Elisa Cavezzali, Gloria Gardenal, Ugo Rigoni

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Elisa Cavezzali
Ca' Foscari University of Venice, Italy

Gloria Gardenal
Ca' Foscari University of Venice, Italy

Ugo Rigoni
Ca' Foscari University of Venice, Italy

Abstract

This study investigates whether financial education and financial literacy influence the risk taking of non-professional investors and the diversification strategies they pursue. To this purpose, we submitted a questionnaire to 711 US residents. Our results show that financial education prevents financial illiteracy and changes the investment process of investors. On the other hand, financial literacy, measured according to the synthetic metric introduced by Lusardi and Mitchell, does not influence risk taking. Financial education indirectly exerts its influence also on a simple diversification behaviour, the so-called naïve diversification, pursued equally splitting wealth among investment classes. In fact, whereas for uneducated investors there is no relationship between risk diversification strategies with both financial literacy and the main investor features, for educated investors financial literacy fosters such diversification behaviour. These results have important policy implications showing that financial education can trigger relevant changes in the investment patterns of investors.

Our study introduces a series of novelties. First, we focus on how financial education and financial literacy simultaneously affect the investment process of investors. Moreover, we attempt to disentangle their effects on the risk taking dimension and diversification strategies, which are the most effective way to contain the potentially disruptive effects of risks taken.

Keywords: Risk Taking; Asset allocation; Diversification Behaviour; Financial Literacy; Financial Education.
JEL Codes: G02; G11.

1 Introduction

The purpose of this paper is to investigate whether the financial literacy and financial education of non-professional investors influence the risk-taking behaviour and the diversification strategies they pursue.

Our interest in this issue lies in the fact that all major economies have recently been very active in promoting financial education programs among individuals in order to educate and empower them in personal financial management thus improving their

Corresponding author: Ugo Rigoni, rigons@unive.it, +39 041 2348770, Department of Management, Ca' Foscari University of Venice, Cannaregio 873, Fondamenta San Giobbe, 30121 Venezia.

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financial education outcomes. One example is the Dodd-Frank Act in the US, that established the creation of the Consumer Financial Protection Bureau and, within it, the Office of Financial Education, «which shall develop a strategy to improve the financial literacy of consumers[1]».

The reason behind this attention to develop educational programs is threefold: first, investors are increasingly in charge of their own financial security; second, financial instruments are complex and potentially risky; third, individuals have been proven to often be not sufficiently equipped to make conscious investment decisions: a phenomenon called financial illiteracy. This is one of the reasons why they tend to make several well-documented mistakes' and fail in planning for saving and retirement. Hence, financial illiteracy is also a problem of public interest, the relevance of which has been exacerbated by the recent financial crises. However, it is of crucial importance to understand if and how these programs can effectively help individuals when deciding on their investments.

Several studies show that financial literacy is positively related to self-beneficial financial behaviours, including stock market participation (van Rooij *et al*., 2011; Kimball and Shumway, 2006, Christelis *et al*., 2010) and better diversification (Graham *et al*. 2009), while the effects of various forms of financial education on financial behaviour are less certain.

In our paper, in agreement with recent literature, we separate the concept of financial literacy from that of financial education. As stated by the US President's Advisory Council on Financial Literacy in 2008, financial literacy represents the general personal knowledge and skills of financial concepts (e.g. inflation, compounding, financial instruments and diversification principles), whereas financial education defines a structured path of knowledge that can be also used as a tool to improve financial literacy. It is evident that the two concepts are related, but they are substantially different: financial literacy can depend either on the investor having attended financial courses during his/her life or on having acquired expertise participating in the financial market. Financial education, instead, regards investor's instruction on financial topics (e.g. undergraduate courses, masters, PhD, etc.). We support this conjecture with a specific empirical analysis showing that literacy is influenced by several personal features other than financial education, which is not necessarily the most important.

Our study investigates whether the two concepts play a role in the risk taking decision process of non-professional investors (i.e. non-professional traders or operators in financial markets) as well as in the diversification strategies they pursue. To study this issue, we conducted a survey among 711 US residents, recruited through Amazon Mechanical Turk.

Our results show that financial education affects the risk taking process structurally changing some main patterns of decisions: in fact, there are several differences among those persons who have taken some kind of financial education and those who have not. As for the risk taking process, financially educated individuals assume more risk the more financially educated and risk tolerant they are. On the other hand, uneducated individuals

[1] Dodd-Frank Wall Street Reform and Consumer Protection Act, Title X – Bureau of Consumer Financial Protection 2010, Section 1013.

are influenced also by other personal features, like age and gender. In both cases financial literacy does not play a role: this result challenges the existing literature which supports the hypothesis that it affects risk taking choices.

With respect to the diversification strategies pursued, the results are affected by the diversification notion considered. When we examine simple diversification strategies, such as the naïve diversification rule (that implies splitting wealth equally among asset classes), it turns out that for educated individuals financial literacy pushes them to diversify more, while financial education does not. This doesn't hold for the uneducated individuals, for whom literacy is not influential on their diversification choice. Our results extend the existing literature that has found a similar effect on another diversification issue, the home bias (Graham *et al*. 2009). We also tested whether more sophisticated strategies, exploiting the imperfect correlation between investments, may be explained by levels of literacy and financial education, but we did not find any supporting evidence.

Our study introduces a series of novelties. First of all, different to prior studies that analysed the single effects of financial literacy and financial education on stock market participation separately, we focus on how financial literacy and financial education simultaneously affect the risk taking decisions of investors. Furthermore, we attempt to understand whether financial literacy helps investors to enhance their understanding of diversification techniques. Again, different to existing studies, we adopt an experimental approach that allows us to collect more details about each investment strategy and to develop a more sophisticated and complex analysis. The paper is organised as follows: Section 2 presents the literature; Section 3 describes the questionnaire and the dataset; Section 4 defines our hypothesis and the research design; Section 5 presents the findings; Section 6 concludes the paper.

2 Literature Review

The focus of our research is on the risk taking behaviour of non-professional investors. The literature on this topic is broad and ranges from purely economic contributions to a huge number of studies in the field of psychology. Risk taking relates to the concept of financial risk tolerance, by which we mean the maximum amount of uncertainty that someone is willing to accept when making a financial decision (Grable, 2000). Assessing financial risk tolerance is very important as it reaches into almost every part of economic and social life. However, measuring individuals' risk tolerance tends to be difficult because of the subjective nature of risk taking. For example, Carducci and Wong (1998) tried to identify personality factors that determine financial risk taking in everyday money matters. They discovered that people fitting the Type A personality trait (typically high-achieving «workaholics» who multi-task, push themselves with deadlines, and hate both delays and ambivalence) tend to take greater risks than those fitting the Type B features (as opposed to Type A). However, the investigation of factors that determine financial risk taking can be expanded beyond the testing of purely psychological factors (Carducci and Wong, 1998; Grable and Joo, 1997). Specifically, demographic, socio-economic, and attitudinal characteristics, such as gender, age, marital status, occupation, income and

expectations, all help to explain a person's willingness to take financial risks in everyday life (Slovic, 1966; Blume, 1978).

Our research moves along these lines but with a focus on the role of financial education and financial literacy in guiding the risk taking process. It has already been well documented in the literature that increased educational attainment (Baker and Haslem, 1974; Cicchetti and Dubin, 1994; Shaw, 1996; Zhong and Xiao, 1995) and also superior knowledge of personal financial issues (Cutler, 1995; Grable and Joo, 1997) are associated with increased levels of risk tolerance. However, the relation between financial education, or knowledge, and risk taking is not completely clear. Recent studies, mainly developed by Lusardi and Mitchell, focus on the concept of financial literacy, defined as the general personal knowledge and skills of financial concepts (e.g. inflation, compounding, financial instruments, diversification principles), as opposed to the notion of financial education which, instead, identifies a structured path of knowledge that can be also used as a tool to improve financial literacy (PACFL, 2008). Evidence shows that financial illiteracy is widespread among the US population and is particularly acute among specific demographic groups, such as those with low education, women, African Americans, and Hispanics (Lusardi and Mitchell, 2008). This lack of financial knowledge makes individuals less likely to plan for retirement and to accumulate wealth (Lusardi and Mitchell, 2006, 2007a). At the same time they are more likely to take up high-interest mortgages (Moore, 2003).

According to some academics, financial literacy is positively related to self-beneficial financial behaviours, including stock market participation (van Rooij *et al.*, 2011; Kimball and Shumway, 2006; Christelis *et al.*, 2006) and better diversification. On the other hand, other researchers argue that financial literacy is a secondary concern when it comes to decision making, partly because evidence from financial education programs aimed at increasing individuals' financial literacy has been mixed (Cole, Shastry, 2010; Bernheim *et al.*, 2001). Early evaluations, notably by Bernheim and a series of co-authors, suggest that workplace financial education initiatives increase participation in savings plans (Bayer *et al.*, 1996; Bernheim 2003), while financial education mandates in high schools significantly increase the adult propensity to save (Bernheim *et al.*, 2001). However, more recent research has found that the influence of these education programs is minimal, particularly when benchmarked against other factors, including peer-effects and known behavioural biases like inertia (Duflo and Saez, 2003). This lack of consensus reflects the fact that, as noted in the 2006 report of the Financial Literacy and Education Commission, «a systematic method of evaluation of financial literacy programs does not exist.»

In this paper we further investigate the relation between risk taking, financial literacy and financial education. Consistent with more recent literature, we decided to keep separate the concepts of financial literacy (that can depend either on financial education and/or on the expertise acquired in participating in the financial market) from financial education (i.e. specific courses of finance taken at school/university/master/Phd/...). The nature of the two concepts introduces an endogeneity issue that we properly address throughout the analysis (see Section 5). As regards risk taking, we look at it as the result of the asset allocation strategy chosen. Current literature shows

that, in contrast to the landmark for asset allocation and active portfolio management, i.e. the Modern Porfolio Theory, individuals are unable to properly diversify risk. What they do is to use simple heuristics which facilitate their investment process (Kroll *et al.*, 1988a and 1988b; Weber and Camerer, 1998; Siebenmorgen *et al.*, 2001), such as the «1/N strategy», which implicates splitting wealth equally among available asset classes (notoriously money market funds, bonds and stocks), in a naïve way. Benartzi and Thaler (2001) find applications of this rule in many individuals' retirement allocations. Others (Jobson, Korkie, 1980; Michaud, 1998; Duchin, Levy, 2009; DeMiguel *et al.*, 2009) prove that the naïve rule can even outperform Markowitz's rule. More recently, Fernandes (2013) replicated the naïve diversification bias across different samples using a within-participant manipulation (students, administrative staff, experts, «Mturkers») of portfolio options and discovered that only differences in focus on intuition predicted this bias: the more investors use intuitive judgments, the more likely they are to display the naïve diversification bias.

We believe our study offers an original contribution to this issue in sereval ways: first, we investigate whether the levels of financial literacy and financial education are a driver of the risk taking process of non-professional investors and of their diversification behaviour, influencing the manner and the strategies they use to allocate assets; second, we collect data using an online experiment and recruit around 700 individuals from Mechanical Turk (MTurk in what follows), an online labour market created by Amazon, recently become popular among social scientists as a source of survey and experimental data. Our results allow us to understand if the low ability of individuals to diversify their portfolios can depend on their generalized financial illiteracy and, thus, fill a gap in the literature. Moreover, we enrich more recent literature about naïve diversification as opposed to traditional diversification à la Markowitz. The study also offers some interesting insights for regulators and authorities who are facing the increasing need to educate investors and must decide which direction to give to education programs.

3 Questionnaire and Data

3.1 The Structure of the Questionnaire

In order to address our research questions, we designed an online experiment. Our questionnaire was made of three parts: in the first part we introduced a task, aimed at ascertaining how individuals take risks and define asset allocation strategies; in the second part, we measured the respondent's level of financial literacy; finally, we collected personal information that we used as control variables[2] in our analyses.

As for the design of the first part, our source of inspiration was a paper by Siebenmorgen and Weber (2003). In their work, the authors test a behavioural model for asset allocation based on the concepts of pure risk and naïve diversification, using German

[2] The questionnaire is fully reported in the Appendix.

financial advisors as a participation pool. They discover that the behavioural model explains professional investment advisors' recommendations more accurately than the classic Markowitz model. Since our purpose is to study non-professional individuals, we simplified the questionnaire developed by Siebenmorgen and Weber, in order to make it understandable by non-experts and more suitable to our research idea. Subjects had to imagine they had a friend, characterised by a specific socio-economic profile and investment goals, who needed advice on how to invest a certain amount of money they had just inherited from their deceased grandmother. Five asset classes represented the given investment alternatives: short-term monetary funds; bonds; blue chip stocks; small cap stocks; and, foreign stocks. For each asset class we provided respondents with a brief definition and a description of the risk-return features. Given this set of information, respondents were asked to recommend a possible asset allocation, taking into account their friend's risk attitude. The recommendation implied choosing a weight (from 0 to 100%) for each asset class, the sum of which add to 100%. We designed the questionnaire in such a way that each respondent had to propose three asset allocations, categorised as cautious, moderate or risk loving. The three risk profiles were proposed in random order, ruling out possible automatic choices.

As better argued in Section 4, the choice to introduce a fictitious friend rather than asking the respondent to take a decision for himself is a tool to standardise the respondent beliefs by profile. We are aware that this approach could potentially introduce a bias in the asset allocation decision process of our respondents; however, the literature indicates that this should not be an issue. Harvey *et al.* (2006), for instance, find that activities associated with risk-seeking show no differences between judgements of risk acceptability for self and others, either when others have similar values to the respondents or when they had different values from them. Moreover, the literature has shown that individuals are not consistent when they make decisions for today and for the future, evidence that led many theorists to conceptualise the human mind as composed of multiple selves (Ainslie, 1992; Elster, 1984; Schelling, 1984; Thaler and Shefrin, 1981). In particular, perceptions and judgments of future selves sometimes resemble perceptions and judgments of other people better than those of present selves (e.g. Pronin and Ross, 2006). Individuals literally perceive their future selves as they would perceive another person. Furthermore, the construal level theory (Trope and Liberman, 2003) claims that increases in temporal and social distance are likely to decrease people's focus on concrete and immediate concerns and increase their focus on abstract goals and outcomes (also Vallacher and Wegner, 1987). Therefore, the *escamotage* of the fictitious friend should return results more coherent and robust with the strategic asset allocation approach that our respondents adopt.

In the second part of the questionnaire, we asked our respondents 5 questions in order to assess their level of financial literacy. Questions were taken from the set developed by Annamaria Lusardi and Olivia Mitchell in their numerous studies about this topic. To our purposes and in order to keep the questionnaire short and manageable, we focused our attention on 5 dimensions: numeracy (question 1); inflation (question 2); safety: stock or mutual fund (question 3); riskiness: stock or bond (question 4); time value of money (question 5). The standard questions used in the literature in order to measure a

generic level of financial literacy are the first three; however, the authors also developed a more extended set of questions aimed at detecting more sophisticated levels of financial knowledge. In our study, we decided to add questions 4 and 5, in order to have a more reliable measure of literacy. At the same time we tried to keep the questionnaire short and manageable, given the nature of our respondents and the channel we used to distribute our survey (see next sub-section).

The third part of the questionnaire was designed to collect socio-demographic information such as: gender, age, marital status, education, financial education (number of courses of finance attended during life), job and risk attitude.

3.2 Collecting Data through Amazon Mechanical Turk

We submitted our questionnaire, via web in July 2012 using Amazon Mechanical Turk (MTurk in what follows) as a recruitment channel. MTurk is an online labour market created by Amazon to assist «requesters» in hiring and paying «workers» for the completion of computerised tasks (Paolacci and Chandler, 2014). Tasks are typically completed in a very short time (minutes) and usually pay in cents rather than dollars. Psychologists first, but also the other social scientists, have recently discovered the potential of the MTurk workforce as a «large pool of participants, constantly available to complete research studies at a low cost» (Paolacci and Chandler, 2014, p. 184).

In 2014, the MTurk workforce was composed of more than 500,000 individuals from 190 countries. Surveys conducted so far indicate that they predominantly reside in the United States and India, with less than a quarter of them residing elsewhere (Paolacci *et al*., 2010; Ross *et al*., 2010). In general, workers are diverse but not representative of the populations they are drawn from, reflecting that Internet users differ systematically from non-Internet users. Workers tend to be younger (about 30 years old), overeducated, underemployed, less religious, and more liberal than the general population (Berinsky, Huber and Lenz, 2012; Paolacci *et al*., 2010; Shapiro *et al*., 2013). Within the US, Asians are overrepresented and Blacks and Hispanics are underrepresented relative to the population as a whole (Berinsky *et al*., 2012).

Along with the increased use of Mturk questions regarding its reliability have surfaced. Buhrmester *et al*. 2011 describe and evaluate the potential contributions of this tool to the social sciences and discover, among other results, that: participation is affected by compensation rate and task length, but participants can still be recruited rapidly and inexpensively; realistic compensation rates do not affect data quality; and the data obtained are at least as reliable as those obtained via traditional methods. The reasons why «Mturkers» participate in the HITs (human intelligence tasks) posted are both extrinsic and intrinsic (e.g., «to make basic ends meet» and because «tasks are fun»; Paolacci *et al*., 2010; Ross *et al*., 2010), thus suggesting that the rewards of working on MTurk are not merely monetary. Other factors affect the likelihood of workers' seeing and selecting a task, including task complexity (Kazai *et al*., 2012), time of sampling (Komarov *et al*., 2013), and whether the task was discussed in an online forum (Chandler, Mueller and Paolacci, 2014). A very recent study by Lakkaraju (2015) shows that, except for gender,

there is no statistically significant difference in terms of demographics characteristics as a function of HIT posting time.

Given the potentialities of MTurk, we decided to distribute our survey using this channel for one main reason, namely regarding the type of individuals we wanted to address: i.e. the «average» investor. Behavioural research in financial accounting and economics often aims to address issues relevant to individual or non-professional investors, citing regulators' concerns for the «average» investor (e.g., Rennekamp, 2012) or the importance of individual investors in US capital markets (e.g., Koonce and Lipe, 2010). While a small number of such studies access investor groups, many such studies utilise convenience samples of graduate business student participants in experiments. A recent working paper by Krische (2014) shows that limiting the pool of participants in the original research (as it is done in the majority of the experimental papers) increases the power of the statistical tests, but doing so may overstate the generalisability of the findings to less sophisticated investor populations.

Using MTurk allowed us to reach a more heterogeneous sample of people (regarding key aspects for our research such as financial education, education, job, age,..) and also to get a greater number of participants (at lower cost) than we could have had if we had run our experiment in the lab.

In order to better fit our research questions, we imposed some constraints while posting our survey on MTurk: in particular, we excluded financial professionals and not US residents.

We also fixed a flat payment of $0.25/min, which corresponded to $15/hour, an amount of money totally in line with the minimum wage in the US in 2012 (i.e. $12.25/hour)[3].

After posting the survey, we got 711 full responses to the questionnaire in less that 12 hours. Our target sample was 500 respondents (considering that the number of participants to experiments in the lab is noticeably lower), therefore 711 was a satisfactory number for our purposes.

In the next sub-section, we provide some descriptive statistics about the responses collected, divided by socio-demographic information, financial literacy and education, and risk taking behaviour.

3.3 Descriptive Statistics

Table 1 reports information about our 711 respondents. 54% of our sample is made up of men (382 subjects) and the remaining 46% of women (329). The average age is 31.5 years old (median 27). As far as occupation is concerned, around 45% of the respondents are students, 17% are employed, 16% unemployed, 22% retired. 50% are in a couple.

The education level is high: the median is, in fact, equal to 5 (i.e. bachelor degree). In terms of risk attitude, our respondents are predominantly indifferent to risk (median = 2).

The characteristics of this sample are in line with what we have previously stated about the «Mturkers»: they are mainly young people, students, underemployed, with a high education. However, the presence of retired people guarantees heterogeneity to our

[3] For more information, see: http://wiki.wearedynamo.org/index.php?title=Fair_payment.

Table 1: Respondents' socio-demographic characteristics, financial literacy, financial education, risk attitude

Stats	Education	Fin_Literacy	Fin_education	Risk_Att	Age	Gender	Unemployed	Student	Employed	Retired	Marital_Status
Mean	4.70	3.79	0.67	1.89	31.51	0.54	0.16	0.45	0.17	0.22	0.50
Median	5	4	0	2	27	1	0	0	0	0	0
Sd	0.76	1.11	1.61	0.67	11.74	0.50	0.37	0.50	0.38	0.41	0.50
N	711	711	711	711	711	711	711	711	711	711	711
Min	1	0	0	1	15	0	0	0	0	0	0
Max	7	5	20	3	77	1	1	1	1	1	1

Table 2: Respondents' financial literacy level (conditional frequencies by gender)

	FL_Interest rate		FL_Inflation		FL_Diversification		FL_Risk		FL_Lottery	
Correct	90.86%		76.93%		66.53%		88.47%		56.26%	
	M	F	M	F	M	F	M	F	M	F
	93.46%	87.84%	84.29%	68.39%	73.56%	58.36%	88.48%	88.45%	58.38%	53.80%
Wrong	9.62%		16.35%		9.13%		2.88%		31.73%	
	M	F	M	F	M	F	M	F	M	F
	5.24%	10.03%	11.26%	23.40%	7.07%	9.12%	6.02%	3.04%	39.53%	41.03%
I don't know	1.69%		6.19%		25.46%		6.89%		3.52%	
	M	F	M	F	M	F	M	F	M	F
	1.31%	2.13%	4.45%	8.21%	19.37%	32.52%	5.50%	8.51%	2.09%	5.17%

Table 3: Respondents by financial education and literacy

	Fin_Education										
Fin_Literacy	0	1	2	3	4	5	6	7	8	10	20
0	5										
1	20										
2	63	4	5								
3	122	10	5	3	1	2					
4	189	24	23	4	6	3	3		1		
5	134	22	27	8	5	11	3	2	4	1	1
Tot.	533	60	60	15	12	16	6	2	5	1	1

sample and the possibility to reach the «average individual». We have to make a remark about nationality (not reported in the tables): as claimed before, we selected only US residents. Our respondents were nearly 100% American citizens, therefore we excluded this information from our analysis.

Moving to the financial literacy issue, we asked our respondents five questions taken from the leading literature in order to assess their knowledge of the financial basics. The first question investigates the knowledge of numeracy (*FL_Interest rates*) while the second addresses the effect of inflation on the purchasing power (*FL_Inflation*). The third question looks at the diversification concept and, in particular, at the greater safety of investing in more than a single stock (*FL_Diversification*), whereas the fourth at the riskiness of bonds and stocks (*FL_Risk*). Finally, the fifth question once again investigates knowledge of interest rates in a more complex setting (*FL_Lottery*). Table 1 shows that the median level of literacy is 4 (5 is the maximum), whereas Table 2 reports the statistics regarding each question, divided by gender.

Interestingly, one of the topics in which they appear less prepared on is diversification: in particular, they consider investing in a single company stock less risky than investing in a stock mutual fund. It's also interesting to observe that, consistent to previous studies (Chen, Volpe, 2002; Lusardi, Mitchell, 2008), women are less literate than men. Moreover, the presence of the «I don't know» alternative prevented respondents from replying at random. There is no missing data in our dataset as each respondent was required to reply to all the questions if they wanted to reach the end of the questionnaire and be paid.

We have also collected information about the financial education of our participants, here approximated by the number of courses in finance attended. Table 1 shows that

the average number is 0.67 (median = 0) but the range of variability (min-max) is high: there is, in fact, somebody who attended 8 courses and 1 person that attended 20. In order to understand how financial literacy and financial education are distributed among our respondents, we present Table 3, where we have counted the number of individuals by courses of finance attended and level of financial literacy. As we can see from the table, there are 533 respondents (75%) who have never attended a course of finance. However, a single course of finance moves respondents to a minimum level of financial literacy equal to 2. As the number of courses in finance increases, the level of literacy becomes higher, showing that financial education positively affects financial literacy.

Finally, we report information about the asset allocation proposed by our respondents, the average risk taken and the diversification strategies used. Table 4 summarises the overall decisions made. The top-part of the table reports the average results of the total sample, whereas the three sub-sections below differentiate the average decisions according to the three different risk profiles proposed in the questionnaire: cautious, moderate (well-balanced) and aggressive.

The columns of the table present three categories of portfolio risk (columns 2, 3, 4), defined in detail in the next section, as well as the average weights assigned to each asset class (columns 5-9) representing asset allocation decisions. Respondents invested on average 26.27% of their friend's portfolio in short term monetary funds, 27.05% in bonds, 20.24% in blue chips, 13.50% in small caps and 12.94% in foreign stocks. This asset allocation implies a portfolio risk of 9.10% (s.d. 4.79%) using the average weights chosen by our respondents and weekly returns of five market indexes of the last ten years used as the benchmark for each asset class[4].

The column labelled «Naïve_div» is defined as the complement to 1 of the Herfindahl-Hirschman index (*HH_Index*). The *HH_Index* is defined as:

$$HH\_Index = \sum_{j=1}^{N} w_j^2 \tag{1}$$

where w_j is the percentage invested in the asset class *j*. The index takes value 1 when the portfolio is invested in only one asset class, and value 1/N when resources are split equally among the suggested asset classes. Therefore, the *Naïve_div* variable is defined as:

$$1 - (HH\_Index) \tag{2}$$

which tends to 0 in correspondence to a strategy of concentration and to 0.8 when a pure naïve diversification strategy is implemented.

The average value of this index is equal to 63.10% indicating a tendency to prefer some asset classes (typically short term investments, bonds and blue chips) with respect to others.

The sophisticated diversification (*Sophisticated_Div*), reported in column 4, is a standardized measure of the difference between a theoretical portfolio standard devia-

[4] See Section 4 for a complete description of its computation.

Table 4: Respondents' asset allocation decisions (%)

Total	Portfolio_Risk	HH_Index	Theoric_Risk	Naïve_Div	Sophisticated_Div	Short	Bond	Blue Chips	Small Caps	Foreign
Mean	9.10	36.90	11.16	63.10	26.57	26.27	27.05	20.24	13.50	12.94
St. Dev.	4.79	19.05	5.17	80.95	17.51	21.82	21.45	15.64	11.98	13.66
Min	0.15	20.00	0.15	80.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	24.85	100.00	24.85	0.00	90.61	100.00	100.00	100.00	100.00	100.00
Cautious										
Mean	6.60	42.97	8.48	57.03	32.33	30.87	36.96	15.73	8.60	7.83
St. Dev.	4.09	20.98	4.62	79.02	21.61	24.20	24.44	14.80	9.35	10.45
Min	0.15	20.00	0.15	80.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	21.97	100.00	22.49	0.00	90.61	100.00	100.00	100.00	70.00	100.00
Moderate										
Mean	8.81	33.16	10.96	66.84	26.85	27.00	27.49	19.66	13.79	12.06
St. Dev.	4.02	16.94	4.41	83.06	15.29	19.79	17.79	12.89	10.82	10.92
Min	0.15	20.00	0.15	80.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	24.85	100.00	24.85	0.00	78.60	100.00	100.00	85.00	100.00	100.00
Aggressive										
Mean	11.88	34.58	14.03	65.42	20.53	20.94	16.71	25.32	18.11	18.92
St. Dev.	4.69	17.49	4.89	82.51	12.25	20.05	16.19	17.40	13.45	16.41
Min	0.15	20.00	0.15	80.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	24.00	100.00	24.26	0.00	79.38	100.00	100.00	100.00	85.00	100.00

Table 5: Analysis of the respondents' asset allocation choices and naïve diversification strategies

Panel A. Respondents' asset allocation choice by class of naïve diversification strategies						
Naïve_Div Ranges	Portfolio_Risk	Short	Bond	Blue Chips	Small Caps	Foreign
0-0.2	4.81	47.46	35.63	9.50	1.09	6.31
N	127	127	127	127	127	127
0.2-0.4	5.85	36.23	39.26	11.26	7.03	6.22
N	98	98	98	98	98	98
0.4-0.6	6.91	33.24	34.92	17.25	6.85	7.73
N	364	364	364	364	364	364
0.6-0.8	10.17	22.24	23.72	22.39	16.49	15.14
N	1544	1544	1544	1544	1544	1544
Total	9.10	26.27	27.05	20.24	13.50	12.94
N	2,133	2,133	2,133	2,133	2,133	2,133
Panel B. Respondents' asset allocation choice by naïve diversification strategies and fictitious profile						
Naïve_Div Ranges	Portfolio_Risk	Short	Bond	Blue Chips	Small Caps	Foreign
			Cautious			
0-0.2	3.40	44.23	47.83	5.75	0.20	1.99
N	69	69	69	69	69	69
0.2-0.4	3.92	35.31	49.92	10.79	1.25	2.73
N	52	52	52	52	52	52
0.4-0.6	4.67	37.23	43.39	12.68	3.68	3.01
N	180	180	180	180	180	180
0.6-0.8	8.32	25.26	30.66	19.38	13.11	11.58
N	410	410	410	410	410	410
Total	6.60	30.87	36.96	15.73	8.60	7.83
N	711	711	711	711	711	711
			Moderate			
0-0.2	3.12	62.80	28.80	0.00	4.40	4
N	25	25	25	25	25	25
0.2-0.4	5.90	38.20	38.60	10.80	9.28	3.12
N	25	25	25	25	25	25
0.4-0.6	5.94	37.92	35.74	14.80	5.29	6.25
N	93	93	93	93	93	93
0.6-0.8	9.66	23.14	25.60	21.71	15.79	13.77
N	568	568	568	568	568	568
Total	8.81	26.99	27.49	19.66	13.79	12.06
N	711	711	711	711	711	711
			Aggressive			
0-0.2	9.04	42.58	15.30	24.55	0.45	17.12
N	33	33	33	33	33	33
0.2-0.4	10.55	36.19	13.62	12.95	18.67	18.57
N	21	21	21	21	21	21
0.4-0.6	12.32	20.57	17.32	28.79	14.72	18.59
N	91	91	91	91	91	91
0.6-0.8	12.02	19.17	16.80	25.27	19.66	19.09
N	566	566	566	566	566	566
Total	11.88	20.94	16.71	25.32	18.11	18.92
N	711	711	711	711	711	711

tion where the correlation among asset class returns are all set equal to 1 and the actual portfolio standard deviation (see the next section for a full definition of the variable): a value greater than 0 indicates an effort (conscious or not) to exploit correlations among the different types of investments and, therefore, to implement a sophisticated portfolio diversification.

The choices made by our respondents according to the three risk profiles proposed, reveals some peculiarities. For the «cautious» profile, the average asset allocation proposed implies an investment of 30.87% of the portfolio in short term monetary funds;

36.96% in bonds; 15.73% in blue chips; 8.60% in small caps and 7.83% in foreign stocks. The risk taken, implicit in such an asset allocation, is small with respect to the other risk profiles and equal to 6.60% (with a standard deviation of 4.09%). With regards to the «moderate» profile, the tendency is to invest less in short-term funds and bonds and more in stocks. On the other hand, average portfolio riskiness increases by 2 points percent with respect to the «cautious» profile. Finally, as for the «aggressive» profile, the stock component further increases while bond component decreases. Here, the foreign stock component also increases significantly. The overall portfolio risk for this profile is the highest with an average value equalling 11.88%.

With regards to the risk taking behaviours and the diversification strategies carried out by our respondents, we present Table 5 (Panel A and B), in which we try to depict the distribution of the asset allocation proposed by class of naïve diversification (Panel A) and then by naïve diversification and (friend's) risk profile (Panel B).

Table 5 shows a clear trend in asset allocation choices combined with a naïve diversification strategy. The decrease in the naïve diversification indicator is, in fact, associated to a decrease in portfolio risk levels and an increase in investment percentages in low risk assets. For instance, in correspondence to low naïve diversification indexes (between 0 and 20%), the average percentage of investment in low risky assets is about 83% (47% in short and 35% in bond) against 17% in risky assets.

On the contrary, investors willing to reach a high-risk portfolio target, diversify more and split their money among the higher risk asset classes offered (small, blue chips and foreign investments). For example, in correspondence with high levels of diversification (indexes between 60% and 80%), respondents reduce their investment in low risky assets (on average about 45% of their wealth) against 54% in risky assets. No investor concentrated wealth in just one (highly risky) asset. This evidence seems to hold regardless of the fictitious profile the asset allocation is selected for. In correspondence with the «aggressive» profile, the trend is still evident even if it is less marked (see Panel B).

4 Hypothesis Development and Research Design

Our aim is to investigate whether risk taking decisions and diversification strategies pursued by non-professional investors are affected by their level of financial literacy and financial education. Summarising the main empirical results from prior literature, several studies show that financial literacy is positively related to self-beneficial financial behaviours, including stock market participation (Van Rooij *et al*., 2011; Kimball and Shumway, 2006; Christelis *et al*., 2006) and better diversification (Graham *et al*. 2009), while the effects of various forms of financial education on financial behaviour are less certain.

Consistent with the reference studies, we keep the two concepts of financial literacy and financial education separate and we test the simultaneous effect of these two individual characteristics on the risk taking process.

The President's Advisory Council on Financial Literacy (PACFL, 2008) provides a simplified version of a «consensus» definition of financial literacy and financial educa-

tion. The Council states that, whereas financial literacy represents the general personal knowledge and skills of financial concepts (e.g. inflation, compounding, financial instruments and diversification principles), financial education defines a structured path of knowledge that can be also used as a tool to improve financial literacy[5]. Therefore, we argue that financial literacy and financial education can be related. However, as they represent different constructs, the impact on investor's risk taking decisions must be analysed simultaneously and we expect that both financial literacy and financial education positively affect it.

Before applying these conceptual constructs, we investigate the relation between them, testing how financial education affects the financial literacy of our respondents.

We measure financial literacy through the *Fin_Literacy* variable that, according to prior literature, is the sum of all five responses to the financial literacy questions collected in the questionnaire. Each answer was valued 1 if the respondent's answer was correct and 0 otherwise. The «I do not know» answer was treated as zero. Therefore, *Fin_Literacy* is a scalar that can assume values from 0 (financial illiteracy) to 5 (highest level of financial literacy). *Fin_Literacy* is also an ordinal variable with five possible outcomes in meaningful order. Instead, the *Fin_Education* variable indicates the level of specific education in the financial field and is measured as the number of courses in finance taken.

Because of the nature of our dependent variable (*Fin_Literacy*), we run an ordered logistic regression model[6] that estimates the probabilities of having a high (low) level of financial literacy conditionally to a set of independent variables. In the regression, we include, as independents, *Fin_Education*, but we also check for other respondents' characteristics such as their general education level, age, gender, risk attitude, job and, finally, marital status. The qualitative information regarding gender (*Gender*), job (*Job*)[7] and marital status (*Marital_Status*)[8] has been codified as dummy variables. Age (*Age*) is treated as a quantitative variable, while investors' risk attitude (*Risk_Att*) has been translated into a numeric scale, from 1 (low risk attitude) to 3 (high risk attitude). We also include the general level of individual education (*Education*) taking values from 1 (lowest education level) to 7 (highest education level) in the model. Main descriptive statistics of these variables are reported in Table 1.

Therefore, the dependent variable assumes 6 different values according to this rule:

[5] OECD defines financial education as «the process by which financial consumers/investors improve their «understanding of financial products and concepts and, through information, instruction and/or objective advice, develop the skills and confidence to become more aware of financial risks and opportunities, to make informed choices, to know where to go for help, and to take other effective actions to improve their financial well-being» (2005, p. 26).

[6] Logit and probit models tend to produce very similar probability values. However, we prefer the logit one to avoid some technical issues on the estimation of the model parameters.

[7] The list of respondents' jobs has been reduced to the following four classes:

1) Unemployed;
2) Student;
3) Employed;
4) Retired.

In the regression, we insert three out of four variables for the over-identification issue.

[8] We included the respondent's marital status as a dummy variable, equal to 1 if the respondent is «in couple», 0 otherwise.

$$(3) \qquad Fin\_Literacy_i = \begin{cases} 0 \; if \; Fin\_Literacy_i^* \leq u_1 \\ 1 \; if \; u_1 \; Fin\_Literacy_i^* \leq u_2 \\ 2 \; if \; u_2 \; Fin\_Literacy_i^* \leq u_3 \\ 3 \; if \; u_3 \; Fin\_Literacy_i^* \leq u_4 \\ 4 \; if \; u_4 \; Fin\_Literacy_i^* \leq u_5 \\ 5 \; if \; Fin\_Literacy_i^* > u_5 \end{cases}$$

where *Fin_Literacy** represents the latent variable for the observed *Fin_Literacy*, $u_j (j = 1,..., 5)$ indicates the unknown ancillary parameters to be estimated through a logistic probability distribution applied to the observed *Fin_Literacy* variable, *i* indicates each respondent.

Once we establish that financial literacy is not simply a proxy for financial education (see Section 5.1), we test how the levels of investors' financial literacy and financial education affect their risk taking behaviour.

Although prior research has focused on stock market participation as a possible approximation of investor risk taking, we argue that it is an imperfect proxy. For this reason, in contrast to prior literature, we represent the risk-taking behaviour of non-professional investors through two different dimensions: the total amount of risk taken and the diversification strategies pursued.

In particular, we assume as a dependent variable the overall portfolio risk obtained by our respondents (*Portfolio_Risk*) through their asset allocation choices. In order to construct the variance-covariance matrix of our respondents' choices and, thus, get the portfolio standard deviation, we used the percentages that they selected for each suggested asset class as weights and the daily returns over a 10-year time horizon of 5 market benchmarks as proxies for the performances of the five asset classes. More specifically, our benchmarks were the following: the Standard and Poor's 500 Index (SPX Index) for blue chip stocks, the Standard and Poor's Small Cap 600 Index (SML Index) for small caps, the MSCI All Country World ex-US Index (MXWDU Index) for foreign stocks, the J.P. Morgan Global Aggregate Bond Index (JGAGUSUS Index) for bond asset class and the Barclays US 3 month Libor Cash Index (BXIIU3IC Index) for short term investments.

To complete our investigation on the drivers of risk taking decisions we then moved our analysis to observe the drivers of the diversification strategy applied. Since investors can decide how to exploit the diversification principle in order to reach a desired level of risk, we test whether financial literacy and financial education can also affect the diversification strategies pursued by our respondents.

Prior literature distinguishes between two main types of diversification behaviour: the sophisticated one and the naïve one. The first one is derived from the Modern Portfolio Theory, dating back to Markovitz's seminal work (1952). It suggests that investors optimise the risk-return exposure of their investment portfolios, splitting their wealth over different assets, considering the statistical linkage between them. Unfortunately, this task is generally quite complex and demanding. For this reason, psychological studies (e.g. Tversky and Kahneman, 1981; Simon, 1955 and 1979; Payne, Bettman and Johnson, 1992) show that decision makers adopt, in practice, various kinds of simplifying diversification heuristics, (e.g. Simonson, 1990; Read and Loewenstein, 1995). Specifically,

when the number of macro asset classes is relatively small, investors prefer to apply a naïve diversification strategy, simply investing an equal fraction (1/N) of their wealth in each asset class offered (Huberman and Jiang, 2006).

For this reason, we capture the risk diversification strategies pursued by investors assuming two different and alternative specifications. First, we represent the naïve diversification strategy through a proxy (*Naïve_Div*) defined as the complement to 1 of the Herfindahl-Hirschman index (*HH_Index*). The Herfindahl-Hirschman index is defined as:

$$HH\_Index = \sum_{j=1}^{N} w_j^2 \tag{4}$$

where w_j is the percentage invested in the asset class *j*. The index takes value 1 when the portfolio is invested in only one asset class, and value *1/N* when resources are split equally among the suggested asset classes. Therefore, the *Naïve_Div* variable is defined as:

$$1 - (HH\_Index) \tag{5}$$

which tends to 0 in correspondence to a strategy of concentration and to 0.8 when a pure naïve diversification strategy is implemented.

Sophisticated diversification behaviour is, instead, approximated by a measure that evaluates the extent to which the imperfect correlation among asset classes reduces portfolio risk, given the weights chosen for each asset class. We call this index *Sophisticated_Div* and it is defined as:

$$Sophisticated\_Div = \frac{\sigma^2_{p/\rho=1} - \sigma^2_P}{\sigma^2_{p/\rho=1}} \tag{6}$$

where $\sigma^2_{P/\rho=1}$ is the variance of portfolio returns when all correlations are set equal to 1 and σ^2_P is the actual portfolio variance.

In our framework, as the weights attributed to each asset class were always positive, the index takes values close to 0 when the correlations among asset classes are close to 1 and/or when the portfolio was highly concentrated. This indicates that no diversification benefit was derived from a sophisticated diversification strategy.

We expect sophisticated diversification will depend on financial literacy i.e. the effective knowledge of financial tools and, conversely that naïve diversification behaviour, a simplified mental heuristic, will not. Moreover, whereas financial education should not affect naïve diversification, it might instead affect a sophisticated diversification strategy. In fact, financial education indicates the level of an individual's financial culture; this does not necessarily translate into skills and abilities that allow the investor to apply the same financial principles and concepts.

In the set of independent variables, we include our main regressors (*Fin_Literacy* and *Fin_Education*) and a set of control variables summarising the respondents' socio-demographic features, such as age (*Age*), gender (*Gender*), job (*Job*), marital status (*mari-*

tal_Status), education (*education*) and their risk attitude (*Risk_Att*) which have already been defined.

In more formal terms, we test the following fixed effects regression models:

$$Portfolio\_Risk_{ij} = \alpha + \beta_1 Fin\_Literacy_i + \beta_2 Fin\_education_i + \\ + \beta_3 Age_i + \beta_4 Gender_i + \beta_5 Job_i + \beta_6 Marital\_Status_i + \\ + \beta_7 Education_i + \beta_8 Risk\_Att_i + \varepsilon_{ij} \tag{7}$$

$$Naïve\_Div_{ij} = \alpha + \beta_1 Fin\_Literacy_i + \beta_2 Fin\_education_i + \\ + \beta_3 Age_i + \beta_4 Gender_i + \beta_5 Job_i + \beta_6 Marital\_Status_i + \\ + \beta_7 Education_i + \beta_8 Risk\_Att_i + \varepsilon_{ij} \tag{8}$$

$$Sophisticated\_Div_{ij} = \alpha + \beta_1 Fin\_Literacy_i + \beta_2 Fin\_education_i + \\ + \beta_3 Age_i + \beta_4 Gender_i + \beta_5 Job_i + \beta_6 Marital\_Status_i + \\ + \beta_7 Education_i + \beta_8 Risk\_Att_i + \varepsilon_{ij} \tag{9}$$

Here i represents the respondent while j indicates the fictitious profile (cautious, aggressive or well-balanced) proposed to the respondent in the questionnaire. ε_{ij} represents the error term and includes also the individual error component.

We are aware that investigating risk taking behaviour would have also required the analysis of the actual investing behaviour of the respondent, instead of simply suggesting a fictitious profile. However, this approach would have also required consideration of measures of the respondents' personal features, such as beliefs on the expected market trends, i.e. expected return and risk (as expressed by variance and covariance), preferences, investing time horizon and so on. Asking this information to our non-professional, and therefore inexpert, investors or providing them with some guidelines would have probably generated an issue regarding their correct usage. The bias that would have derived from this approach, although interesting to be investigated, would not have been in line with the focus of this study and therefore we preferred to tackle the issue using a different approach. We adopted the tool of the fictitious profile because it allows us to standardise the respondent beliefs by profile. Furthermore, the fixed effects methodology applied here enables us to focus on financial literacy and financial education, controlling for the unobserved features of the respondent with regard to investment advice. Our fixed effects model provides a method to control for omitted variable bias. Fixed effects models, in fact, remove the effect of those individual time-invariant characteristics, permitting the assessment of the net effect of the predictors on the outcome variable.

Furthermore, since our descriptive evidence (see Tab. 3) shows that a great number of respondents (533) are financially uneducated (*Fin_Education* equal to zero) but nevertheless show a certain heterogeneity in the financial literacy measure, we run our models (7), (8) and (9) separately in the two datasets of respondents: firstly on the financially educated (*Fin_Education* greater than zero) and secondly on the financially uneducated (*Fin_Education* equal to zero).

5 Findings

5.1 The Relation between Financial Literacy and Financial Education

Table 6 reports findings for the ordered logistic regression (1)[9]. The logit coefficients are in log-odds units[10] and cannot be read as OLS coefficients. Therefore, we can interpret the sign of the regression output, but not the magnitude of the coefficients, as they do not indicate the impact of the predictors on the dependent variable probability. Estimating the impact requires calculation of the predicted probabilities for given values of the outcome and the elasticity (or alternatively the marginal effects) showing the change in outcome probability when the independent variable increases by one unit. Table 7 reports this latter information.

In line with previous literature (see Section 2 and 3 for details), our evidence shows that financial literacy is associated with some demographic characteristics of individuals. It is higher for men, older individuals, those with a higher level of education, but, in our dataset, it does not depend on either marital status (being in a couple or not) or on job in a clear way. The positive significant sign of the unemployed coefficient is isolated and could be related to some of the specific features of the category.

The elasticity reported in Table 7 shows that, overall, our predictors have a significantly different relevance in affecting the financial literacy variable. The elasticity coefficients of the significant variables are in fact different from each other and they keep order of importance, regardless of the specific outcomes[11].

As expected, financial education positively affects the level of financial literacy (Tab.7), but it is not decisive. The responsiveness of financial literacy to a change in financial education remains low at different levels of financial literacy, especially if compared to some of the other variables (see *Age*, *Risk_Att* and *Education* variables). However, column (1), (2) and (3) show that the maximum impact of financial education corresponds to the minimum level of financial literacy (especially when it takes values from 0 to 2), while the impact of financial education for high levels of financial literacy is less prominent. In line with expectations, this means that having a good level of financial education can help to increase financial literacy more when financial literacy levels are low, while an improvement in financial education is relatively less incisive when financial literacy is already good.

Further, our results indicate that financial literacy, at least in correspondence to the lowest levels (from 0 to 2), is elastic to changes in education. This means that changing the education level (e.g. taking an entire Master program) will affect the probability to improve financial literacy by one level more than proportionally. The elasticity reduces at higher values of financial literacy. Specifically, as expected also due to the distribution

[9] We imposed our model to have robust standard errors to some kinds of misspecification. Furthermore, the model chi-square is highly significant (Prob > chi2 = 0.0000).

[10] The logarithm of the odds $p/(1-p)$.

[11] We do not comment on column (5). In correspondence to a financial literacy level equal to 4, the p-values indicate elasticity that is not significant.

Table 6: Financial literacy, financial education and other investor's features

Variables	(1)	(2)	(3)
	Fin_Literacy	Fin_Literacy	Fin_Literacy
Fin_Education	0.367***		0.263***
	(5.73e-11)		(2.86e-06)
Age		0.0471***	0.0463***
		(1.72e-10)	(5.36e-10)
Gender		0.747***	0.667***
		(3.48e-07)	(7.88e-06)
Risk_Att		0.529***	0.469***
		(1.15e-05)	(0.000143)
Education		0.383***	0.245**
		(0.000511)	(0.0321)
Unemployed		0.391	0.442*
		(0.102)	(0.0669)
Student		0.105	0.119
		(0.596)	(0.545)
Employed		−0.217	−0.220
		(0.422)	(0.420)
Marital_Status		0.174	0.115
		(0.229)	(0.430)
Constant cut1	−4.806***	−0.443	−1.157*
	(0)	(0.509)	(0.0950)
Constant cut2	−3.163***	1.224**	0.512
	(0)	(0.0367)	(0.403)
Constant cut3	−1.683***	2.756***	2.048***
	(0)	(1.92e-06)	(0.000750)
Constant cut4	−0.482***	4.046***	3.351***
	(1.39e-08)	(0)	(5.47e-08)
Constant cut5	1.088***	5.764***	5.110***
	(0)	(0)	(0)
Observations	711	711	711
Pseudo-R^2	0.026	0.064	0.076

of the variable, the general education level has the smallest impact in correspondence to an average value of financial literacy equal to 3 (column (4)).

An interesting comparison can be made between financial education and education role. As discussed and shown in Table 7, the elasticity of financial education and the general education level are far from similar at the different outcome levels. The interpretation of these two impacts shows an evident difference in terms of the relevance of the two variables. Financial literacy shows a high elasticity to the general education of individuals, but it is relatively inelastic with respect to their financial education, regardless of the specific level of financial literacy considered. According to our numbers, in fact, to exert the same effect of an education change an individual should take at least 6 courses in finance.

However, a change in the education level means a commitment in terms of time and resources far more demanding than adding one level to the financial education. Taking six or seven courses in finance can be tough but still less binding than a complete education programme. Therefore, our findings show that individuals can benefit from financial education programmes, even though the relevance of just a handful of courses (one or two) should not be overstated.

To conclude, we state that financial literacy is not a mere function of the features we have considered as demonstrated by both the low Pseudo-R^2 of the logit regression (0.076) and the inelasticity of the financial literacy variable with respect to the predictors

Table 7: The elasticity coefficients of financial literacy, financial education and other investor's features

	(1) Pr(Fin_ Literacy = 0) = 0.00487		(2) Pr(Fin_ Literacy = 1) = 0.002046		(3) Pr(Fin_ Literacy = 2) = 0.0824		(4) Pr(Fin_ Literacy = 3) = 0.1998		(5) Pr(Fin_ Literacy = 4) = 0.4131		(6) Pr(Fin_ Literacy = 5) = 0.2793	
	Elasticity	p-value	Elasticity	p-value	Elasticity	p-value	Elasticity	p-value	Elasticity	p-value	Elasticity	p-value
Fin_Education	−0.174	0.000	−0.169	0.000	−0.151	0.000	−0.102	0.000	0.005	0.354	0.126	0.000
Age	−1.453	0.000	−1.416	0.000	−1.266	0.000	−0.854	0.000	0.041	0.356	1.052	0.000
Gender	−0.356	0.000	−0.347	0.000	−0.310	0.000	−0.209	0.000	0.010	0.353	0.258	0.000
Risk_Att	−0.881	0.000	−0.858	0.000	−0.767	0.000	−0517	0.000	0.025	0.357	0.638	0.000
Education	−1.134	0.032	−1.105	0.033	−0.988	0.034	−0666	0.034	0.032	0.383	0.821	0.032
Unemployed	−0.070	0.067	−0.069	0.067	−0.061	0.071	−0.041	0.071	0.002	0.391	0.051	0.067
Student	−0.053	0.545	−0.052	0.545	−0.047	0.546	−0.031	0.546	0.002	0.597	0.039	0.545
Employed	0.037	0.420	0.036	0.420	0.032	0.418	0.022	0.418	−0.001	0.563	−0.027	0.421
Marital_Status	−0.057	0.430	−0.055	0.430	−0.050	0.429	−0.033	0.429	0.002	0.555	0.041	0.430

Table 8: Portfolio risk, financial literacy and financial education

Panel A – The financially educated investors			
Variables	(1) Portfolio_Risk	(2) Portfolio_Risk	(3) Portfolio_Risk
Fin_Literacy	0.00412		0.00359
	(0.262)		(0.348)
Fin_Education	0.00284**		0.00254*
	(0.0343)		(0.0675)
Age		3.13e-05	−2.54e-05
		(0.592)	(0.410)
Gender		0.000962	−0.000796
		(0.794)	(0.870)
Unemployed		−0.00622	−0.00275
		(0.514)	(0.798)
Student		0.000741	0.00263
		(0.730)	(0.442)
Employed		−0.00957***	−0.00721**
		(0.00590)	(0.0482)
Marital_Status		−0.000460	−0.000671
		(0.672)	(0.571)
Education		0.00417	0.00294
		(0.336)	(0.394)
Risk_Att		0.00963**	0.00825**
		(0.0151)	(0.0284)
Constant	0.0711**	0.0553	0.0438
	(0.0308)	(0.110)	(0.240)
Observations	534	534	534
R-squared (within)	0.038	0.038	0.067
Number of profile_n	3	3	3
Panel B – The financially uneducated investors			
Variables	(1) Portfolio_Risk	(2) Portfolio_Risk	(3) Portfolio_Risk
Fin_Literacy	0.00180		−0.000523
	(0.643)		(0.891)
Fin_Education	–		–
Age		0.000344	0.000359*
		(0.110)	(0.0584)
Gender		0.00840**	0.00862*
		(0.0370)	(0.0604)
Unemployed		−0.00318	−0.00305
		(0.452)	(0.367)
Student		0.00191*	0.00193
		(0.0784)	(0.113)
Employed		0.000902	0.000802
		(0.813)	(0.849)
Marital_Status		−0.00475*	−0.00466**
		(0.0933)	(0.0417)
Education		0.00286	0.00290
		(0.307)	(0.257)
Risk_Att		0.00847***	0.00862***
		(0.00146)	(0.00519)
Constant	0.0827**	0.0480*	0.0488
	(0.0207)	(0.0798)	(0.129)
Observations	1,599	1,599	1,599
R-squared (within)	0.002	0.045	0.045
Number of profile_n	3	3	3

of main interest, i.e. financial education. Specifically, results support our assumption that financial literacy and financial education should be treated separately: financial literacy does not perfectly mirror financial education.

5.2 Risk Taking Behaviour, Financial Literacy and Financial Education

Focusing on the core research interest of this paper, the relation between risk taking behaviour, financial literacy and financial education partially coincides with our expectations.

Table 8 reports how financial literacy and financial education affect the first risk-taking dimension (portfolio risk), while Table 9 and 10 show how they relate to the diversification strategies pursued in the risk-taking process. Since our models include a set of variables that could suffer from a multicollinearity issue, we run the variance inflation factor (*VIF*) test to exclude this hypothesis. As the *VIFs* of our set of variables are all not greater than 2, we can exclude that our results could be affected by this issue[12].

Financial education experience plays a role in risk taking behaviour of non professional investors. As expected, the risk-taking patterns of financially uneducated investors and financially educated ones are significantly different. Table 8, in fact, shows that if financial education has been totally absent from the investor's experience (Panel B), the only significant drivers of the risk amount choices are related to personal features of the respondents, such as their age, gender, marital status, as well as their risk attitude, but not their financial literacy. Conversely, as documented in Panel A, financial education experience leads to different investors' risk-taking features. Personal characteristics lose their relevance in driving risk taking choices while the level of financial education positively affects the portfolio riskiness level that investors wish to take: the more a person is financially educated, the more they tend to assume risks. However also in this instance, having a broader knowledge of financial tools and skills, as expressed by financial literacy, does not influence the amount of desired risk.

Further, as far as the naïve diversification strategy is concerned, results are mixed. Table 9 shows that for non-financially educated investors (Panel B) we cannot detect any specific pattern that drives their diversification behaviour. They diversify regardless of both their individual characteristics and their level of financial literacy[13]. This result is in line with the nature of naïve diversification that should represent an innate approach to the diversification process.

The evidence reverses when financial education is present (Panel A): financial literacy has a positive significant impact on the *Naïve_Div* variable. Therefore, financially educated investors diversify more in correspondence to increasing levels of financial literacy or, in other words, financial education changes the diversification pattern enforced by the non-professional investors that implement their financial skills to diversify their investment portfolios. This result is not related to the specific number of courses taken. The *Fin_Education* variable is not significant in itself. What makes the difference is to have

[12] VIF shows by how much other coefficients variances (and standard errors) increase due to the inclusion of each predictor. A rule of thumb is that if VIF is less than 10, then the multicollinearity issue is not present.

[13] As a robustness check, to have a more homogenous dataset, we drop from the not financially educated investors those financially illiterate (*Fin_Literacy* equal to zero and 1) and we repeat the analysis. However, the results do not change.

Table 9: Naïve diversification strategies, financial literacy and financial education

Panel A – The financially educated investors			
Variables	(1) Naïve_Div	(2) Naïve_Div	(3) Naïve_Div
Fin_Literacy	0.00812*		0.0102***
	(0.0508)		(0.00887)
Fin_Education	0.00308		0.00196
	(0.547)		(0.684)
Age		−0.00164*	−0.00180*
		(0.0723)	(0.0583)
Gender		−0.0309**	−0.0347**
		(0.0224)	(0.0153)
Unemployed		−0.00150	0.00318
		(0.945)	(0.865)
Student		−0.000787	0.00222
		(0.956)	(0.873)
Employed		−0.0148	−0.0103
		(0.528)	(0.643)
Marital_status		−0.0147	−0.0143
		(0.133)	(0.108)
Education		0.0501**	0.0474**
		(0.0120)	(0.0156)
Risk_Att		0.0273**	0.0257**
		(0.0163)	(0.0310)
Constant	0.605***	0.418***	0.392***
	(5.27e-05)	(0.00824)	(0.00821)
Observations	534	534	534
R-squared (within)	0.004	0.042	0.045
Number of profile_n	3	3	3
Panel B – The financially uneducated investors			
Variables	(1) Naïve_Div	(2) Naïve_Div	(3) Naïve_Div
Fin_Literacy	0.000750		−0.00403
	(0.887)		(0.639)
Fin_Education	–		–
Age		0.000354	0.000467
		(0.261)	(0.252)
Gender		0.0186	0.0203
		(0.120)	(0.174)
Unemployed		−0.0278	−0.0268
		(0.183)	(0.204)
Student		0.0111	0.0113
		(0.561)	(0.560)
Employed		−0.00618	−0.00695
		(0.787)	(0.754)
Marital_status		−0.0311***	−0.0304***
		(0.00819)	(0.00376)
Education		0.0138	0.0141
		(0.254)	(0.249)
Risk_Att		0.0300*	0.0311
		(0.0837)	(0.110)
Constant	0.623***	0.505***	0.511***
	(0.000734)	(0.00693)	(0.00491)
Observations	1,599	1,599	1,599
R-squared (within)	0.000	0.032	0.033
Number of profile_n	3	3	3

a basic understanding of finance that enables respondents to become familiar with the main topics, not the specific level of financial education achieved.

Table 10: Sophisticated diversification strategies, financial literacy and financial education

Panel A – The financially educated investors			
Variables	(1) Sophisticated_Div	(2) Sophisticated_Div	(3) Sophisticated_Div
Fin_Literacy	0.00659		0.0137
	(0.591)		(0.390)
Fin_Education	−0.00291		−0.00311
	(0.554)		(0.563)
Age		−0.00179**	−0.00202**
		(0.0142)	(0.0386)
Gender		−0.0139	−0.0178
		(0.284)	(0.335)
Unemployed		0.0252	0.0258
		(0.516)	(0.573)
Student		0.00165	0.00309
		(0.901)	(0.750)
Employed		0.0396	0.0431
		(0.299)	(0.236)
Marital_status		0.00923	0.0110
		(0.287)	(0.284)
Education		−0.0115	−0.0142
		(0.286)	(0.176)
Risk_Att		−0.00359	−0.00335
		(0.648)	(0.535)
Constant	0.244**	0.384**	0.354**
	(0.0384)	(0.0115)	(0.0304)
Observations	534	534	534
R-squared	0.002	0.019	0.025
Number of profile_n	3	3	3
Panel B – The financially uneducated investors			
Variables	(1) Sophisticated_Div	(2) Sophisticated_Div	(3) Sophisticated_Div
Fin_Literacy	0.0102		0.0165
	(0.503)		(0.314)
Fin_Education	–		–
Age		−0.00138**	−0.00184**
		(0.0187)	(0.0283)
Gender		−0.00232	−0.00927
		(0.853)	(0.338)
Unemployed		−0.0216	−0.0256
		(0.221)	(0.113)
Student		−0.0144	−0.0152
		(0.286)	(0.276)
Employed		−0.0342**	−0.0310**
		(0.0216)	(0.0108)
Marital_status		0.0126*	0.00973**
		(0.0624)	(0.0431)
Education		8.07e−05	−0.00128
		(0.993)	(0.883)
Risk_Att		0.00484	0.000231
		(0.558)	(0.958)
Constant	0.229**	0.310**	0.284*
	(0.0375)	(0.0266)	(0.0561)
Observations	1,598	1,598	1,598
R-squared (within)	0.005	0.019	0.029
Number of profile_n	3	3	3

As for the sophisticated strategy, column (3) in Table 10 indicates that our respondents do not take advantage of an advanced form of diversification in relation to either their financial literacy or their financial education. We cannot find any systematic feature af-

fecting the use of the sophisticated strategy. This is probably because our respondents, as non-professional investors, are inexpert on the application of a sophisticated diversification principle regardless of both their financial education and literacy.

Overall, our results suggest that financial education is relevant to the risk taking of non-professional investors while the role of the financial literacy is less evident.

Our research hypotheses are therefore only partially satisfied. Specifically, we were expecting to find different patterns in the risk taking process of financially educated and uneducated investors and our evidence supports this approach. The difference in risk taking behaviour, represented by both the portfolio riskiness and the diversification strategies, depends on the variable of whether or not investors have taken a finance course. Nevertheless, the specific number of courses taken, that is, the incremental level of financial education, has an effect only on the amount of risk chosen, not on the strategies pursued to diversify it. Financial education is a discriminating factor in risk taking patterns, but the amount of education is not.

However, as for diversification strategies, our results show that only financially educated investors activate their financial knowledge and skills (literacy), to diversify portfolio risk, albeit only in a naïve way (Table 10 – Panel A). This evidence is at odds with our expectations to find a relation between both investors' financial education and literacy and sophisticated diversification strategies, but not with the naïve diversification strategy.

As for the puzzling relation between the naïve diversification strategy and the financial literacy of educated investors, we argue that the reason of this result could be related to the complexity of the diversification task. As documented by prior descriptive statistics (see Section 3.1. and 3.3), in fact, the question on the diversification concept was perceived by our respondents as the second most critical one. Therefore, the financially educated investors could have taken advantage of their financial knowledge to run the exercise and tackle the complexity of the issue, while the uneducated investors enforce this strategy only as an innate and behavioural pattern, regardless of any financial competence or skills.

As for the absence of a relation between sophisticated diversification strategies and financial education and literacy, our guess is that non-professional investors, even though financially literate and educated, could experience some troubles enforcing the more complex diversification strategies.

Finally, we interpret our findings arguing that the implementation of financial programs is important to the extent that it allows individuals to become familiar with the finance world. Financial education, even at an introductory level, is in fact associated to a change in decision patterns, but we cannot find empirical evidence supporting the beneficial role of an increasing financial education level and literacy ensuring a greater skill in risk-taking decisions.

6 Conclusions

We recruited 711 US residents through Amazon Mechanical Turk to investigate whether the financial literacy and financial education of non-professional investors

influence the risk-taking behaviour and the diversification strategies they pursue. Our contribution to the debate on whether it is important or not to increase individual's financial expertise is twofold: first, we discover that financial education plays a positive role in elevating individuals out of financial illiteracy. In fact, having attended a single course in finance moves the minimum level of financial literacy to 2 (on a 0-5 scale). Second, when we looked at how literacy and education affect risk taking behaviour. We discover that the former doesn't play any role whereas the latter is significant: in particular, we show that the more a person is financially educated and risk tolerant, the more he/she assumes risk. On the other hand, the uneducated individuals' decision process seems to be guided by other personal features, like age, gender and marital status. In both cases financial literacy does not play any role, a result that challenges the existing literature which supports the hypothesis that it is a driver of risk taking choices.

However, financial literacy becomes crucial when we look at the diversification strategies individuals use to allocate their money. In particular, when we examine simple diversification strategies, as for example the naïve diversification rule, financial literacy pushes them to diversify more, but only in the educated respondents sub-sample. This doesn't hold for the uneducated, for whom both literacy and education are not influential on their diversification choice.

Our results introduce an important policy implication as they show that financial education not only contributes to eradication of financial illiteracy, but it also triggers an evolution in the investment process where financial knowledge can foster simple diversification practices, that are still able to protect investors from the most disruptive consequences involved in taking financial risks.

Appendix

Questionnaire[14]

We are a research group in Behavioural Finance. We want to study how people deal with investment activity. In this context we are especially interested in your choices given the current market situation. Please take your time to carefully go through the following instructions and then reply.

PART 1: THE ASSET ALLOCATION DECISION

Imagine you have a friend whose profile is described as follows:

He has just got his MBA. He is 26 years old, single and does not own any real estates or other wealth. Shortly, however, he will inherit USD 350,000 from his deceased grandmother. He has just accepted his first job offer a few weeks ago (net income: USD 30,000). He wants to invest this money but he doesn't have any particular objective for

[14] The questionnaire, in its first part, presents a structure taken from Siebenmorgen and Weber (2003).

his investment, except that he may need part of the money in one year for a new car or in five years for a house.

Now imagine that your friend describes his risk attitude with the following words.

[PROFILE A: CAUTIOUS[15]]

«I am CAUTIOUS. As an MBA-graduate I know that risky assets are supposed to have higher returns, but I couldn't bear to "gamble" with my grandma's savings. Definitely I am willing to invest part of the capital in stocks and I am willing to accept a possible loss of – say – 10% in a year. But after 10 years I should at least be left with my 350,000 and some interest».

Assume that the following investment alternatives are available:

– *Short-term*: interest-paying investments such as money market funds, cash accounts, short-term bonds with maturity up to 1 year;

– *Bonds*: interest-paying investments with maturity 5 to 20 years such as high-quality bonds or corresponding bond-funds;

– *Blue Chips*: large capitalization US stocks, such as those belonging to the S&P500 index or mutual funds investing in these stocks;

– *Small Caps*: small capitalization US stocks that do not belong to the S&P500 index or corresponding mutual funds;

– *Foreign stocks*: a mixture of foreign Blue Chips, Small Caps and mutual funds of foreign stocks.

Historically, short-term investments and bonds are considered less risky investments, whereas all the investments in stocks (national and foreign) are riskier but on average they can guarantee higher earnings.

How would you suggest to invest his money for the next 12 months?

Please insert percentages (numbers from 0 to 100) in the empty boxes below. You can decide to allocate your money as you prefer, even putting all of it in one of the alternatives. THE SUM OF THE PERCENTAGES MUST *ADD UP TO 100%.*

Short-term
Bonds
Blue Chips
Small Caps
Foreign stocks
Total

[PROFILE B: MODERATE]

Now imagine that your friend describes his risk attitude with the following words:

[15] The 3 risk profiles di rischio (cautious, well-balanced, aggressive) have been presented in a random ordering while submitting the questionnaire.

«Please offer me a WELL BALANCED investment strategy, to invest these USD 350,000. The strategy should have potentials for growth and gains without being too risky. As a result I am completely aware that a possible drawback of the markets might produce a portfolio performance of -20% in one year, which is hard to make up for. That's OK. But please be careful that the portfolio risk is not too big».

Assume that the following investment alternatives are available:

– *Short-term*: interest-paying investments such as money market funds, cash accounts, short-term bonds with maturity up to 1 year;

– *Bonds*: interest-paying investments with maturity 5 to 20 years such as high-quality bonds or corresponding bond-funds;

– *Blue Chips*: large capitalization US stocks, such as those belonging to the S&P500 index or mutual funds investing in these stocks;

– *Small Caps*: small capitalization US stocks that do not belong to the S&P500 index or corresponding mutual funds;

– *Foreign stocks*: a mixture of foreign Blue Chips, Small Caps and mutual funds of foreign stocks.

Historically, short-term investments and bonds are considered less risky investments, whereas all the investments in stocks (national and foreign) are riskier but on average they can guarantee higher earnings.

How would you suggest to invest his money for the next 12 months?

Please insert percentages (numbers from 0 to 100) in the empty boxes below. You can decide to allocate your money as you prefer, even putting all of it in one of the alternatives. THE SUM OF THE PERCENTAGES MUST *ADD UP TO 100%.*

Short-term
Bonds
Blue Chips
Small Caps
Foreign stocks
Total

[PROFILE C: AGGRESSIVE]

Now imagine that your friend describes his risk attitude with the following words:

«As I have never dreamed of these USD 350,000, I DO NOT MIND POSSIBLE LOSSES! I ask you to invest this money in a way that it will seize very good opportunities for potential gains. Of course I do not want to gamble with this money, but I am willing to accept the high risk of an aggressive and opportunity-taking investment strategy, which makes sense for the moment. So I hope to generate a high income with this inheritance».

Assume that the following investment alternatives are available:

– *Short-term*: interest-paying investments such as money market funds, cash accounts, short-term bonds with maturity up to 1 year;

– *Bonds*: interest-paying investments with maturity 5 to 20 years such as high-quality bonds or corresponding bond-funds;

– *Blue Chips*: large capitalization US stocks, such as those belonging to the S&P500 index or mutual funds investing in these stocks;

– *Small Caps*: small capitalization US stocks that do not belong to the S&P500 index or corresponding mutual funds;

– *Foreign stocks*: a mixture of foreign Blue Chips, Small Caps and mutual funds of foreign stocks.

Historically, short-term investments and bonds are considered less risky investments, whereas all the investments in stocks (national and foreign) are riskier but on average they can guarantee higher earnings.

How would you suggest to invest his money for the next 12 months?

Please insert percentages (numbers from 0 to 100) in the empty boxes below. You can decide to allocate your money as you prefer, even putting all of it in one of the alternatives. THE SUM OF THE PERCENTAGES MUST *ADD UP TO 100%.*

Short-term
Bonds
Blue Chips
Small Caps
Foreign stocks
Total

PART 2: THE RESPONDENTS' FINANCIAL LITERACY

We can now move to the second part of this study. We kindly ask you to reply to the following few questions.

a) Suppose you have $100 in a savings account and the interest rate is 2 percent per year. After 5 years, how much do you think you will have in the account if you leave the money to grow: more than $102, exactly $102, less than $102?

More than $102
Exactly $102
Less than $102
I don't know.

b) Imagine that the interest rate on your savings account was 1 percent per year and inflation was 2 percent per year. After 1 year, would you be able to buy more than, exactly the same as, or less than today with the money in this account?

More than today
Exactly the same as
Less than today
I don't know

c) Do you think that the following statement is true or false? Buying a single company stock usually provides a safer return than a stock mutual fund.

True
False
I don't know

d) Do you think that the following statement is true or false? Bonds are riskier than stocks.

True
False
I don't know.

e) Suppose you have just won $1 million in a lottery. What do you do?

You take all the money immediately
You take $100.000 each year for ten years
I don't know

PART 3: THE RESPONDENTS' DEMOGRAPHICS

We are nearly done! This is the last part of our study. We would be very grateful if you could provide some personal information.

a) Could you indicate your gender?

M
F

b) Could you indicate your age (in numbers)?

.....

c) Which is your nationality?

.....

d) Which is your education level?

None
Elementary school
Middle school
High school
Bachelor (indicate below the number of courses in finance)
.....
Master degree (indicate below the number of courses in finance)
.....
Doctoral degree (indicate below the number of courses in finance)
.....

e) Which is your marital status?

Single
In a relationship/Engaged
Registered partnership
Married and living together with spouse
Married, living separated from spouse
Divorced
Widowed

f) Which is your employment status?
Not employed
Student
Employee
Self-employed
Retired

g) Which of the following statements comes closest to the amount of financial risk that you are willing to take when you save or make investments?
Take above average financial risks expecting to earn above average returns
Take average financial risks expecting to earn average returns
Not willing to take any financial risks.

CONCLUSION

We thank you very much for participating in this research!
Your data will be processed shortly and payments will be completed as soon as possible.
Please remember to copy and paste the Qualtrics ID showing in the next window into the box on Mechanical Turk.

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