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MEASURING FINANCIAL LITERACY AMONG STUDENTS: AN APPLICATION OF RASCH ANALYSIS

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Abstract: *We examine financial literacy among Italian college students using Rasch analysis. Our findings support the appeal of adopting such technique in measuring financial literacy: the provided set of information is not limited to a crude figure, indicating whether the population has passed or failed the test. On the contrary, the specific areas where deficiencies mostly occur are located. Among them, the group showing highest knowledge deficit can be determined.*

Keywords: *Financial literacy, young adults, Rasch analysis*

1. Introduction

In recent years, financial literacy has gained the attention of a wide range of organizations, both at the national level - policymakers and financial regulatory authorities - and at the international level, with the OECD leading the way with its International Gateway for Financial Education (IGFE) and the International Network on Financial Education (INFE). Interested groups are concerned that consumers may lack the minimum knowledge of financial concepts to be able to make informed financial decisions in their day-by-day life, namely: budgeting; managing money, credit and debt effectively; assessing needs for insurance and protection; evaluating the different risks and returns involved in savings and investment options; saving for long-term goals. Such lack of financial literacy has been widely acknowledged as an aggravating factor of the recent financial crisis [8]. At the same time, the crisis has exacerbated the risks that less financially literate consumers face: lacking the sophistication required to absorb financial shocks, they are more vulnerable to financial market fluctuations [4].
Several studies, mainly focused on the US and the UK, have tried to provide sound measures of financial literacy [7] and considerable progress has been made by the OECD in the design of a

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survey attempted to identifying national levels of financial literacy, with the double goal of ensuring a benchmark for national strategies of financial education and enabling cross-countries comparisons [9]. There is a common view that surveys should rely on a number of questions that cover a mixture of attitudes and knowledge as well as they showed capture behavior relating to financial topics such as money management, financial planning, savings and investment.
By contrast, the process of data analysis is less explored by existing studies. Both bivariate and multivariate analysis are applied; in general, responses to the proposed questions are simply summed up to generate an index (score) of financial literacy, which typically ranges between zero and the maximum number of correct answers. Our paper contributes to the existing literature by exploring the opportunity to adopt Rasch analysis in the domain of financial literacy and to test whether different profiles of students show different levels of specific areas of financial literacy at the beginning of their university carriers. Rasch models are used to quantify aspects as ability, attitudes and personal traits. They have been widely adopted in educational research and psychometrics leading to interesting results. For instance, PISA surveys have been adopting Rasch models since 2000 [6]. The specific property, that makes these models increasingly used in other areas of research, refers to the provision of a metric which considers both the test's difficulty and the respondent' specific abilities.
The paper is organized as follows. Section 2 describes the survey instrument, the sample and the applied methodology. Survey results are presented in Section 3 and Section 4 concludes.

2 Survey Instrument, Sample and Methodology

2.1 Survey Instrument and Sample

The questionnaire consisted of 39 questions, the first 13 of which comprised a selection of the Jump$tart Coalition test of financial literacy. We translated and adapted to the Italian context the multiple choice test questions used in the 2008 Jump$tart Coalition Survey of High School and College Students [5] aimed at assessing the financial literacy of Young American Adults. These questions can be grouped into three specific areas: a) money management; b) saving and investing; c) spending and credit (See Appendix 1). In addition to a section covering demographic variables (e.g. gender, nationality, age, educational attainment) and family characteristics (e.g. parents' educational attainment; parents' occupational position), the survey included 8 questions measuring financial behavior, 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 non-random sample of more than 400 students attending their first year of college at the Economics Faculty of Milano-Bicocca University. The test was submitted during class attendance and students had no prior information of being tested on financial topics. The majority of tested students had previously chosen either a Major in Finance or in Marketing, thus enabling a robustness check on our sample composition. In general, freshmen of the Faculty of Economics, as opposed to other college students, are expected to deliver better results in a financial literacy test considering their interests and attitudes towards economic and financial subjects. In this sense our results could not be generalized. However, we expect that the Major choice (with Finance as a proxy for more financially literate students) could be relevant in predicting differences among Economics students and that it may help our results to take a broad view.

After discarding some missing values (majority of non-answered test questions), we end up with 351 observations, with a balanced distribution between male and female, mostly aged 19, predominantly Italian living with their parents (more than 85%) (see Table 1).
No student answered incorrectly to the overall questionnaire and no student was able to correctly answer every question in the test. To summarize, the students displayed, on average, a limited level of financial literacy: on a scale ranging between one and ten, their score is 5.5. Our results confirm the outcomes of "PattiChiari" surveys [1] on the Italian adult population.

Table 1. Sample distribution.

Variable	n.obs. (%)	Variable	n.obs. (%)
Gender		**Major**	
Male	181 (51.6)	Finance	155 (44.2)
Female	170 (48.4)	Marketing	196 (55.8)
Nationality		**Schooling**	
Italian	294 (83.7)	Academic track (liceo)	172 (49.0)
Other	57 (16.3)	Non academic track (technical institutes)	179 (51.0)
Living		**Parents' schooling (highest level of the two)**	
With parents	302 (86.0)	College degree or higher	153 (43.6)
On their own	49 (14.0)	Up to high school certificate	198 (54.6)

2.2 The Rasch model and the differential item functioning

A Rasch model [11] "is an item response model aimed at measuring one or more quantitative latent variables on a metric level of measurement; it presents the properties of sufficiency, separability, specific objectivity, latent additivity" [12] and invariance of parameters estimates. When the invariance property is not guaranteed, it is useful to evaluate differences among persons belonging to specific groups. The differential item functioning (DIF) allows to find out whether certain subgroups have an advantage or a disadvantage in testing. Therefore, a variety of statistical methods was suggested for detecting DIF in the Rasch model. Most of these methods are designed for comparing pre-specified focal and reference groups, such as males and females [13].
The Rasch model assumes that the probability to answer correctly to an item is a logistic function of the difference between the ability parameter for the *n-th* person (θ_n) and the item difficulty parameter for *i-th* item (β_i), that is:

$$logit\{P(x_{ni}=1|\theta_n)\} = \theta_n - \beta_i \qquad n=1,\ldots,N;\ i=1,\ldots,I \tag{1}$$

where x_{ni} is the score of the *n-th* person for the item *i-th* (x_{ni} =1 for correct answer, x_{ni} =0 for an incorrect answer).

Moreover, the simplest form of the Rasch DIF model [10] can be expressed as follows:

$$logit\{P(x_{ni}=1|\theta_n\,;\,g)\} = \theta_n - \beta_i + \gamma_i \cdot G \qquad n=1,\ldots,N;\ i=1,\ldots,I \tag{2}$$

where γ_i is the DIF index parameter for the *i-th* item, and *g* indicates either the reference group or the focal group, $G = 1$ if $g = R$ (reference group), $G = 0$ if $g = F$ (focal group). Under this model, γ_i is the item difficulty difference between the focal group and the reference group.

3. Results[1]

The 13 items regarding financial literacy were first analyzed as correct/incorrect items, then a simple Rasch model was tested and finally the Items with the DIF among students' characteristics[2] were tested.

Table 2. Item difficulty Estimates with associated error estimates for each item.

Item	Difficulty	Standard Error	Outfit MSQ	Infit MSQ	Outfit t	Infit t
X1	-0.740	0.112	0.948	0.954	-0.810	-1.070
X2	0.877	0.122	1.056	1.000	0.630	0.020
X3	-0.197	0.109	0.973	0.981	-0.500	-0.480
X4	-1.003	0.115	1.014	1.039	0.210	0.800
X5	2.411	0.189	0.476	0.766	-2.900	-1.770
X6	-2.454	0.167	1.376	1.026	1.850	0.260
X7	-0.416	0.109	0.963	0.940	-0.660	-1.540
X8	0.554	0.116	0.926	0.962	-1.000	-0.750
X9	-1.802	0.136	0.980	0.919	-0.120	-1.050
X10	1.633	0.148	0.861	0.848	-0.930	-1.680
X11	2.399	0.195	0.777	0.854	-0.970	-1.000
X12	0.023	0.11	0.935	0.959	-1.170	-1.020
X13	-1.216	0.119	0.923	0.926	-0.880	-1.370

Table 2 reports the results of the Rasch analysis using model (1), i.e. the results on difficulty of the items. The goodness-of-fit Andersen's test shows that the model well fitted the data[3]. Item X6 resulted as the most difficult while items X5 and X11 were the easiest. Both items X5 and X6 belong to the area of savings and investments; however, while the former tested students' ability in the domain of stock market investment, the latter examined their ability to calculate cash inflows and outflows. Tested students showed a high level of numeracy, yet they displayed limited knowledge of more sophisticated financial issues. Item X11 belonged to the spending and credit area and required a basic knowledge of financial instruments. Moreover infit and outfit MSQ estimates showed reasonable values.

In order to detect which items were showing DIF, the Mantel-Haenszel test [10] was used. Table 3 reports those items showing DIF with respect to our estimate of the difficulty parameter for the reference and the focal group; the estimate of the Mantel-Haenszel common odds ratios (α_{MH}) and the Mantel-Haenszel delta difference (Δ_{MH}=-2.35·lnα_{MH}) [3]. According to the Educational

[1] The results were obtained using WINSTEPS and R (plus the add-on *eRm* and *diffR* packages) software.

[2] Socio-demographic characteristics (Gender, Major, High School, Job experience) plus one issue on financial behaviour (i.e. owning a checking account)

[3] Test value: 11.243, pvalue=0.423, df=11.

Testing Service (ETS) delta scale, we presented only those items with DIF for which Δ_{MH} is classified as large (that is $|\Delta_{MH}| \geq 1.5$) [3].

Table 3. Difficulty parameters for reference and focal group and DIF effect size estimates.

Item	Reference	Focal	α_{MH}	Δ_{MH}
Major	*Finance*	*Marketing*		
X11	+3.73	+2.17	0.17	4.16
X13	-1.01	-1.80	2.27	-1.93
Gender	*Female*	*Male*		
X6	-3.14	-2.28	0.52	1.54
School	*Liceo*	*Other*		
X5	+2.05	+3.32	0.26	3.17
Having Job	*Yes*	*No*		
X5	+3.00	+2.30	2.21	-1.86
X6	-2.24	-3.70	2.47	-2.13
Checking Account	*Yes*	*No*		
X9	-1.52	-2.22	1.98	-1.61
X10	+2.07	+1.37	0.46	1.82

With respect to the variable "Major", items X11 and X13 showed DIF. In particular, Marketing students seem to have less basic knowledge on spending and to find greater difficulties in understanding the functioning of public pensions. This result suggests that the Major choice, a proxy for students' interest in financial issues, is critical in defining which students are more able to answer on items relating to spending or money management area.
With regard to gender, item X6 had DIF. Regarding stock market investments females seem then to be disadvantaged with respect to their male colleagues, confirming previous literature results [1].
As far as the schooling variable is concerned, item X5 presented a DIF: e.g. college students with a high school diploma attained in a technical school find it easier to calculate cash inflows and outflows. Concerning job experience, items X5 and X6 displayed DIF, that is students without job experience (the focal group has 141 units) showed a lower ability to respectively the easiest and the most difficult item than their mates who mix work and study.
Finally, items X9 and X10 showed DIF with respect to financial behavior: those students who do not possess a checking account (representing the focal group with 112 units) showed a lower ability to answer on questions belonging to the areas of savings or money management.

4. Conclusions and future work

To the best of our knowledge, this study is the first to apply the Rasch model in the domain of financial literacy testing. Relative to traditional methods of assessing an index of financial literacy, Rasch analysis has the advantage of simultaneously measuring both the respondents' ability and the test items' difficulty. Our findings support the opportunity of adopting such techniques in measuring financial literacy: the set of information provided is not limited to a

crude figure, indicating whether the population has passed or failed the test. On the contrary, the specific areas where deficiencies mostly occur are located. Among them, the group showing highest knowledge deficit can be determined. These outcomes could be crucial in designing programs of financial education.

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