed in the lower panel indicates that the coefficients of our instruments have the expected positive sign; two of the coefficients (college degree in economics and fathers' education) are statistically different from zero at the 1 percent level. In particular, having an economics degree improves the literacy score by 0.48, while father's college degree is associated with an increase in literacy of 0.33. Overall, the three instruments are powerful: the Anderson canonical correlation statistic on the three instruments is 54.84 and the F-test on the excluded instruments is 18.32. Furthermore, the Sargan test (0.295) does not reject the null hypothesis that the over-identifying restrictions are valid. The positive coefficient of family size in the first stage regression suggests the presence of externalities in financial management at the household level (the literacy indicator refers to the household head).

[5]Attanasio and Low (2004) consider conditions under which estimation of a log-linearized Euler equation for consumption yields consistent estimates of the preference parameters. They perform a Montecarlo experiment consisting of solving and simulating a simple life cycle model under uncertainty, and show that in most situations the estimates obtained from the log-linearized equation are not systematically biased. The only exception is when discount rates are very high.

Turning to the Euler equation estimates (upper panel in Table 3) we see that the age coefficient is positive and statistically different from zero, while the coefficient of family size is close to zero and imprecisely estimated. The coefficient of financial literacy is positive and statistically different from zero at the 5 percent level. Interpreting this coefficient requires some additional assumptions about the relation between the interest rate and financial literacy. Plausible assumptions on this relation suggest that each point of financial literacy is associated with an increase in the expected return to saving between 0.2 and 1 percent (see Section 5). Considering first the upper bound of this interval (1%), the coefficient implies an EIS of 0.088; the lower bound for the effect of literacy on the interest rate (0.2%) implies instead an EIS of 0.44.

The $0.1 - 0.4$ range for the EIS includes available estimates of the parameter that are commonly regarded as reliable (the mid-point of the interval is 0.25, implying a coefficient of relative risk aversion of 4). Of course, this calculation assumes that the unknown function $\ln f(\Phi_{t+1})$ directly maps into an interest rate function with realistic support for the interest rate. In the next section we provide further evidence that financial sophistication indeed improves portfolio performance, drawing on a special section of the SHIW (available only for 2010) and on evidence from other papers that investors' experience and financial literacy improve portfolio performance.

The second specification in Table 3 refers to total consumption (including the purchase of durable goods). Results are qualitatively similar, with a notable stronger effect of literacy (the coefficient is 0.11). The other two regressions in Table 3 restrict the sample to households with heads aged less than 65 years. Indeed, it may be more appropriate to focus attention on people in the labor force, who face rather different constraints and shocks to their resources (e.g., income and unemployment shocks) with respect to the elderly, for whom health shocks, bequest motives, and survival risk play more important roles. The results are largely confirmed. We still find a strong positive correlation between the instruments and literacy in the first stage estimates. Furthermore, dropping the elderly, the coefficient of literacy in the second stage is slightly higher (0.098 in column 3, and 0.13 in column 4).

In the baseline specification we construct the literacy indicator adding one point for each question answered correctly. Since this procedure is rather arbitrary, in Table 4 we present estimates obtained introducing the three dummies separately, distinguishing again between non-durable and total consumption, and reporting estimates for the full sample (upper panel) and the sample that excludes the elderly (lower panel). In all regressions the coefficient of the literacy indicator is positive, and is statistically different from zero in 10 out of 12 specifications (the exception is the regression for non-durable consumption when the literacy indicator is the risk diversification question). The coefficients are also similar in size, ranging from 0.19 (when for the full sample we use the interest rate question) to 0.40 (when for the the "20-65" sample we use the mortgage question). Assuming that responding correctly to one of the questions allows consumers to increase the return to saving by one percentage point, the results again suggest realistic values of the EIS (ranging from 0.2 to 0.4).

4.2 Robustness checks

In Table 5 we provide a further check for the stability of the results augmenting the Euler equation by a set of 19 regional dummies. The disturbance term ε_{t+1} in equation (5) is a forecast error, the difference between realized and expected consumption growth. According to the permanent income hypothesis with rational expectations, the conditional expectation of a forecast error should be zero, i.e. $E_t(\varepsilon_{i,t+1})$. The empirical analog of this expectation is an average taken over long periods of time, rather than across a large number of households.

As pointed out by Chamberlain (1984), there is no guarantee that the cross-sectional average of forecast errors will converge to zero as the dimension of the cross-section becomes larger. This typically happens in the presence of aggregate shocks which lead all households to revise expectations simultaneously. The problem is often handled by including time dummies in the Euler equation. This approach is restrictive because it rules out aggregate shocks being not evenly distributed in the population. Regional dummies can proxy for group-level shocks that might be correlated with other terms of the Euler equation, and checking the stability of the results is particularly useful if the panel is short (as in our case). However it is apparent from the estimates in Table 5 that our estimates are unaffected by the inclusion of these dummies.

The Euler equation that we estimate so far assumes that markets are perfect, that consumers can freely move resources over time, and therefore that there are no borrowing constraints. In the presence of such constraints, consumption growth is affected by households' resources.[6] Thus in Table 6 we add to the baseline specification (the log of) lagged disposable income as a proxy for current resources. We find a negative income coefficient (as predicted by models with borrowing constraints) but the coefficient of the literacy indicator is barely affected in this extended specification (0.11 in column 1 and 0.15 in column 3) even if we drop households where the respondent is over 65 (columns 3 and 4).

An alternative way to control for the presence of borrowing constraints is to focus on a sample of households that are unlikely to face such constraints. In Table 7 we implement Zeldes's (1989) classical approach and split the sample according to whether or not households have relatively high liquid assets (more than 2-months' income). In the high-wealth sample (about 62% of the total sample) the coefficient of literacy is 0.17 (0.16 if the 65+ are excluded), while in the low-wealth sample the coefficient is close to zero and not statistically different from zero. This result is remarkable, because the Euler equation fails in the presence of credit constraints, and should apply only to individuals who can smooth consumption over time.

[6]Note that liquidity constraints are not the only explanation of an effect of household resources on consumption growth. For instance, non separability between leisure and consumption or myopia might also explain this correlation.

5 Financial literacy and portfolio performance

Our empirical results provide meaningful estimates of the EIS only under the assumption that financial sophistication is correlated with portfolio performance, and that more sophisticated individuals expect higher returns on their wealth. We can offer several pieces of evidence to corroborate our findings, and to show that financial literacy is indeed correlated with portfolio performance.

The first evidence is that, at any point in time, there is substantial dispersion in portfolio returns, contrary to the assumption of standard intertemporal models in which all consumers have the same beliefs and purchase the same set of assets. Furthermore, part of portfolio performance is associated with financial sophistication. The evidence comes from detailed analysis of portfolio performance in Sweden, Germany, China, India, and other countries for which extensive panel data on individual accounts are available.

Calvet *et al.* (2007) and (2009) uncover substantial heterogeneity in account performance using Swedish data, and find that part of the variability of returns across investors is explained by financial sophistication. In particular, they show that predictors of financial sophistication (such as wealth, income, occupation and education) are associated with higher Sharpe ratios, and that richer and more sophisticated households invest more efficiently. Hackethal *et al.* (2012) use data on German brokerage accounts and find that years of experience tend to contribute to higher returns. This is consistent with other studies indicating that the magnitude of investment mistakes decreases with sophistication and experience. Feng and Seasholes (2005) find that investor sophistication and trading experience eliminate the reluctance to realize losses.[7]

Campbell *et al.* (2012) study investment strategies and performance of individual investors in Indian equities over the period 2002 to 2012.[8] Indian data provide no information

[7] See also Grinblatt and Keloharju (2001), Zhu (2002), and Lusardi and Mitchell (2007).

[8] They find substantial heterogeneity in the time-series average returns, with the 10^{th} percentile account under-performing by 2.6% per month and the 90^{th} percentile account over-performing by 1.23% per month

on the demographic characteristics of investors, and therefore the authors cannot measure financial sophistication using information about investors, as in Calvet *et al.* (2007) and (2009) or survey evidence about their financial literacy (as in Lusardi and Mitchell, 2007 and in the presebte paper). Instead, Campbell *et al.* (2012) study learning by relating account age (length of time since the account was opened) and past portfolio mistakes, to the performance of each account; they find that account performance improves significantly with account age, that stocks whose individual investors have older accounts tend to outperform the value-weighted Indian stock market, and that the increase is monotonic in account age. The difference in performance between the oldest and youngest accounts is 35 to 40 basis points per month (about 20 basis points per month in their lower estimates with further controls). Since older accounts have a smaller tendency to under-diversify, lower turnover, and a smaller disposition effect, these results suggests that learning is important among Indian individual investors.

A second piece of evidence comes from direct evidence available in the 2008 SHIW, but unfortunately not repeated in later years. Half of the sample was asked: *At which interest rate (not considering taxes) do you think you can invest without risk for a year (think of 1-year T-bills, or saving accounts)?* The cross-sectional average of the 3,156 valid answers (excluding 8 values with implausible values that exceed 10%) is 2.47 percent (median is 2), with a standard deviation of 1.48. Using this information, we can estimate the following approximation of equation (1):

$$r_{it} = \alpha_0 + \alpha_1 \Phi_{it} + \alpha_2 \Phi_{it}^2 + X_{it}' \gamma + \varepsilon_{it} \tag{6}$$

where r_{it} is the subjective risk-free rate, Φ_{it} is the same literacy variable used in the Euler equation (the sum of the three literacy indicators, or three separate dummy variables), and X_{it} a set of additional controls including age and its square, a dummy for gender, the log of family size, education, a dummy for an economic degree, and dummies for parents' education.

The first regression in Table 8 shows that financial sophistication is associated with a higher interest rate. The coefficient of literacy is positive (0.35) and statistically different from zero at the 5 percent level, indicating that for each correct question the associated subjective risk-free interest rate increases by 15 basis points. The square term is negative (-0.051); although the coefficient is not precisely estimated, it suggests that the highest impact of literacy on interest rates is at low literacy levels. Figure 1 plots the implied returns to literacy using the estimated coefficients of Φ_{t+1} and $\Phi_{t+1}^2$and shows that the range of financial literacy explains about 60 basis points of the subjective interest rate, and that the impact declines slightly at higher levels of literacy.

The second regression shows that the correlation does not change if we expand the specification by including demographic variables (age, gender, education, family size). In fact, none of the demographic variable is statistically different from zero. The third regression adds our three instruments, again the results are unaffected. The other regressions in Table 8 introduce the three literacy dummies separately. The variable most closely correlated with the subjective risk-free interest rate is the dummy based on the risk diversification question, which in fact is the indicator most naturally correlated with portfolio performance.[9] In particular, the point estimate indicates that those individuals who understand risk diversification report a subjective risk-free rate that is 27 basis points higher than those who do not understand the question.

To summarize, several papers show that in many countries financial sophistication, as measured by direct survey questions, investors' experience and education, is associated with higher portfolio returns. In addition, direct evidence available for a section of our survey shows that financial literacy is the most important determinant of the cross-sectional variability of (one-period ahead) subjective risk-free interest rates. With the important caveat that the question refers to the "risk-free rate" and not to the overall portfolio return, this increases our confidence that the positive correlation between consumption growth and fi-

[9]Robust regressions deliver similar results and for reasons of space are not reported. Also dropping observations with implausible responses (the reported risk-free rate exceeds 5%) does not change any of the results.

nancial literacy we estimated in Section 4 is indeed linked to the elasticity of intertemporal substitution.

6 Conclusions

A growing literature relates financial sophistication to household economic outcomes, such as saving, wealth, planning for retirement, asset allocation, asset composition, and debt. Previous work finds a positive association between financial literacy and many of these outcomes, but it has remained an open issue through which channel does financial sophistication affect portfolio outcomes.

In this paper we posit that the main channel is financial literacy which affects the return to saving. Our approach recognizes that individuals can acquire the financial sophistication needed to improve portfolio performance, and that the decision to acquire financial information trades-off costs and benefits. We provide a life-cycle model in which, in each period, individuals invest in financial literacy and choose how much to save, setting the stage for our empirical application, which was estimating a Euler equation for consumption augmented by indicators of financial sophistication. The estimated equation is an equilibrium condition between consumption growth and financial literacy. To address this endogeneity issue, we used an instrumental variables approach, using as instruments for financial literacy background education variables for the respondent and the individual's parents.

Our results indicate that the expected growth rate of consumption increases with financial literacy, which accords well with the idea that more literate individuals access better performing portfolios. Under the assumption that financial literacy maps directly onto an interest rate function, we estimate that the intertemporal elasticity of substitution ranges between 0.1 and 0.4, consistent with results available in the empirical consumption literature. We complement our findings with direct evidence on the link between financial literacy and the subjective risk-free rate, suggesting that more sophisticated consumers indeed expect higher returns on their portfolios.

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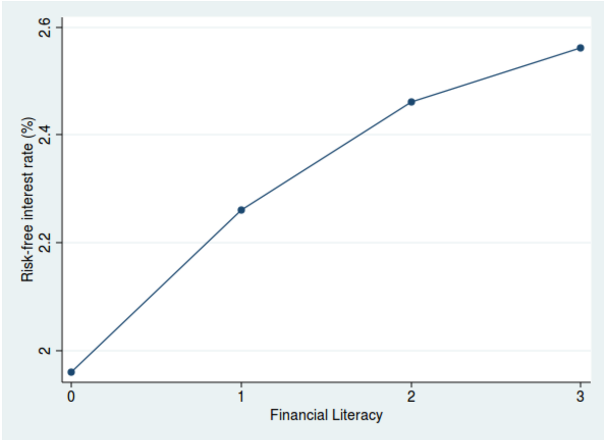
FIGURE 1. Risk-free interest rate and financial literacy



Note. The figure plots the predicted values of the regression of the subjective risk-free interest rate on financial literacy and its square. The data are drawn from SHIW 2008, where half of the sample is asked: *At which interest rate (not considering taxes) do you think you can invest without risk for a year (think of 1-year T-bills, or saving accounts)?*

Table 1. Fraction of correct answers to the financial literacy questions

	Interest rate question	**Risk diversification question**	**Mortgage contract question**	**All questions**
Age < 30	0.71	0.54	0.70	0.36
Age $\in [31 - 45]$	0.80	0.57	0.72	0.40
Age $\in [46 - 60]$	0.79	0.55	0.73	0.39
Age > 60	0.66	0.41	0.57	0.27
Economic Degree				
No	0.72	0.48	0.65	0.33
Yes	0.93	0.81	0.76	0.62
Father College Graduate				
No	0.72	0.48	0.65	0.32
Yes	0.88	0.63	0.77	0.50
Mother College Graduate				
No	0.73	0.48	0.65	0.33
Yes	0.89	0.67	0.86	0.60
Overall	0.73	0.49	0.65	0.33

Note. The table reports the fraction of correct answers to the questions on interest rate compounding, risk diversification and mortgage contract questions, by selected characteristics of the respondent and of the respondent's parents. For the exact wording of questions see Appendix B. The sample is drawn from the 2008 and 2010 SHIW for a total of 8,743 observations.

Table 2. Sample statistics

Variable	Mean	Std. Dev.	Min.	Max.
Growth Rate of Non-Durable Consumption	0.012	0.276	-0.852	2.017
Growth Rate of Consumption	0.009	0.306	-0.916	0.999
Financial Literacy	1.86	1.025	0	3
Age < 30	0.018	0.134	0	1
Age $\in [31-45]$	0.174	0.379	0	1
Age $\in [46-60]$	0.315	0.465	0	1
Age > 61	0.492	0.5	0	1
Log of Family Size	0.772	0.526	0	1.609
Economic Degree	0.011	0.104	0	1
Father is College Graduate	0.023	0.148	0	1
Mother is College Graduate	0.008	0.089	0	1
Log of Disposable Income	9.997	0.636	3.976	12.678

Note. The table reports sample statistics for the variables used in the estimation. The sample is drawn from the 2008 and 2010 SHIW for a total of 8,743 observations.

Table 3. Baseline specification

	Full sample		$Age \in [20, 65]$	
	Non-Dur. Cons.	Total Cons.	Non-Dur. Cons.	Total Cons.
Φ_{t+1}	0.088**	0.113**	0.098**	0.131**
	(0.039)	(0.044)	(0.047)	(0.054)
Age	0.001**	0.002***	−0.001	−0.001
	(0.001)	(0.001)	(0.000)	(0.000)
Log of Family Size	0.007	−0.001	0.029***	0.020**
	(0.011)	(0.012)	(0.009)	(0.010)
2010 Time Dummy	0.036***	0.029***	0.038***	0.026***
	(0.006)	(0.007)	(0.008)	(0.009)
N. of obs.	8,743		5,381	
Sargan statistic	0.295	0.011	1.977	0.697
χ_2 p-value	0.863	0.994	0.372	0.706
Anderson LM statistic	54.670		45.279	
χ_3 p-value	0.000		0.000	
F-test on excluded instruments	18.323		15.201	
p-value	0.000		0.000	

First stage

	Full sample	$Age \in [20, 65]$
Age	−0.013***	0.000
	(0.001)	(0.001)
Log of Family Size	0.235***	0.086***
	(0.022)	(0.026)
2010 Time Dummy	0.040*	0.024
	(0.021)	(0.025)
Degree in Economics	0.488***	0.503***
	(0.102)	(0.103)
Father is College Graduate	0.333***	0.221**
	(0.076)	(0.086)
Mather is College Graduate	0.182	0.300**
	(0.126)	(0.127)
R^2	0.079	0.010

Note. The top panel reports IV estimation of the Euler equation. The bottom panel reports the first stage results. One star indicates that the coefficient is statistically different from zero at the 10% level, two stars at the 5% level, three stars at the 1% level.

Table 4. Using various financial literacy indicators

Full sample

	Non-Durable Consumption			Total Consumption		
	Interest rate question	Risk diversification question	Mortgage contract question	Interest rate question	Risk diversification question	Mortgage contract question
Φ_{t+1}	0.268**	0.195**	0.283	0.332**	0.244**	0.392**
	(0.122)	(0.088)	(0.162)	(0.138)	(0.100)	(0.189)
Age	0.001**	0.001**	0.001	0.002**	0.001**	0.002**
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Log of Family Size	0.012	0.018**	−0.009	0.006	0.014	−0.024
	(0.010)	(0.008)	(0.021)	(0.011)	(0.009)	(0.025)
2010 Time Dummy	0.041***	0.023**	0.051***	0.035***	0.013	0.049***
	(0.006)	(0.010)	(0.009)	(0.007)	(0.011)	(0.010)
Sargan statistic	0.128	0.342	1.696	0.161	0.315	1.084
χ_2 p-value	0.938	0.843	0.428	0.922	0.854	0.582
Anderson LM statistic	31.062	44.846	16.345			
χ_3 p-value	0.000	0.000	0.001			
F-test on excluded instruments	10.383	15.014	5.454			
p-value	0.000	0.000	0.001			

$Age \in [20, 65]$

	Non-Durable Consumption			Total Consumption		
	Interest rate question	Risk diversification question	Mortgage contract question	Interest rate question	Risk diversification question	Mortgage contract question
Φ_{t+1}	0.300**	0.252**	0.216	0.402**	0.310**	0.358*
	(0.152)	(0.111)	(0.174)	(0.176)	(0.127)	(0.206)
Age	−0.001*	−0.000	−0.001*	−0.001	−0.000	−0.001*
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Log of Family Size	0.036***	0.036***	0.020	0.030***	0.030***	0.003
	(0.009)	(0.009)	(0.016)	(0.010)	(0.010)	(0.018)
2010 Time Dummy	0.042***	0.017	0.053***	0.031***	0.001	0.051***
	(0.008)	(0.013)	(0.013)	(0.010)	(0.015)	(0.016)
Sargan statistic	1.864	0.599	4.580	0.666	0.032	2.953
χ_2 p-value	0.394	0.741	0.101	0.717	0.984	0.228
Anderson LM statistic	24.140	31.013	14.713			
χ_3 p-value	0.000	0.000	0.002			
F-test on excluded instruments	8.073	10.384	4.912			
p-value	0.000	0.000	0.002			

Note. Both panels report IV estimation of the Euler equation. The top panel uses the whole sample, the bottom panel excludes the 65+. The definition of Φ_{t+1} varies between columns, according to the column heading. Column heading "Interest rate question" indicates that Φ_{t+1} is a 0/1 dummy equal to 1 if the interest rate question is answered correctly; column heading "Risk diversification question" that Φ_{t+1} is a 0/1 dummy equal to 1 if the risk diversification question question is answered correctly; column heading "Mortgage contract question" that Φ_{t+1} is a 0/1 dummy equal to 1 if the mortgage question is answered correctly. One star indicates that the coefficient is statistically different from zero at the 10% level, two stars at the 5% level, three stars at the 1% level.

Table 5. Introducing regional effects

	Full sample		$Age \in [20, 65]$	
	Non-Dur. Cons.	Total Cons.	Non-Dur. Cons.	Total Cons.
Φ_{t+1}	0.093^{**}	0.123^{**}	0.109^{*}	0.150^{**}
	(0.045)	(0.051)	(0.056)	(0.064)
Age	0.001^{**}	0.002^{**}	-0.001^{*}	-0.001
	(0.001)	(0.001)	(0.000)	(0.000)
Log of Family Size	0.002	-0.008	0.023^{**}	0.012
	(0.014)	(0.016)	(0.011)	(0.013)
2010 Time Dummy	0.034^{***}	0.027^{***}	0.036^{***}	0.023^{**}
	(0.007)	(0.008)	(0.008)	(0.010)
N. of obs.	8,743		5,381	
Sargan statistic	0.318	0.052	2.253	0.907
χ_2 p-value	0.853	0.974	0.324	0.635
Anderson LM statistic	45.415		36.409	
χ_3 p-value	0.000		0.000	
F-test on excluded instruments	15.172		12.160	
p-value	0.000		0.000	

Note. The table reports IV estimation of the Euler equation. One star means 10% significantly different from zero, two stars 5%, three stars 1%. A full set of regional dummies is included. The left panel uses the whole sample, the right panel excludes the 65+.

TABLE 6. Introducing disposable income

	Full sample		$Age \in [20, 65]$	
	Non-Dur. Cons.	Total Cons.	Non-Dur. Cons.	Total Cons.
Φ_{t+1}	0.118^{**}	0.151^{***}	0.116^{**}	0.154^{**}
	(0.049)	(0.055)	(0.053)	(0.061)
Age	0.002^{**}	0.002^{***}	-0.000	-0.000
	(0.001)	(0.001)	(0.000)	(0.001)
Log of Family Size	0.011	0.005	0.032^{***}	0.025^{**}
	(0.011)	(0.012)	(0.009)	(0.010)
2010 Time Dummy	0.036^{***}	0.028^{***}	0.040^{***}	0.029^{***}
	(0.007)	(0.007)	(0.008)	(0.009)
Log of y_{t-1}	-0.048^{***}	-0.059^{***}	-0.030^{***}	-0.039^{***}
	(0.013)	(0.015)	(0.011)	(0.012)
N. of obs.	8,743		5,372	
Sargan statistic	0.538	0.060	1.825	0.616
χ_2 p-value	0.764	0.970	0.402	0.735
Anderson LM statistic	39.257		37.894	
χ_3 p-value	0.000		0.000	
F-test on excluded instruments	13.133		12.702	
p-value	0.000		0.000	

Note. The table reports IV estimation of the Euler equation. One star means 10% significantly different from zero, two stars 5%, three stars 1%. The left panel uses the whole sample, the right panel excludes the 65+. The left-hand side variable is the growth rate of total consumption.

Table 7. Sample split by credit constraints indicator

	Full sample		$Age \in [20, 65]$	
	Constrained households	Unconstrained households	Constrained households	Unconstrained households
Φ_{t+1}	0.030	0.170**	0.063	0.164**
	(0.065)	(0.070)	(0.080)	(0.080)
Age	0.001	0.002**	−0.000	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Log of Family Size	0.021	−0.019	0.030*	0.009
	(0.019)	(0.020)	(0.016)	(0.016)
2010 Time Dummy	0.019	0.039***	0.005	0.040***
	(0.012)	(0.009)	(0.015)	(0.012)
N. of .obs	3,284	5,459	2,107	3,274
Sargan statistic	0.531	0.315	1.040	1.119
χ_2 p-value	0.767	0.854	0.594	0.572
Anderson LM statistic	23.292	26.453	17.692	24.629
χ_3 p-value	0.000	0.000	0.001	0.000
F-test on excluded instruments	7.775	8.828	5.903	8.223
p-value	0.000	0.000	0.000	0.000

Note. The table reports IV estimation of the Euler equation. One star means 10% significantly different from zero, two stars 5%, three stars 1%. The left panel uses the whole sample, the right panel excludes the 65+. For "Constrained households" the ratio between financial wealth and annual disposable income is smaller or equal than 1/6, for "Unconstrained households" is larger than 1/6.

Table 8. Financial sophistication and the subjective risk-free interest rate

Φ_{t+1}	0.352**	0.347**	0.348**			
	(0.153)	(0.152)	(0.153)			
Φ^2_{t+1}	−0.051	−0.052	−0.053			
	(0.038)	(0.038)	(0.038)			
Interest rate question				0.069	0.072	0.072
				(0.093)	(0.093)	(0.093)
Risk diversification question				0.282***	0.266***	0.263***
				(0.055)	(0.056)	(0.056)
Mortgage contract question				0.015	0.002	0.001
				(0.067)	(0.067)	(0.067)
Male		−0.008	−0.010		−0.022	−0.023
		(0.060)	(0.061)		(0.061)	(0.061)
Age		−0.012	−0.012		−0.011	−0.011
		(0.013)	(0.013)		(0.013)	(0.013)
Age square		0.037	0.034		0.031	0.029
		(0.114)	(0.114)		(0.114)	(0.114)
Log of Family Size		0.032	0.032		0.033	0.033
		(0.060)	(0.060)		(0.060)	(0.060)
Years of Education		0.003	0.002		0.002	−0.000
		(0.006)	(0.007)		(0.007)	(0.007)
Degree in Economics			0.201			0.186
			(0.178)			(0.178)
Father is College Graduate			0.038			0.054
			(0.149)			(0.149)
Mather is College Graduate			−0.129			−0.121
			(0.247)			(0.247)
N. of .obs	3,156					
R^2	0.007	0.014	0.014	0.009	0.016	0.016

Note. The table reports the results of the regression of the subjective risk-free interest rate on indicators of financial literacy and additional controls. One star means 10% significantly different from zero, two stars 5%, three stars 1%.

Appendix A Deriving equations (2) and (3)

This appendix shows how to derive the consumption Euler equation and the law of motion of financial literacy. The value function satisfies:

$$V_t(A_t, \Phi_t) = \max_{\{c_t, \Phi_{t+1}\}} [u(c_t) + \beta E_t V_{t+1}(A_{t+1}, \Phi_{t+1})] \tag{A-1}$$

Differentiating both sides of equation (A-1) with respect c_t and Φ_{t+1}, we obtain:

$$u'(c_t) - \beta f(\Phi_{t+1}) E_t V^1_{t+1}(A_{t+1}, \Phi_{t+1}) \tag{A-2}$$

and

$$[s_t f'(\Phi_{t+1}) - p f(\Phi_{t+1})] E_t V^1_{t+1}(A_{t+1}, \Phi_{t+1}) + E_t V^2_{t+1}(A_{t+1}, \Phi_{t+1}) = 0 \tag{A-3}$$

where $V^1_{t+1}(A_{t+1}, \Phi_{t+1})$ and $V^2_{t+1}(A_{t+1}, \Phi_{t+1})$ are, respectively, the derivative of the value function with respect to its first and second argument.

Differentiating both sides of equation (A-1) with respect A_t and Φ_t one obtains:

$$V^1_t(A_t, \Phi_t) = \beta f(\Phi_{t+1}) E_t V^1_{t+1}(A_{t+1}, \Phi_{t+1}) \tag{A-4}$$

and

$$V^2_t(A_t, \Phi_t) = \beta(1-\delta) \left[s_t f'(\Phi_{t+1}) E_t V^1_{t+1}(A_{t+1}, \Phi_{t+1}) + E_t V^2_{t+1}(A_{t+1}, \Phi_{t+1}) \right] \tag{A-5}$$

Exploiting (A-2) and (A-4), one obtains the usual Euler equation for consumption:

$$u'(c_t) = \beta f(\Phi_{t+1}) E_t u'(c_{t+1})$$

To derive the law of motion of Φ_{t+1}, we proceed as follows. We solve (A-3) with respect to $E_t V^2_{t+1}(A_{t+1}, \Phi_{t+1})$, exploit (A-4) and substitute into (A-5), obtaining:

$$V_t^2(A_t, \Phi_t) = p(1-\delta)V_t^1(A_t, \Phi_t) \tag{A-6}$$

Finally, exploiting (A-6) to rewrite (A-3) one can show that:

$$[s_t f'(\Phi_{t+1}) - pf(\Phi_{t+1})] + p(1-\delta) = 0$$

Appendix B Financial Literacy Indicators

In 2008 and 2010, the Survey of Households Income and Wealth includes questions to the topic of financial information, regarding mortgages, interest compounding and risk diversification. We construct the financial literacy indicator using the following three questions:

1. Which of the following types of mortgage do you think would allow you from the very start to fix the maximum amount and number of installments to be paid before the debt is extinguished?

    - Floating-rate mortgage
    - Fixed-rate mortgage
    - Floating-rate mortgage with fixed installments
    - Don't know

2. Imagine leaving 1,000 euros in a current account that pays 1% interest and has no charges. Imagine that inflation is running at 2%. Do you think that if you withdraw the money in a year's time you will be able to buy the same amount of goods as if you spent the 1,000 euros today?

    - Yes
    - No, I will be able to buy less
    - No, I will be able to buy more

- Don't know

3. Which of the following investment strategies do you think entails the greatest risk of losing your capital?

    - Investing in the shares of a single company
    - Investing in the shares of more than one company
    - Don't know