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*Consumption growth, the interest rate, and financial sophistication**

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Abstract

We propose a model in which financial sophistication improves portfolio returns and therefore the incentive to substitute consumption intertemporally. The model delivers an 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 sophistication drawn from the Italian Survey of Household Income and Wealth. We find that consumption growth is positively correlated with financial sophistication, as predicted by the model. We also provide estimates of the intertemporal elasticity of substitution in the range between 0.4 and 0.6.

JEL CODES: E2, D8, G1, J24

Keywords: Consumption growth, Euler equation, financial sophistication.

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), an essential ingredient of macroeconomic models. For example, if the 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 current consumption, offsetting the demand shock. Obtaining an estimate of EIS therefore is crucial for assessing the effectiveness of fiscal and monetary policies, and for evaluating many other policy issues.

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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 (the consumption innovation) might be correlated with the interest rate. An early application is Hall (1988), which uses various measures of real interest rates and different sampling periods, and concludes that, at least for the USA, 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 US 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. More recently, Blundell *et al.* (2012) allowing for non-separabilities of consumption and labor supply in a two earners model estimate that EIS is around 0.5.

In the present paper, building on Arrow's (1987) insight, we posit that financial sophistication allows consumers to access better investment opportunities. We derive an 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 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 consider this channel may result 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 sophistication (measured with standard questions on knowledge on financial matters). Even though the panel is relatively short, the information contained in the survey is a unique source of data on consumption, financial sophistication and subjective expectations of interest rates. The data allow us to recognize that investment in financial information is an endogenous variable in the consumer optimization problem, and implement an IV approach using appropriate instruments for financial sophistication. The results indicate that financial sophistication is positively associated with consumption growth, consistent with the model's prediction. Splitting the sample by wealth indicators, we find that the correlation between financial sophistication 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. Finally, we explore the relation between consumption growth and the variation in the interest rate due to differences in financial sophistication, and estimate the EIS in the range of 0.4–0.6.

The remainder of the paper is organized as follows. Section 2 presents a model where individuals face income uncertainty and must choose how much to consume and how much to invest in financial information in each period. Section 3 describes the data, our measure of consumption and the indicators of financial sophistication. Section 4 discusses the econometric issues that arise in estimating the Euler equation for consumption and presents the empirical results. Section 5 explores the link between financial sophistication and the return to saving, using self-reported information on the risk-free rate available in our survey. Section 6 concludes.

2 The model

We integrate investment in financial information 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 sophistication has costs and benefits. On the costs side, investing in financial sophistication requires time and monetary resources. On the benefits side, financial sophistication 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 sophistication in a multi-period model with endogenous saving and investment in financial information.[1] The setup is a partial equilibrium model, and neglects any asset pricing implication.[2] 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

[1] In related work, Jappelli and Padula (2013) study the implication of a model with endogenous accumulation of financial information for the age-profiles of wealth and financial sophistication in the presence of social security.

[2] Padula and Pettinicchi (2013) investigate the asset pricing implications of financial education.

financial sophistication according to:

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

Raising the stock of financial information 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 financial sophistication. Each period, financial information 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 the gross-investment in financial information. The initial stock of information 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:

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

where

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

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:

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

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

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 information. Equation (3) states that in equilibrium the marginal return from financial information, $s_t f'(\Phi_{t+1})$ equals the cost of information, $p[f(\Phi_{t+1}) - (1-\delta)]$. 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:

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

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). The expression indicates that consumption growth is positively correlated with the stock of financial information, to an extent that depends on the elasticity of substitution σ. It is important to notice that the omission of the conditional variance term in the estimation of (5) is likely to lead to a downward bias in the estimate of the impact of financial sophistication on consumption growth (the σ parameter). To see why, note that in the model higher financial sophistication leads to higher returns and higher cash-on-hand. This reduces the need for precautionary saving, the conditional variance of consumption and the expected growth rate of consumption.[3]

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 use instruments that are correlated with the stock of financial information, 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 a measure of financial sophistication. The panel included in the 2006–10 Survey of Household Income and Wealth (SHIW) meets this requirement. It offers widely used indicators of financial sophistication, 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), Bartiloro *et al.* (2010), and Biancotti *et al.* (2012).

The SHIW includes a rotating panel component: in each survey, about 45% of the households are also interviewed 2 years later.[4] Most importantly for the present study, the 2008 and 2010 SHIW contains three core questions on financial sophistication:

[3] In the more general case of stochastic interest rate, the sensitivity of consumption growth to the interest rate depends also on the correlation between the interest rate (and therefore financial sophistication) and the variance of consumption growth. While in this case the direction of the bias is ambiguous, the bias is smaller if the control variables capture some of the variability of the conditional variance of consumption growth.

[4] 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.

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 US 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 sophistication (Lusardi and Mitchell, 2011). The question on understanding mortgage contracts is one of two questions posed in the 2009 National Financial Capability Survey (Lusardi, 2011). Therefore our indicators include three out of the five standard questions on financial sophistication.[5] In 2008, the SHIW includes also information on the interest rate at which respondents think they can invest their assets; we will use this information in Section 5.

Table 1 reports the distribution of the financial sophistication indicators, merging 2008 and 2010 data. It is apparent that a considerable number of respondents have limited understanding of financial matters: 72.7% correctly answered the compound interest question, 64.8% gave right answers the mortgage question, but only 48.5% correctly answered the diversification question. Overall, there were only 32.8% 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 USA. 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 sophistication 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, missing indicators of financial sophistication or where growth rate of consumption exceeds 100% (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 sophistication.

Table 2 reports descriptive statistics for the main variables used in the estimation. The average yearly growth rate of non-durable consumption is 1.2%, but the average conceals considerable sample heterogeneity (the standard deviation of consumption growth is 0.276). The sample average of the financial sophistication indicator is 1.86, which means that on average people gave the correct answer to less than two 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

[5] 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.

Table 1. *Fraction of correct answers to questions on financial sophistication*

	Interest rate question	Risk diversification question	Mortgage contract question	All questions
Age <30	0.71	0.54	0.70	0.36
Age ∈ 31 – 45]	0.80	0.57	0.72	0.40
Age ∈ 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 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
Financial literacy	1.86	1.025	0	3
Age <30	0.018	0.134	0	1
Age ∈ 31 – 45]	0.174	0.379	0	1
Age ∈ 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
College graduate	0.094	0.292	0	1

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.

in economics (1.2%), and the fraction of heads whose fathers and mothers have a college degree (2.3% and 0.8%, 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 sophistication. However, it is important to stress that this is not a causal relation, because financial sophistication 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 four background education variables as instruments for financial sophistication: whether the respondent has a college degree, 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 four instruments are strongly correlated with financial sophistication. 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. The assumption would be violated if parents' education is related to children's rate of time preferences. We find this channel rather implausible. If education or parents' education shifts the utility function, what appears in the first-order condition of the problem is the change in education (which for adults is zero), not the level of education. An alternative possibility is that education is associated with household resources and borrowing constraints. In the robustness analysis, we control for this possibility using household disposable income and sample splits by wealth.

Two previous studies use an IV approach to address the endogeneity between financial sophistication and choice variables such as wealth, saving and portfolio composition. Christiansen *et al.* (2008) use a large register-based panel dataset 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.* (2012) use an IV approach to isolate the causal effects of financial sophistication on wealth accumulation and wealth components in Chile, using as instruments school attendance and family background.[6] Other recent studies

[6] 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 sophistication, four

acknowledge the endogeneity of financial sophistication with respect to saving decisions and point out that the incentives to invest in financial information can affect the relation between financial sophistication and saving; see Delavande *et al.* (2008), Willis (2009), Calvet *et al.* (2009) and Lusardi *et al.* (2013).

As it has become standard practice in the estimation of a Euler equation for consumption since Zeldes (1989), we control for individual preferences using age and the growth rate of family size (assuming that family size is exogenous and anticipated). The indicator of financial sophistication is entered as the sum of the three indicators (thus it ranges from 0 to 3), or as three separate dummy variables. We also include a time dummy to control for aggregate shocks that hit the Italian economy between 2008 and 2010.[7] As left-hand-side variable we use the growth rate of non-durable consumption (excluding the purchase of durable goods).

Note that we omit the conditional variance of consumption growth (which according 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 sophistication, not to perform an excess sensitivity test.[8]

4.1 Baseline results

Table 3 reports our baseline specification omitting the demographic variables. 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 education and college degree in economics and fathers' education) are statistically different from zero at the 1% level and one at the 5% level. In particular, having a college degree improves the financial sophistication score by 0.4, having an economics degree improves the score by an additional 0.25, while father's college degree is associated with an increase in the score of 0.17. Overall, the four instruments are powerful: the Anderson canonical correlation statistic on the three instruments is 170 and the

coefficients are statistically different from zero in the first stage regression (economic background and enrollment rates during childhood).

[7] Since we use two growth rates of consumption (2006/08 and 2008/10), we introduce only one time dummy.

[8] 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.

Table 3. *Growth rate of consumption and overall measure of financial sophistication*

	Full sample				Age ∈ [20, 65]			
Φ_{t+1}	0.053**	(0.021)	0.059**	(0.026)	0.086**	(0.037)	0.069*	(0.036)
Age			0.001**	(0.000)			−0.000	(0.000)
Growth rate of family size			0.253***	(0.015)			0.227***	(0.021)
2010 time dummy			0.037***	(0.006)			0.038***	(0.008)
No. of obs.	8,743				5,381			
Sargan statistic	1.131		1.411		2.252		2.420	
χ_2 p-value	0.770		0.703		0.522		0.490	
Anderson LM statistic	170.036		113.759		74.173		72.639	
χ_3 p-value	0.000		0.000		0.000		0.000	
F-test on excluded instruments	42.901		28.599		18.654		18.256	
p-value	0.000		0.000		0.000		0.000	
	First stage							
	Full sample				Age ∈ [20, 65]			
Age			−0.016***	(0.001)			0.000	(0.001)
Growth rate of family size			0.021	(0.055)			0.174***	(0.063)
2010 time dummy			0.033	(0.021)			0.018	(0.025)
Degree in economics	0.255**	(0.111)	0.203*	(0.108)	0.295***	(0.109)	0.291***	(0.109)
Father is college graduate	0.166**	(0.080)	0.171**	(0.078)	0.126	(0.087)	0.130	(0.087)
Mother is college graduate	0.190	(0.131)	0.017	(0.127)	0.193	(0.127)	0.189	(0.127)
College graduate	0.403***	(0.041)	0.326***	(0.040)	0.236***	(0.043)	0.234***	(0.043)
R^2	0.019		0.074		0.014		0.015	

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.

F-test on the excluded instruments is 42.9. Furthermore, the Sargan test (1.13) does not reject the null hypothesis that the overidentifying restrictions are valid. In the second specification, the negative coefficient of age in the first-stage regression suggests that younger respondents score better in terms of financial sophistication, other things equal.

Turning to the Euler equation estimates (upper panel in Table 3), we see that the coefficient of financial sophistication is positive and statistically different from zero at the 5% level, thus confirming the model's implication on the correlation between financial sophistication and consumption growth. These estimates do not immediately point to a particular value of the EIS. However, in Section 5, we complement them considering explicitly the link between financial sophistication and the return to saving. The second specification in Table 3 adds demographic controls and a time dummy. The age and growth rate of family size coefficients are both positive and statistically different from zero. In particular, the coefficient of family size is usually interpreted as indication that consumers save (consumption growth is higher) in anticipation of an increase of family size. Results for financial sophistication are similar, with a slightly higher effect of sophistication (the coefficient is 0.061). The other two regressions of Table 3 restrict the sample to households with heads aged <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. We still find a strong positive correlation between the instruments and financial sophistication in the first-stage estimates. Furthermore, dropping the elderly, the coefficient of financial sophistication in the Euler equation is higher than in the baseline estimates (0.086 in column 3 and 0.073 in column 4).

In the baseline specification, we construct the financial sophistication 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 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 financial sophistication indicator is positive. The coefficients are also similar in size, ranging from 0.12 (when for the full sample we use the risk diversification question) to 0.27 (when for the '20–65' sample we use the mortgage question).

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.

Table 4. *Financial sophistication indicators and consumption growth*

	Full sample											
	Baseline						Demographic controls					
	Interest rate question		Risk diversification question		Mortgage contract question		Interest rate question		Risk diversification question		Mortgage contract question	
Φ_{t+1}	0.158**	(0.063)	0.125**	(0.049)	0.205**	(0.092)	0.170**	(0.075)	0.128**	(0.057)	0.262*	(0.137)
Age							0.001*	(0.000)	0.001*	(0.000)	0.002*	(0.001)
Growth rate of family size							0.252***	(0.016)	0.255***	(0.015)	0.248***	(0.017)
2010 time dummy							0.040***	(0.006)	0.028***	(0.008)	0.049***	(0.008)
No. of obs.	8,743											
Sargan statistic	1.036		0.983		1.953		1.237		1.498		1.957	
χ_2 p-value	0.793		0.805		0.582		0.744		0.683		0.581	
Anderson LM statistic	103.689		133.510		44.718		72.333		97.645		21.538	
χ_3 p-value	0.000		0.000		0.000		0.000		0.000		0.000	
F-test on excluded instruments	26.062		33.614		11.202		18.142		24.526		5.386	
p-value	0.000		0.000		0.000		0.000		0.000		0.000	

Table 4 (*cont.*)

	Age ∈ [20, 65]											
	Baseline						Demographic controls					
	Interest rate question		Risk diversification question		Mortgage contract question		Interest rate question		Risk diversification question		Mortgage contract question	
Φ_{t+1}	0.231**	(0.105)	0.195**	(0.079)	0.275	(0.192)	0.183*	(0.101)	0.164**	(0.079)	0.205	(0.180)
Age							−0.000	(0.000)	0.000	(0.000)	−0.000	(0.000)
Growth rate of family size							0.228***	(0.021)	0.234***	(0.020)	0.221***	(0.026)
2010 time dummy							0.040***	(0.008)	0.024**	(0.011)	0.052***	(0.014)
No. of obs.	5,381											
Sargan statistic	2.470		1.243		4.861		2.624		1.507		4.445	
χ_2 p-value	0.481		0.743		0.182		0.453		0.681		0.217	
Anderson LM statistic	48.663		58.234		12.778		48.809		55.126		13.267	
χ_3 p-value	0.000		0.000		0.012		0.000		0.000		0.010	
F-test on excluded instruments	12.209		14.624		3.195		12.240		13.832		3.316	
p-value	0.000		0.000		0.012		0.000		0.000		0.010	

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.

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Table 5. *Regressions with regional dummies*

	Full sample				Age ∈ [20, 65]			
Φ_{t+1}	0.052**	(0.023)	0.058**	(0.029)	0.096**	(0.044)	0.076*	(0.043)
Age			0.001*	(0.001)			−0.000	(0.000)
Growth rate of family size			0.255***	(0.015)			0.229***	(0.021)
2010 time dummy			0.036***	(0.006)			0.036***	(0.008)
No. of obs.	8,743				5,381			
Sargan statistic	1.205		1.477		2.513		2.771	
χ_2 p-value	0.752		0.688		0.473		0.428	
Anderson LM statistic	153.233		98.231		58.394		57.138	
χ_3 p-value	0.000		0.000		0.000		0.000	
F-test on excluded instruments	38.540		24.620		14.613		14.289	
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%. A full set of regional dummies is included. The left panel uses the whole sample, the right panel excludes the 65+.

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. Even though the regression includes a time dummy, the approach is restrictive because it rules out aggregate shocks that are 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.[9]

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.[10] 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 financial sophistication indicator is barely affected in this

[9] In further robustness checks, we interact region and wave fixed effect. The results are similar: the coefficient on Φ_{t+1} is 0.055 (with a standard error of 0.029) in the full sample and 0.070 (and standard error of 0.042) in the sample of those aged 20–65.

[10] 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.

Table 6. *Regressions adding lagged diposable income*

	Full sample				Age ∈ [20, 65]			
Φ_{t+1}	0.079***	(0.027)	0.089**	(0.035)	0.106**	(0.043)	0.088**	(0.043)
y_{t-1}	−0.036***	(0.009)	−0.034***	(0.011)	−0.023**	(0.009)	−0.020**	(0.009)
Age			0.001**	(0.001)			0.000	(0.000)
Growth rate of family size			0.245***	(0.016)			0.221***	(0.021)
2010 time dummy			0.036***	(0.006)			0.039***	(0.008)
No. of obs.	8,743				5,372			
Sargan statistic	1.210		1.374		2.039		2.214	
χ_2 p-value	0.751		0.712		0.564		0.529	
Anderson LM statistic	112.300		68.424		57.434		54.940	
χ_3 p-value	0.000		0.000		0.000		0.000	
F-test on excluded instruments	28.237		17.155		14.419		13.782	
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+. The left-hand side variable is the growth rate of non-durable consumption.

extended specification (0.079 in column 1 and 0.092 in column 2) even if we drop households where the respondent is over 65 (columns 3 and 4).[11]

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 3-months' income). In the high-wealth sample (about 62% of the total sample) the coefficient of financial sophistication is 0.067 (0.084 if we include demographic controls), while in the low-wealth sample the coefficient is 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.

Before moving to the analysis of the correlation between financial sophistication portfolio performance, it is worth emphasizing that the validity of our results rests on the identification assumption that the education of parents has no direct effect on the growth rate of consumption. However, if time preference is heritable, one

[11] As an alternative control for the effect of liquidity constraints, we also include in the regression the growth rate of disposable income. The results are similar: the coefficient of Φ_{t+1} is 0.059 (standard error of 0.026) in the full sample and 0.069 (standard error of 0.036) in the sample of those aged 20–65. An additional reason to control for the growth rate of income has to do with our choice of instruments. By adding the growth rate of income in our regressions, we rule out that education is just a proxy for the growth rate of income.

Table 7. *Sample split by credit constraints indicator*

	Baseline				Demographic controls			
	Constrained households		Unconstrained households		Constrained households		Unconstrained households	
Φ_{t+1}	0.048	(0.038)	0.067**	(0.030)	0.056	(0.056)	0.079**	(0.038)
Age					0.001	(0.001)	0.001**	(0.001)
Growth rate of family size					0.226***	(0.021)	0.284***	(0.022)
2010 time dummy					0.021**	(0.010)	0.051***	(0.008)
No. of .obs.	4,060		4,683		4,060		4,683	
Sargan statistic	0.209		1.480		0.543		1.477	
χ_2 p-value	0.976		0.687		0.909		0.688	
Anderson LM statistic	50.355		93.471		25.719		59.332	
χ_3 p-value	0.000		0.000		0.000		0.000	
F-test on excluded instruments	12.651		23.577		6.437		14.902	
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 monthly disposable income is smaller than than 3, for 'Unconstrained households' is larger than 3.

would expect that more highly educated parents would, on average, have more patient children. Therefore, we explore the robustness of the results using an alternative set of instruments, and exploiting a reform that increased compulsory school age in Italy. We thus replace education (for fathers, mothers and children) with indicators of whether fathers and mothers reached the relevant school age in 1962 (when compulsory age was raised to 14). The variability induced by the school reform is exogenous, but rather limited. Therefore, we complement the set of instruments noting that in the estimation of the Euler equation at $t+1$ the variables dated t or before are (weakly) exogenous. This allows us to rely on financial literacy in 2008 as an instrument for financial literacy in 2010. The choice is well grounded also in light of the high correlation between financial literacy in the two subsequent waves of data, but reduces further the sample used for estimation. The results confirm the positive association between financial sophistication and the growth rate of consumption: depending on the specification and on the sample used the coefficient for Φ_{t+1} ranges between 0.022 (0.010) and 0.033 (0.018).[12]

[12] The Sargan tests for the validity of the overidentifying restrictions and the F-tests on excluded instruments are passed at the standard significance levels. The Sargan test ranges between 0.590 and 0.691 and the F-test between 124.036 and 300.060.

5 Financial sophistication 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 sophistication 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, 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.[13]

Campbell *et al.* (2012) study investment strategies and performance of individual investors in Indian equities over the period 2002–2012.[14] Indian data provide no information on the demographic characteristics of investors, and therefore the authors cannot measure financial sophistication using information about investors, as in Calvet *et al.* (2007, 2009) or direct survey evidence (as in Lusardi and Mitchell, 2007 and in the present 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 underdiversify, 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* (*net of taxes*) *do you think you can invest without risk for a year* (*think of*

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

[14] They find substantial heterogeneity in the time-series average returns, with the 10th percentile account under-performing by 2.6% per month and the 90th percentile account overperforming by 1.23% per month.

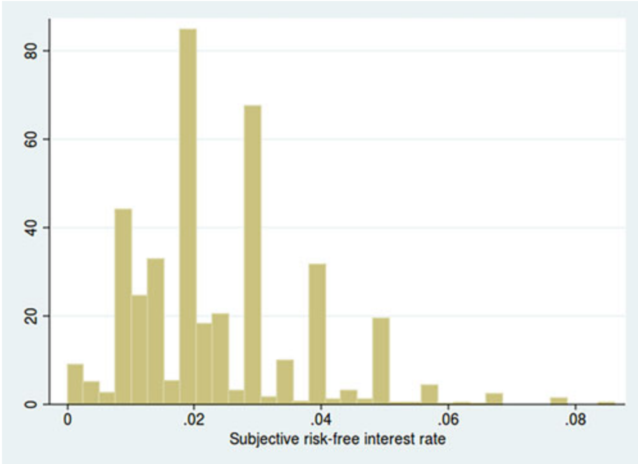

Figure 1. (Colour online) Subjective risk-free interest rate. Note. The figure plots the histogram of the subjective risk-free interest rate. The data are drawn from SHIW 2008, where half of the sample is asked: *At which interest rate (not considering taxes) do you think you can invest without risk for a year (think of 1-year T-bills or saving accounts)?*

1-year T-bills, or saving accounts)? The cross-sectional average of the 3,156 valid answers (excluding eight observations with implausible values exceeding 10%) is 2.47% (median is 2), with a standard deviation of 1.48. The scatter plot of the subjective interest rate is reported in Figure 1, showing that there is a mode at 2% and some bunching of responses, but also a quite reasonable distribution of the variable. The focus of the question is the riskless return, and we see this as a potential limitation. However, to the extent that the cross-sectional variability of the subjective expectation of the riskless return is related to the cross-sectional variability of the returns on risky financial assets, our exercise will also speak about the relation between financial sophistication and portfolio returns.

Using the available measure of the riskless return, we can estimate a three equations system, where the first equation relates our set of instruments to Φ_{t+1}, the second links the reported interest rate to financial sophistication, and the third is the Euler equation for consumption, i.e., equation (5). Table 8 show the results form the estimation of the three equations system. The only complication is that data on the subjective risk-free rate are available only for 2008. Standard errors are adjusted for the presence of generated regressors, as suggested by Murphy and Topel (2002) and Pagan (1984).

The bottom part of Table 8 reports a regression for financial sophistication for the 2008 sample. Results are qualitatively similar to the first-stage regression for the full sample reported in Table 3, except that the coefficients of most variables are less precisely estimated. The middle panel reports the relation between financial sophistication and the interest rate, showing that each point of the financial sophistication indicator is associated with 120 basis points increase of the risk-free rate. Since we do not observe risky returns, we cannot draw direct inference on the relation between

Table 8. *Growth rate of consumption, financial sophistication and subjective interest rate*

	$\Delta \ln c_{t+1} = \sigma \ln \beta + \sigma \ln f(\Phi_{t+1}) + x'_t\pi + \epsilon_{t+1}$							
	Full sample				Age $\in$ [20, 65]			
r_{t+1}	0.529**	(0.245)	0.447*	(0.249)	0.697**	(0.349)	0.652*	(0.355)
Age			0.000	(0.000)			0.000	(0.000)
Growth rate of family size			0.254***	(0.015)			0.247***	(0.019)
No. of obs.	8,743				5,414			
	$r_{t+1} = \delta_0 + \delta_1\Phi_{t+1} + \eta_{t+1}$							
	Full sample				Age $\in$ [20, 65]			
Φ_{t+1}	0.012***	(0.004)			0.005	(0.005)		
	$\Phi_{t+1} = z'_t\gamma + v_{t+1}$							
	Fullsample				Age $\in$ [20, 65]			
Age	−0.004***	(0.001)			−0.001	(0.002)		
Growth rate of family size	−0.015	(0.100)			−0.036	(0.112)		
Degree in economics	0.244*	(0.139)			0.235	(0.146)		
Father is college graduate	0.059	(0.112)			0.065	(0.129)		
Mother is college graduate	0.128	(0.185)			0.084	(0.191)		
College graduate	0.077	(0.059)			0.094	(0.065)		
No. of obs.	1,766				1,271			

Note: The table reports the results from the estimation of a system of three recursive equations. The first equation is estimated regressing Φ_{t+1} against the set of instrument, z_t, which includes age, the growth rate of family size and four dummies for whether one has a degree in economics, one is college graduate, and the father and the mother are college graduate. The second equation is estimated regressing r_{t+1} on the predicted value for Φ_{t+1} from the first stage. In the third equation, the growth rate of consumption, $\Delta \ln c_{t+1}$, is regressed on the predicted value for r_{t+1} from the second equation. Asymptotic standard errors in parentheses (see Murphy and Topel, 2002). One star means 10% significantly different from zero, two stars 5%, three stars 1%.

financial sophistication and returns of risky assets. However, in the simplest case in which the equity premium does not vary across households with financial sophistication over and above the riskless return, our results suggest that financial sophistication is positively associated with portfolio returns.[15]

[15] If the equity premium increases with financial sophistication, our results are a lower bound of the effect of financial sophistication on portfolio returns.

The top panel reports the Euler equation for consumption, where consumption growth is regressed on the interest rate, taking into account the fact that the interest rate depends on financial sophistication, which is itself a choice variable. The interest rate coefficient is statistically different from zero, suggesting an EIS of 0.53 in column 1 (statistically different from zero at the 5% level) and 0.45 in column 2 (different from zero at the 10% level). If we drop the elderly, the values of the EIS are slightly higher (0.7 in column 3 and 0.65 in column 4).

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 sophistication is an 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, we obtain plausible estimates of the EIS. These results increase our confidence that the positive correlation between consumption growth and financial sophistication we estimated in Section 4 is indeed linked to the EIS.

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. A previous work finds a positive association between financial sophistication 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 explore the possibility that the main channel is that financial sophistication 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 information 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 the stock of financial information. To address this endogeneity issue, we measure financial sophistication by standard indicators of respondents' knowledge of financial matters, and implement an IV approach, using as instruments for financial sophistication background education variables for the respondent and the individual's parents.

Our results indicate that the expected growth rate of consumption is positively associated with financial sophistication, which accords well with the idea that more sophisticated individuals access better performing portfolios. We complement our findings with direct evidence on the link between financial sophistication and the subjective risk-free rate, suggesting that more sophisticated consumers indeed expect higher returns on their portfolios. Finally, we relate the growth rate of consumption to the variation of the subjective risk-free rate attributable to financial sophistication. A limitation of the present study is that the panel is relatively short. More reliable inference could be obtained using a longer panel, which would allow us to control for the impact of aggregate shocks, and the dynami relation between financial sophistication, interest rates and consumption growth. However, our approach allows us to obtain reasonable estimates of the EIS (between 0.45 and 0.55), consistent with findings of the empirical consumption literature.

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Appendix A – Derivation of equations (2) and (3)

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

$$V_t(A_t, \Phi_t) = \max_{\{c_t, \Phi_{t+1}\}} \left[u(c_t) + \beta E_t V_{t+1}(A_{t+1}, \Phi_{t+1})\right]. \tag{6}$$

Differentiating both sides of equation (6) with respect c_t and Φ_{t+1}, we obtain:

$$u'(c_t) - \beta f(\Phi_{t+1}) E_t V^1_{t+1}(A_{t+1},\ \Phi_{t+1}) \tag{7}$$

and

$$[s_t f'(\Phi_{t+1}) - pf(\Phi_{t+1})] E_t V^1_{t+1}(A_{t+1},\ \Phi_{t+1}) + E_t V^2_{t+1}(A_{t+1},\ \Phi_{t+1}) = 0, \tag{8}$$

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 arguments.

Differentiating both sides of equation (6) with respect A_t and Φ_t one obtains:

$$V^1_t(A_t,\ \Phi_t) = \beta f(\Phi_{t+1}) E_t V^1_{t+1}(A_{t+1},\ \Phi_{t+1}) \tag{9}$$

and

$$V_t^2(A_t,\ \Phi_t) = \beta(1-\delta)[s_t f'(\Phi_{t+1})E_t V_{t+1}^1(A_{t+1},\ \Phi_{t+1}) + E_t V_{t+1}^2(A_{t+1},\ \Phi_{t+1})]. \quad (10)$$

Exploiting (7) and (9), 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 (8) with respect to $E_t V_{t+1}^2(A_{t+1},\ \Phi_{t+1})$, exploit (9) and substitute into (10), obtaining:

$$V_t^2(A_t,\ \Phi_t) = p(1-\delta)V_t^1(A_t,\ \Phi_t). \quad (11)$$

Finally, exploiting (11) to rewrite (A-8) one can show that:

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

Appendix B – Financial Sophistication 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 sophistication indicators 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.