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Financial Literacy and Undergraduates. Application of Latent Regression Rasch Model



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Abstract

We investigate the issue of university students' financial literacy (FL) to provide evidence that IRT models are appropriate measures when the construct is made of both quantitative and qualitative items and to explore how and to what extent latent regression models add to traditional interpretations of factors associated with FL. We surveyed 366 Business Studies freshmen at the beginning of 2009-10 academic year in a large Italian University. Results confirm the influence of variables found to be relevant in previous studies and suggest that more research is needed on the role of non-observable traits in influencing financial literacy.

Keywords: Financial literacy; Undergraduates; Item response theory; Latent regression models; Gender gap; Aptitudes and behaviours.

JEL Codes: A22; D14; C14.

1 Introduction

Over the past 15 years, much effort has been devoted to analyze the role of financial literacy in individuals' day-by-day life and consequently design proper financial education programs. Policymakers, financial regulatory authorities and consumers' associations are concerned that individuals may lack the minimum knowledge of financial concepts necessary to make informed financial decisions. In some countries and for some social groups this reverberates in high levels of personal and household debt (Lusardi and Tufano, 2009; Stango and Zinman, 2009); poor health (Joo and Garman, 1998); inadequate retirement planning (Hilgert *et al.*, 2003; Lusardi and Mitchell, 2007); inadequate stock market participation (van Rooij *et al.*, 2011); and poor general life outcomes.

While considerable progress has been achieved in the design of surveys aimed at identifying individual levels of financial literacy (OECD-INFE, 2012), the process of data analysis has been less widely explored in existing studies.

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Our study contributes to the existing literature in two ways. First it investigates the usefulness of IRT models in measuring financial literacy. IRT models, in particular Rasch model, are used to measure variables such as ability, attitudes and personal traits and could prove effective tools in the domain of financial literacy measurement. Second, it explores the viability of latent regression models in determining which factors influence the level of financial literacy for a sample of undergraduate students. In fact, Rasch model could include person characteristics to explain person/item effects, enabling an investigation of which factors are linked to one's level of financial literacy, after controlling for item relevance. The latent regression Rasch model is indeed a powerful tool that allows integrating the measurement phase (level of financial literacy) and the analysis phase in the same model.

The majority of often cited studies that report the outcomes of financial literacy surveys – among the whole population and/or among a subset of it – do not provide data concerning the reliability and validity of the measures that were used. We apply well-known psychometric techniques in an area (i.e. financial literacy measurement) where such techniques are novel. From a methodological point of view, two different yet connected aspects need to be carefully analyzed when studying a latent variable such as financial literacy. The first one refers to the definition of a suitable method of measurement able to translate into quantitative information the qualitative information stemming from a set of observable items, which are partial indicators of the latent variable under investigation. The second one is about the detection of a suitable statistical methodology to explain the latent variable. In the most common approach, the latent variable is estimated by means of a measurement model (for instance, a Rasch model) and *then* the estimates are used in a regression model as observed values of the response variable. However, some elements suggest caution toward a two separate steps approach: the bias and the inconsistency of the latent variable estimates (Goldstein, 1980); the underestimation of the true association between the latent variable and the covariates (Mesbah, 2004) and, more in general, the lack of flexibility and integration between applied psychometrics and statistics. A possible solution is represented by a global approach, that we follow, which integrates the measurement phase and the analysis phase within the same model. This is the case of latent regressions (Zwinderman, 1991), which represent the core of our analysis.

Our study focuses on undergraduate students because the foundation of financial autonomy is generally laid down during college years and widespread financial illiteracy among young people is of particular concern for two main reasons. First, as they enter adulthood, a number of important financial decisions are to be undertaken (such as financing college studies; moving away from home; purchasing their first car; using credit cards...), for which they might not be adequately prepared. Misguided financial decisions in the early part of their lives could have potentially disastrous consequences (huge debt; inadequate retirement plans) for their whole life (Lusardi *et al.*, 2010). Second, a lack of financial literacy seems to impact students' university performance: Kezar and Yang (2010) suggest that a student's academic achievement is negatively affected by financial distress, which, in turn, is a more likely outcome in presence of low levels of financial literacy.

The paper is organized as follows. Section 2 reviews the relevant literature. Section 3 defines the survey instrument, the sample and the applied methodology. Survey results

are presented in Section 4 while Section 5 presents the main factors affecting students' financial literacy. Section 6 concludes.

2 Literature Review

There are two strands in the literature that are relevant to our paper. First, we briefly recapitulate the empirical literature on the determinants of financial literacy among college students. Second, we illustrate the measurement strategies used in such analyses and introduce the background literature on Rasch model.

2.1 College students and financial literacy

In general, the degree of financial literacy is predicted by demographic factors: in particular, it increases with education and income and this also proves true in the case of university students.

In general, the level of financial literacy of college students seems wanting and is associated with gender, ethnicity, education, work experience, social origins, interaction with peers and peer behavior.

Gender differences have been documented in the US and Continental Europe: studies conducted in recent years suggest that, on average, female college students are less financially literate than their male counterparts. In particular, female students are less interested in learning about personal finance topics and are more intimidated by financial matters than collegiate males. (Chen and Volpe, 2002; Ford and Kent, 2010; Lusardi *et al.*, 2010 for the US – Milioli *et al.*, 2011; Tagliavini and Ronchini, 2011; Becchetti *et al.*, 2013 for Italy – Oanea and Dornean, 2013 for Romania – Rodrigues *et al.*, 2012 for Portugal – Luksander *et al.*, 2014 for Hungary). However, when studies concentrate the analysis on homogeneous samples of students with respect to their potential interest in economic and financial matters – i.e. students enrolled in business studies – gender differences are not confirmed (Wagland and Taylor, 2009; Marriott *et al.*, 2010; Bongini *et al.*, 2015).

As to the influence of social origin, a number of studies analyzed the influence of parental background (such as schooling attainment) and behavior (such as saving habits) on the acquisition of financial knowledge of their children. Mandell (2008) reports that financially literate high school students are disproportionately more likely to have parents with college degrees. Furthermore, Lusardi *et al.* (2010) find that parents represent an important channel through which young adults acquire financial knowledge. Specifically, those whose mothers have a college education or whose parents have stocks or retirement savings are more financially literate. Limiting our focus to college students, the study by Cude *et al.* (2006) highlights that students reported their parents' influence on their money management behavior: parents play a major role in the financial socialization of their children and this process occurs at an early stage, a finding confirmed in a study by Gutter *et al.* (2010) who showed that financial literacy is significantly influenced by social learning, namely by parents behavior and by the interaction with peers.

The students' field of study seems to have an influence on financial literacy. A number of studies have reported an association between academic major (or getting training in personal finance) and financial literacy. Findings suggest that students undergoing financial education or undertaking business studies perform better than other students (Chen and Volpe, 2002; Beal and Delpachitra, 2003; Bernheim *et al.*, 2001; Bernheim and Garrett, 2003; Chinen and Endo, 2012). Nonetheless the evidence is mixed: Cull and Whitton (2011) found that business students do not perform better than average when answering a question on compound interest.

Finally, regarding experiences, Chen and Volpe (2002) for the US and Beal and Delpachitra (2003) for Australian collegiate suggest that work experience significantly improves students' financial literacy. Besides more practical experience with financial markets helps individuals in perceiving financial matters as less intimidating (Goldsmith and Goldsmith, 1997; Ford and Kent, 2010).

Besides the reviewed analysis of sociological variables associated with financial literacy, we are recently witnessing a scientific interest in non-observable variables and traits, e.g. cognitive abilities, psychological traits and aptitudes. In the case of university students, Norvilitis *et al.* (2006) find several factors related to college student debt: as well as financial literacy and the number of credit cards, some psychological variables were identified, such as attitudes toward possessions and spending. Other factors, which might be at the origin of diversified degrees of financial literacy, can be found in genetic traits. Empirical evidence is provided by pieces of research on portfolio allocation: studying investing behavior of twins, Barnea *et al.* (2010) find a variation in risk allocation which they attribute to genetic factors. In the same vein Cesarini *et al.* (2010), analyzing the choice of the Swedish population during a peculiar change in the national pension scheme conclude that approximately 25% of the variation of portfolio risk was due to genetic variation. Both pieces of research therefore leave open the possibility that some social groups, including college students, have some sort of aptitude for financial matters.

2.2 Strategies for measuring financial literacy

Methods used to measure financial literacy vary according to the conceptual definitions used, which may encompass different sets of knowledge, skills and behaviors covering a wide variety of financial topics such as budgeting; managing money, credit and debt effectively; assessing the needs for insurance and protection; evaluating the different risks and returns involved in savings and investment options; saving for long-term goals; understanding the capital market system and financial institutions. Houston (2010) and Remund (2010) provide comprehensive literature reviews helping to frame the issue of the conceptual definition of financial literacy.

As a matter of fact, without an agreed-upon definition, financial literacy has been measured dissimilarly across researchers and studies. The construct has been operationalized in different ways, either covering a wide variety of financial topics or focusing on one single aspect; analogously, the number of questions used to assess financial literacy levels

also varied widely, ranging from 3 to 45 total items. Across studies, both performance tests – multiple-choice questionnaires – and self-report methods have been employed to measure financial literacy. Performance tests are mainly knowledge-based while self-reports tend to assess perceived knowledge. More recently, tests are designed to gauge both objective knowledge and perceived knowledge. We follow this trend and include both objective and subjective instruments.

As we consider financial literacy a latent concept that must be inferred from the responses of individuals to objective and subjective items, we are faced with the problem of calculating an overall index of financial literacy. Besides, different questions have different difficulties and such a characteristic should be taken into consideration when creating an overall index. With respect to this point, the process of data analysis has been so far less explored in existing financial literacy studies: in general, responses to the proposed questions are simply summed up to generate an index of financial literacy, which typically ranges between zero and the maximum number of correct answers; then, both bivariate and multivariate techniques are usually applied to relate such scores to a set of explanatory variables (socio-demographic and other variables, such as investment or debt attitudes, for instance). In sum, until very recently, the analysis of financial literacy has only relied on Classical Test Theory (CTT).

To the best of our knowledge, only three studies have attempted to improve financial literacy research by introducing a psychometrically developed index of financial literacy: Bongini *et al.* (2012, 2015), Knoll and Houts (2012) and more recently Despard and Chowa (2014). The primary statistical method adopted by these studies is item response theory (IRT), a collection of statistical models that provide quantitative values describing how each item (e.g. question) performs in the population. IRT enables researchers to take into account certain properties of the questions themselves in order to assess individuals' level of financial literacy; besides IRT also helps overcoming the weaknesses of CTT, that are: *a*) the score in a test is not an absolute characteristic of a respondent – it depends on the content of the test –; *b*) the difficulty of the items may vary depending on the sample of respondents who take a specific test – it is therefore difficult to compare respondents' results between different tests –. On the contrary, IRT aims to measure one or more ordinal/quantitative latent variables on a metric level of measurement. The IRT framework encompasses a group of models, and the applicability of each model in a particular situation depends on the nature of the test items and the viability of different theoretical assumptions about the test items. For test items that are dichotomously scored, there are three IRT models, known as three-, two- and one-parameter IRT models. The one-parameter IRT model, also called Rasch model (Rasch, 1960), has some desirable mathematical properties that are not shared by the other two models. Rasch model is used to quantify aspects such as ability and personal traits and have been widely adopted in educational research and psychometrics leading to interesting results (Bond and Fox, 2007). For instance, PISA surveys have been adopting Rasch model since 2000 (Liu *et al.*, 2008).

Moreover person properties or item characteristics can be included in Rasch model to explain person or item effects (De Boeck and Wilson, 2004) obtaining Explanatory Item Response Models. These models are therefore a tool for both measurement and explanation.

3 Survey Instrument, Sample and Methodology

3.1 Survey instrument and sample

For the purpose of our analysis, financial literacy was measured using both multiple choice and self-assessment items (see Table 1.A and Table 1.B). The survey instrument consisted of 38 questions, 13 of which selected from the Jump\$tart Coalition test of financial literacy. The multiple-choice test used in the 2008 Jump\$tart Coalition Survey of College Students, and aimed at assessing the financial literacy of Young American Adults, was translated and adapted to the Italian context. Questions are grouped into three areas: *a*) money management; *b*) saving and investing; *c*) spending and credit. They are meant to express the concepts underlying basic financial transactions, financial planning, day-to-day financial decision-making or functioning of the banking system up to more complex issues, such as risk and returns of different asset classes or retirement planning. Each question had four endings; in the Italian version a fifth one, equivalent to «Don't know» was added. We believed that it was important not to force the respondents to select an answer if they felt they did not know the correct answer.

In addition to multiple-choice questions measuring objective financial knowledge, we also added 8 questions referring to students' self-assessment of their financial knowledge (on a four-point scale from none to very good) concerning the following concepts: payoff, expected return, retirement funds, revolving payment, compound rate, portfolio diversification, risk and return, money supply.

Furthermore, the survey instrument included three sections covering: *a*) demographic variables (e.g. gender, nationality, age, educational attainments, work experience); *b*) family characteristics (e.g. parents' educational attainment; parents' occupational position); *c*) questions related to students' past experience with financial instruments, such as the use of payment instruments or insurance instruments, incurrence of debt, and ability to program cash flows.

The survey was conducted on a sample of 400 undergraduate students at a large State University in the Northern part of Italy, who were taking a Bachelor's degree in Business Studies and attending their first semester at college. The rationale for this choice was that business students are expected to improve their financial knowledge as they complete further years of study. In fact, even in their first year, Business Studies students score better in financial literacy tests than other college students (Chen and Volpe, 2002; Beal and Delpachitra, 2003; Chinen and Endo, 2012). However, differences may arise among business students depending on the major of choice, e.g. Management, Finance, Marketing, or Economics. In fact, when business schools offer different majors (like in Italy) students have to make a choice upon enrolment. In particular, in our sample University, majors tend to be quite different from each other being designed to specialize students in one specific subject area. Therefore, freshmen can choose to major in Marketing, Finance, or Management, on the understanding that any major except from Finance will offer hardly any finance-related subjects. Moreover, Finance is the major with the higher numerical content in the Business School. Since we assume that students are aware of this and make choices which reflect a personal interest in financial matters, we would expect the choice

Table 1.A: Multiple Choice Items (*indicates correct answer)

Item	Question	Correct answers (%)	Area
X1	Inflation can cause difficulty in many ways. Which group would have the greatest problem during periods of high inflation that last several years? a.) Older, working couples saving for retirement. b.) Older people living on fixed retirement income.* c.) Young couples with no children who both work. d.) Young working couples with children. e.) Not enough information to be able to answer	36.1	Money Management
X2	Rebecca has saved \$12,000 for her college expenses by working part-time. Her plan is to start college next year and she needs all of the money she saved. Which of the following is the safest place for her college money? a.) Locked in her closet at home. b.) Stocks. c.) Corporate bonds. d.) A bank savings account.* e.) Not enough information to be able to answer	71.5	Savings and Investments
X3	Which of the following types of investment would best protect the purchasing power of a family's savings in the event of a sudden increase in inflation? a.) A 10-year bond issued by a corporation. b.) A certificate of deposit at a bank. c.) A twenty-five year corporate bond. d.) A house financed with a fixed-rate mortgage.* e.) Not enough information to be able to answer	51.7	Savings and Investments
X4	Many people put aside money to take care of unexpected expenses. If Juan and Elva have money put aside for emergencies, in which of the following forms would it be of LEAST benefit to them if they needed it right away? a.) Invested in a down payment on the house.* b.) Checking account. c.) Stocks. d.) Savings account. e.) Not enough information to be able to answer	32.7	Savings and Investments
X5	David just found a job with a take-home pay of \$2,000 per month. He must pay \$900 for rent and \$150 for groceries each month. He also spends \$250 per month on transportation. If he budgets \$100 each month for clothing, \$200 for restaurants and \$250 for everything else, how long will it take him to accumulate savings of \$600. a.) 3 months. b.) 4 months.* c.) 1 month. d.) 2 months. e.) Not enough information to be able to answer	90.7	Savings and Investments
X6	Sara and Joshua just had a baby. They received money as baby gifts and want to put it away for the baby's education. Which of the following tends to have the highest growth over periods of time as long as 18 years? a.) A checking account. b.) Stocks.* c.) A U.S. Govt. savings bond. d.) A savings account. e.) Not enough information to be able to answer	10.5	Savings and Investments
X7	Rob and Mary are the same age. At age 25 Mary began saving \$2,000 a year while Rob saved nothing. At age 50, Rob realized that he needed money for retirement and started saving \$4,000 per year while Mary kept saving her \$2,000. Now they are both 75 years old. Who has the most money in his or her retirement account? a.) They would each have the same amount because they put away exactly the same b.) Rob, because he saved more each year c.) Mary, because she has put away more money d.) Mary, because her money has grown for a longer time at compound interest* e.) Not enough information to be able to answer	43.9	Savings and Investments
X8	Which of the following statements is NOT correct about most ATM (Automated Teller Machine) cards? a.) You can generally get cash 24 hours-a-day. b.) You can generally obtain information concerning your bank balance at an ATM machine. c.) You can get cash anywhere in the world with no fee.* d.) You must have a bank account to have an ATM Card. e.) Not enough information to be able to answer	66.1	Spending and credit

Table 1.A: (Follows)

Item	Question	Correct answers (%)	Area
X9	Savings programs are protected by the Fondo Interbancario di Tutela. Which of the following is guaranteed protection? a.) Commercial papers b.) A checking account at the bank.* c.) A bond issued by a bank d.) A Treasury Bond. e.) Not enough information to be able to answer	18.3	Savings and Investments
X10	If each of the following persons had the same amount of take home pay, who would need the greatest amount of life insurance? a.) An elderly retired man, with a wife who is also retired. b.) A young married man without children. c.) A young single woman with two young children.* d.) A young single woman without children e.) Not enough information to be able to answer	82.7	Money Management
X11	Which of the following instruments is NOT typically associated with spending? a.) Debit card. b.) Certificate of deposit.* c.) Cash. d.) Credit card. e.) Not enough information to be able to answer	88.8	Spending and Credit
X12	Which of the following statements is true? a.) Banks and other lenders share the credit history of their borrowers with each other and are likely to know of any loan payments that you have missed.* b.) People have so many loans it is very unlikely that one bank will know your history with another bank c.) Your bad loan payment record with one bank will not be considered if you apply to another bank for a loan. d.) If you missed a payment more than 2 years ago, it cannot be considered in a loan decision. e.) Not enough information to be able to answer	53.7	Spending and Credit
X13	John started his career in banking in 1995 and he earns € 2.000 per month. If he retires when he is 65 years old, what will be the likely amount of his public pension, in % of his last salary? a.) 30%-35% b.) 80-100% c.) 50% d.) 60% * e.) Not enough information to be able to answer	27.1	Money Management
	Mean score Money Management area	59.4 (49.7)	
	Mean score Savings and Investments area	45.6 (53.1)	
	Mean score Spending and Credit	69.5 (84.3)	
	Grand mean	53.9 (60.4)	

Table 1.B: Self-assessment Items

Code	How do you rate the degree of your knowledge: 1) very good; 2) good; 3) poor; 4) none	Self-assessment (% of 1 & 2)	Area
D1	Payoff	11.0	Savings and Investments
D2	Expected return	32.4	Savings and Investments
D3	Retirement funds	42.7	Savings and Investments
D4	Revolving payment	11.7	Spending and Credit
D5	Compound rate	34.9	Savings and Investments
D6	Portfolio diversification	34.9	Savings and Investments
D7	Risk and return	72.7	Savings and Investments
D8	Money supply	33.7	Money Managements

Table 2: Sample distribution (n = 366)

Variable	%	Variable	%
Gender		Major	
Male	51.0	Finance	40.7
Female	49.0	Other majors	59.3
Nationality		Schooling	
Italian	86.9	Academic track (liceo)	46.4
Other	13.1	Non academic track (technical institutes)	53.6
Living		Parents' schooling (highest level of the two)	
With parents	85.0	College degree or higher	19.7
On their own	16.0	Up to high school diploma	80.3
Financial experience		Parents' Social level	
Yes	64.5	High	21.0
No	35.5	Medium-Low	79.0
Work experience			
Yes	55.5		
No	44.5		

of major (with the Finance major being a proxy for more financially literate students) to be significant in predicting differences among Business students and helping our results gain a broader insight into the explicative factors underlying financial literacy levels.

Our sample is representative of the whole population of freshmen enrolled at the University, with respect to the Major and Gender covariates. The test was administered during class time and students had no prior warning of being tested on financial topics.

After discarding for missing values, we ended up with 366 observations, with a balanced distribution between male and female, mostly aged 19, predominantly Italian, living at home (more than 80%) as reported in Table 2.

3.2 Methodology: the latent trait models

According to Rasch model, a student's response to a binary item (i.e., right/wrong, true/false, agree/disagree) is determined by the individual's level of knowledge (ability/trait) of financial literacy (θ_p) and by the level of financial literacy (difficulty) expressed by the i -th item (β_i). One way of expressing Rasch model is in terms of the probability that an individual with a particular trait will correctly answer an item that has a particular difficulty:

$$P(X_{pi} = 1 | \theta_p, \beta_i) = \frac{e^{(\theta_p - \beta_i)}}{1 + e^{(\theta_p - \beta_i)}} \quad (1)$$

where X_{pi} refers to response (X) made by the p -th student to the i -th item ($X_{pi} = 1$ refers to a «correct» response or an endorsement of the item); θ_p refers to the level of knowledge (ability) of financial literacy of the p -th student and β_i level of financial literacy (difficulty) of the i -th item.

The estimates of the ability and difficulty that result from a Rasch model are referred to as logits. A logit is the natural logarithm of an odds ratio (Cox, 1970); in our case, the odds ratio could be defined as the ratio of the probability for getting a correct response

to the probability for not getting one. In other words, frequencies of an event occurring in a testing situation translate in a number of items accomplished or failed. Thus, if our students succeed on half of the items, the odds of the success are 1/1 and their ability estimate as a logit is the natural log of 1, which is zero. The natural log transformation provides a convenient means of looking at a person's logit and determining whether or not a person is relatively able (positive logit) or unable (negative logit). The same interpretation holds true for items. A relatively difficult item will have a positive logit, whereas a relatively easy item will have a negative logit.

At the same time (1) assumes that the probability of a given student answering an item correctly is a logistic function of the difference between the p -th person's level of knowledge of financial literacy and the level of financial literacy expressed by the i -th item, that is:

$$\eta_{pi} = \ln \frac{p(X_{pi} = 1 | \theta_p, \beta_i)}{1 - p(X_{pi} = 1 | \theta_p, \beta_i)} = \theta_p - \beta_i \quad (2)$$

A typical representation of the difference between the two locations, $(\theta_p - \beta_i)$, is an 'item map' where the item difficulties can be placed like points along a line and the person's ability as a point along the same line.

Generally speaking, the Rasch model converts raw scores into linear and reproducible measurement. The Rasch model's hypotheses are unidimensionality, local independence and monotonicity. Moreover the Rasch model possesses the properties of sufficiency, separability, specific objectivity and invariance of parameter estimates (Bond and Fox, 2007).

In order to explain differences among students with respect to financial literacy, person properties or characteristics can be included in Rasch model (1) as predictors obtaining the latent regression Rasch model. Such a model, described by Zwinderman (1991) is particularly helpful when sub-populations can be identified in the sample.

The model differs from Rasch model in that θ_p is replaced with a linear regression equation in equation (1) $\theta_p = \sum_{j=1}^J \vartheta_j Z_{pj} + \varepsilon_p$, so that:

$$n_{pi} = \sum_{j=1}^J \vartheta_j Z_{pj} + \varepsilon_p - \beta_i \quad (3)$$

where Z_p is the value of the student p on student property (covariate) j ($j = 1, \dots, J$), ϑ_j is the regression weight of the student property j , ε_p is the effect remaining after the effect of the person properties is accounted for (with $\varepsilon_p \sim N(0, \sigma_p^2)$).

The Linear Logistic Test Model (LLTM) was introduced by Fischer (1973) and it is a Rasch model that includes parameters for the impact of test variables on item difficulty. In this model item properties are used to explain the difference between items in terms of the effect they have on η_{pi} , that is:

$$n_{pi} = \theta_p - \sum_{j=1}^k w_{ij} \alpha_j \quad (4)$$

where α_j is the difficult parameter for the item property j ($j = 1..k$) and w_{ij} is the value of the item i on the property j . Normally, $w_{ij} = 1$ if the item i has the item property j and $w_{ij} = 0$ otherwise.

Combining (3) and (4) yields a latent regression LLTM (Zwinderman, 1997):

$$\eta_{pi} = \sum_{j=1}^j \vartheta_j Z_{pj} + \varepsilon_p - \sum_{j=1}^k w_{ij} \alpha_j$$

that includes the person contribution and item contribution. The person contribution is explained in terms of person properties, while the item contribution is explained in terms of item properties.

In our analysis, we first build measures of tested financial knowledge and of self-assessed financial knowledge. We subsequently show the results of the explanatory item response models. Parameters estimations and other data manipulation were obtained using R (lme4 package) and SAS softwares.

4 Survey Main Results: Descriptive Analysis

Table 1.A (column 3) reports the thirteen multiple-choice questions with the percentage of correct answers for each question.

No respondent was able to answer all thirteen multiple-choice questions correctly; two respondents wrongly answered to all thirteen. Italian college students rated poorly on the Money Management items: only 27% of respondents knew how state pensions work while a meager 36% knew the effects of inflation. Of the seven questions on savings and investments, the question most frequently answered correctly was on budgeting in order to save (X5), with 90.7% correctly passing a sort of numeracy test. However, the percentage of correct answers fell considerably when it came to questions on risk, return and liquidity (X2, 71.5%), on protecting purchasing power from inflation (X3, 51.7%), on compound interest (X7, 43.9%), the value of liquidity (X4, 32.7%) and the working of deposit insurance (X9, 18.3%). Finally, only about 10.6% of students were able to identify correctly the historical returns of different asset classes (X6). Among the spending and credit questions, the one most often answered correctly was on transaction instruments (X11, 88.8%); despite this, item X8 – on how ATM cards work – was answered correctly by a much lower percentage of respondents: students can recognize what financial instruments can be used for spending purposes, but are less aware of their costs and operative characteristics. Finally, more than 53.7% of respondents answered the question about credit history correctly, which is quite a surprising achievement given the low spread of debt among young Italian students.

The second group of items is related to perceived knowledge (Table 1.B). Students were asked to rate on a four-point scale their level of knowledge about specific financial topics, related to our three areas of savings and investments, spending and credit, and money management. Students' insight into their own financial knowledge reveals poor acquaintance with the proposed topics, with the exception of risk and return, where 73% of respondents rated their competence on the specific item as high or very high. Perceived knowledge is lowest in topics like «payoff» (D1) and «revolving payment» (D4). This result is not surprising, given that the former deals with one of those typical terms that

business students only encounter during their course of study; as regards the latter, low levels of competence are probably due to a limited use of credit cards as means of borrowing in Italy.

In our analysis multiple-choice items (X1-X13) were transformed into a binary scale as follows: a correct response was recoded as 1, and all other responses were recoded as 0. Similarly, polytomous test items (D1-D8) were converted into a binary scale. In particular, responses «very good» and «good» were recoded as 1, while responses «poor» or «none» were recoded as 0.

The first step to build the Rasch model refers to the issue of item versus construct validity. In other words, one needs to check whether the whole set of items is measuring the same construct. In our case, given that the items pertain to two different groups (multiple-choice items and subjective-knowledge items) we are also faced with the need to test whether the two different groups measure different constructs. We followed the ensuing procedure: first, the two groups were considered one at a time; then, the whole set of twenty one items were tested together; finally, we tested combination of the items.

The fit of the model was evaluated using the conditional likelihood ratio test statistic proposed by Andersen (1973). Andersen's test statistics are shown in Table 3. The tests of fit for the two groups of items taken separately are accepted; on the contrary, the test of the model including simultaneously objective and subjective measures of financial literacy is rejected. Finally, considering every possible item combination, several groups of items could be considered as belonging to the same latent trait. In order to choose the best combination of items, infit and outfit statistics were used to determine whether the item responses fit the expectations of Rasch model (Wright and Masters, 1990). Items with infit or outfit mean square MNSQ values lower than 0.6 and 1.4 indicated potential misfits (Wright *et al.*, 1994). Misfit items have not been considered to verify the unidimensionality of the final item group. As a last confirmatory test, a principle component analysis on the residuals was applied to ensure the unidimensionality of the group of items. Results shown in Table 3 point out that a set of 17 items out of 21 had construct validity in measuring money management, saving and investments awareness, spending and credit behaviors. These are the whole set of objective items plus four subjective items, namely questions D1-D3-D4 and D8. For such a combination every infit and outfit MNSQ value is within the range of 0.6-1.4. The principal component analysis on the residuals shows that the first factor extracted explains 6.2 % of test score, i.e. no dominant component exists among the residuals of the chosen group.

Table 4 shows the results of the Rasch model applied to the items X1-X13; D1, D3, D4, D8.

The estimated person variance is 0.272 on the logit scale and, as shown in formula (2), the odds increase by a factor 1.69 when θ increases by one standard deviation, that means, taking as the base case a person with a probability of 0.50 of responding correctly on an item, then someone with a θ -value has a probability of responding correctly equal to 0.63. Moreover the standard error of the estimated person variance is 0.03.

The estimated *item parameters* vary from -2.353 to 2.526 on the logit scale with an average value of 0.241. Given the equation (2), lower values of the item parameters imply lower probabilities of answering correctly or endorsing the proposed topic. Not

Table 3: Andersen's test statistics

Model	Test Statistics	df	p-value
X1-X13	6.304	12	0.10
D1-D8	11.743	7	0.11
X1-X13; D1-D8	81.564	20	>0.0001
X1-X13; D1,D3,D4,D8	19.799	16	0.19

Table 4: Estimates of the Rasch model

Parameters	Rasch Models				
	Estimate	Std Error	z-Value	Pr(> z)	
X1	+0.548	0.115	+4.781	<0.001	***
X2	-1.023	0.123	-8.285	<0.001	***
X3	-0.068	0.114	-0.613	0.540	
X4	+0.804	0.119	+6.778	<0.001	***
X5	-2.526	0.195	-12.926	<0.001	***
X6	+2.231	0.174	+12.799	<0.001	***
X7	-0.282	0.112	-2.511	0.010	*
X8	-0.674	0.117	-5.785	<0.001	***
X9	+1.560	0.140	+11.128	<0.001	***
X10	-1.718	0.147	-11.675	<0.001	***
X11	-2.326	0.181	-12.850	<0.001	***
X12	-0.186	0.112	-0.0955	0.090	.
X13	-0.967	0.122	+7.926	<0.001	***
D1	+2.353	0.182	+12.901	<0.001	***
D3	+0.328	0.113	+2.918	0.003	**
D4	+2.259	0.176	+12.827	<0.001	***
D8	-0.776	0.118	+6.567	<0.001	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

surprisingly, Items D1, D4 and X6 appeared the most difficult while items X5 and X11 appeared the least difficult. For instance, the value -2.353 related to item D1 means that the model estimates that only a mere 9.51% of students know the meaning of the term «payoff» whereas the value $+2.526$ for item X5 implies that the model estimates a percentage of 92% of students giving a correct answer in the numeracy test. Similarly, Item X6 is explained by a logit value of -2.231 , which suggests that only 10.74% of the students were able to the answer correctly to question testing students' ability in the domain of stock market investment.

At a first glance, our respondents exhibited poorer perceived knowledge while they showed higher abilities on the items related to numeracy testing and yet limited knowledge of more sophisticated financial issues.

5 Determinants of Financial Literacy

A multivariate analysis enabled us to assess which factors were linked to financial literacy, after controlling for item relevance. We constructed and tested explanatory item response models using as items both the 13 multiple-choice items and 4 out 8 self-assessment items.

We add person properties such as Major, Gender, Nationality, High School background, Parents' Social background, Parents' schooling, Work experience and Financial

Table 5: Goodness of fit

Model	Deviance	AIC	BIC
Rasch	6534.4	6570.4	6691.6
Latent Regression Rasch	6501.6	6561.6	6763.7
LLTM	6624.5	6627.5	6636.3
Latent Regression LLTM	6601.3	6627.3	6678.0

Lower values of the goodness-of-fit indices indicates a better fit.

experience. The items properties were type of knowledge (1 = Tested, 0 = Otherwise) and specific financial area (1 = Saving and Investing, 0 = Otherwise).

We are interested in the extent to which students' financial literacy differ as a function of socio-demographic variables and whether these differences vary as a function of the two types of constructs used (multiple choice items versus self-assessment items).

Since the Rasch model fits the data, we estimated the whole family of explanatory item response models. Table 5 shows their goodness-of-fit indices (AIC, BIC, Deviance). It can be noted that the latent regression Rasch model has a better fit than the other models. The item effect is null and only person effects are at work. Moreover, the log likelihood ratio test for nested models shows there was a significant difference between the Rasch and latent regression Rasch models ($\chi^2(10) = 65.6$, $p < 0.0001$) therefore we reject the null hypothesis that both models are equal and opt for the latter.

Table 6 presents the estimates for the latent regression Rasch model. First of all, the estimated *person variance* is 0.2207 on the logit scale. Several findings emerge from our estimates.

First, there was a strong negative relationship between non-technical high school leavers and financial literacy: the former are 1.33 times less financially skilled than technical high school pupils. Graduating in technical high schools provides students with applied learning, even in financial subjects, which are instead totally absent in academic-track high schools. Our study confirms a widespread result of the empirical literature, which reports a positive association between training in finance and financial literacy.

Second, as to respondents' nationality non-Italian students are at a disadvantage when it comes to financial literacy. This might be owed to comprehension problems, since questions were written in Italian.

Third, as regards parents' role in influencing their children financial literacy, our study confirms the relevance of parents' education: students coming from families with a higher educational attainment are 1.31 times more financially skilled than other students. The same does not hold true for parents' type of occupation, which seems to be non-influential.

Fourth, although with a lower level of statistical significance (10%), financial literacy is positively associated with financial experience and male gender confirming generally acknowledged results in the literature. Students with financial experience are 1.16 times more financially literate than the rest of the sample, while male students, with an estimated effect equal to 0.164, are 1.18 times more financially literate than women. The reader should recall that our Rasch measure is an overall measure of both tested and self-assessed financial literacy. In a companion paper (Authors, 2015) where we analyzed the issue of gender gap, considering both a Rasch measure on objective items (questions

Table 6: Estimates of the latent regression Rasch model

Parameters	Latent regression Rasch				
	Estimate	Std Error	z-Value	Pr(> z)	
X1	+0.760	0.414	+1.835	0.066	.
X2	-1.566	0.164	-9.529	<0.001	***
X3	-0.611	0.155	-3.941	<0.001	***
X4	+0.260	0.160	+1.625	0.104	
X5	-3.069	0.224	-13.719	<0.001	***
X6	+1.688	0.205	+8.254	<0.001	***
X7	-0.258	0.156	-1.659	0.097	.
X8	-1.213	0.159	-7.630	<0.001	***
X9	+1.019	0.177	+5.774	<0.001	***
X10	-2.259	0.183	-12.349	<0.001	***
X11	-2.864	0.211	-13.577	<0.001	***
X12	-0.726	0.155	-4.674	<0.001	***
X13	+0.426	0.163	+2.618	0.009	**
D1	+1.816	0.212	+8.574	<0.001	***
D3	+1.720	0.206	+8.337	<0.001	***
D4	+0.236	0.160	+1.476	0.140	
D8	+0.260	0.160	+1.625	0.104	
Major (Finance = 1)	0.640	0.334	1.916	0.055	.
Family Home (yes = 1)	-0.173	0.117	-1.482	0.138	
Gender (Male = 1)	0.164	0.093	+1.757	0.079	.
High school track (academic type = 1)	-0.285	0.084	-3.401	0.001	***
High school diploma (High final mark = 1)	-0.021	0.092	-0.224	0.822	
Nationality (Italian = 1)	0.328	0.126	2.600	0.009	**
Parents' education (1 = College)	0.272	0.105	2.588	0.010	**
Parents' social background (1 = medium and low background)	-0.140	0.387	-0.363	0.716	
Work experience (yes = 1)	0.100	0.081	1.238	0.216	
Financial experience (yes = 1)	0.153	0.087	1.753	0.080	.

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

X1 to X13) and the overall difficulty of the instrument (Differential Item Functioning), no differences were found between male and female students. Therefore, our new result is entirely dependent upon by those questions that asked students to self-assess their knowledge of financial concepts. Here, our sample of freshmen displayed different levels of self-consciousness according to their gender, even after controlling for item characteristics and other socio-demographic factors. Our evidence confirms the findings of Bucher-Koenen *et al.* (2014) who in their review note that gender differences occur not only in objective measures of financial literacy but also in self-reported financial literacy. When asked to assess their financial knowledge, women tend to give themselves lower scores than men. Not many women who answer the financial literacy questions correctly give themselves high scores while some of those who respond with at least one «do not know» answer rate their knowledge as high, suggesting that the «do not know» answer may – to some extent – measure lack of confidence. Similar evidence was found by Ford and Kent (2010) and by Goldsmith e Goldsmith (1997).

As a final note, we draw the reader's attention to the estimated effect of the Major chosen by the student: 0.640 on the logit scale, which implies that students who choose to major in Finance (whether they be male or female) are 1.90 times more financially skilled than business students enrolled in other majors. Such result means that even among «like» students important group differences arise with respect to the Major's

choice. In our context we consider the choice of majoring in Finance a proxy for «financial aptitude». The concept of «financial aptitude» differs from «financial attitude» by a factor of competency to do a certain kind of work, in our case to deal with financial matters: while attitude is a way of looking at an issue, aptitude is akin to natural or acquired talent or ability. Previous studies have documented that students undertaking business studies performed better in financial literacy tests, probably due to greater interest in broad economic matters, which encompasses financial topics, a greater level of directed reading and more attentive listening to economic/financial issues on the media. We go further, showing that, even among business freshmen, the specific choice of majoring in Finance is associated to higher level of financial literacy. Insofar as such a choice is driven by – among other factors – a specific attentiveness as regards financial matters, our results suggest that financial literacy is associated not only with socio-demographic characteristics but also with personal traits. Further research considering personal, non-observable variables such as aptitude may carry seminal results of interest to educational and financial organizations, both private and public, for their policies.

6 Conclusions

Our paper investigates whether IRT models and latent regression Rasch model are suited to measure and analyze the factors explaining undergraduate students' financial literacy at the beginning of their university careers. First-year Business students were targeted in order to explore such issues on a «like» sample.

The measurement of financial literacy has improved considering both objective and subjective knowledge and simultaneously measuring both the respondents' ability and the test items' difficulty overcoming the problem of arbitrarily equally weighting diverse test questions.

The latent regression model provided a powerful framework to detect and analyze group differences considering both items and persons' characteristics. In particular items' characteristics were not significant in influencing the overall financial index score, while persons' characteristics were relevant factors. In this respect, our findings confirm the results of previous research undertaken since the 1990s in America and Australia into the socio-economic variables associated with financial literacy. Not surprisingly, we found that in Italy too, financial literacy depends on family background, previous high school experience and financial experience.

A novel result of our empirical investigation is that it opens room for personal non-observable traits (genetic or other) that could be at work in influencing the financial literacy of first year college students. Indeed the variable «choice of the Business academic major» could be considered a proxy for an «aptitude for financial matters». Needless to say, there is obviously a need for further research into the concept of aptitude and on the appropriate indicator which might meaningfully represent it. Notwithstanding such shortcomings, we found that Finance students (whether male or female) scoring better than their peers majoring in Marketing or Economics.

Our results corroborate the idea according to which people's financial behavior may depend not only on information or knowledge but also on intrinsic personal attributes. Should this be confirmed by future research, financial literacy constructs and educational plans should be organized consequently.

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