Qualitative Research in Financial Markets

Exploring financial graph literacy: determinants and influence on financial behavior

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Abstract

Purpose – Graphs are widely used in the banking and finance domain to support consumers' decision-making process, but subjects differ in their ability to understand them. This study aims to detect the determinants of the ability to read and process financial information conveyed in the graphical format, i.e. financial graph literacy (FGL) and the relationship between FGL and subjects' actual financial behavior (FB).

Design/methodology/approach – Data are collected by administering a structured questionnaire to the Italian adult population (n = 502). The survey includes different sections aimed at collecting information about sociodemographic and socioeconomic variables, financial literacy and FB. The econometric analyses are developed using OLS and Poisson regressions.

Findings – The results show that gender, geographical area, education, marital status and income are crucial determinants of FGL. Moreover, the analysis reveals that an increase in the FGL indicator is associated with a higher propensity for individuals to purchase banking or financial products or actively manage financial resources; results are robust, even controlling for financial knowledge.

Originality/value – Although previous research investigates the impact of graphs in financial decision-making, no studies measure the ability of consumers to read and interpret financial information conveyed in the graphical format. This study is the first to investigate the determinants of FGL and link it to actual FB. Implications for policymakers, regulatory and supervisory authorities and financial intermediaries are discussed.

Keywords Financial graph literacy, Financial literacy, Financial behavior, Survey

Paper type Research paper

1. Introduction

In various decision-making contexts, such as health care, air traffic and education, graphs are essential for data visualization, facilitating the understanding of quantitative information (Ancker *et al.*, 2006; Garcia-Retamero and Cokely, 2013, 2017; Spiegelhalter *et al.*, 2011).

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Visually presenting information is linked to efficient communication by enhancing clarity (Suwa and Tversky, 2002), increasing speed (Perdana *et al.*, 2018) and facilitating the comprehension of intricate concepts (Wang *et al.*, 2017). In the banking and finance (B&F) domain, where decision-making relies on abundant, quantitative and often complex information, graphs are widely used to visually illustrate data relationships and present information quickly and easily (Almujamed *et al.*, 2013). The ongoing digitization of the financial industry has accelerated the adoption of real-time updates, making charts increasingly popular for condensing vast amounts of information. Financial institutions are integrating graphs into retail customer documentation, such as the Key Investor Information Document, crowdfunding platform pitches and mobile banking applications. This inclusion serves to bolster consumer protection by empowering individuals to make well-informed decisions (Huber and Huber, 2019).

In the health domain, the wide diffusion of graphs to convey information has led numerous researchers to investigate the ability of people to extract and use information to make informed decisions (Feeney *et al.*, 2000; Garcia-Retamero and Cokely, 2017; Lewandowsky and Spence, 1989). Conversely, few studies investigate the role of graphs in the B&F context (Beattie and Jones, 2002; Diacon and Hasseldine, 2007; Hubbard *et al.*, 2016; Lusardi *et al.*, 2017) and only two articles have explored the ability of individuals to understand the information presented graphically (Bank of Italy, 2020; Porzak *et al.*, 2021). In 2020, the Bank of Italy (2020) measured subjects' ability to understand financial graphical information, referred to as *financial graph literacy* (FGL). However, this measure was not linked to consumers' financial behavior (FB). In a following study, Porzak *et al.* (2021) linked subjects' *graph literacy* to FB; however, the measure of graph literacy was not contextualized to the financial domain and was a self-reported measure. Moreover, while the literature on the determinants of financial literacy (FL) is vast (Potrich *et al.*, 2015), no studies investigate the sociodemographic and socioeconomic determinants of FGL.

Overall, previous research underscores the significance of graph literacy in decision-making, as synthesized in the systematic literature review by Zipkin *et al.* (2014), which emphasizes the critical role of graphs in enhancing patients' comprehension and satisfaction. Moreover, a substantial body of research demonstrates the positive impact of various individual financial literacies – such as financial, debt, deposit, credit and insurance literacy – on FB (Bongini *et al.*, 2023; Courchane *et al.*, 2008; Galariotis and Monne, 2023; Kurowski, 2021; Lusardi and Tufano, 2015; Lyons *et al.*, 2007; Sekita *et al.*, 2022; Van Ooijen and Van Rooij, 2016). Building on this foundation, our study addresses a gap in the literature by analyzing the primary factors influencing FGL and establishing a link between this literacy and actual FB. The present research uses an adapted scale, originally designed for the medical field by Galesic and Garcia-Retamero (2011), to objectively measure FGL within the financial context by administering a questionnaire to a representative sample of the Italian adult population. The econometric analyses revealed that gender, geographical area, level of education, marital status and income are crucial determinants of FGL. Moreover, after controlling for FL, results show that FGL is positively related to active FB, a higher propensity for subjects to purchase banking or financial products or services, as well as actively manage and track their financial resources.

The study's contributions are manifold. First, we highlight the main sociodemographic and socioeconomic determinants of FGL, thereby advancing research on the factors influencing financial literacies. Second, we extend the literature on financial decision-making, revealing the influence of an underexplored literacy, FGL, on actual FB. Finally, we extend the literature on graph literacy by focusing on the financial context.

The article is organized as follows. Section 2 synthesizes the literature on graph literacy and FL. Section 3 describes the questionnaire and the data used to conduct the empirical analyses and the results that are highlighted in Section 4. Finally, Sections 5 and 6 discuss the results and offer some conclusions, respectively.

2. Literature review

Graphs enhance comprehension more effectively than numerical or text-based formats by representing quantitative information spatially (Munzner *et al.*, 2006; Tversky, 2001). Unfortunately, visual aids can also negatively impact decision-making, leading to biases or errors. Empirical evidence indicated that not everyone benefits from graphical presentations (Ancker *et al.*, 2006; Garcia-Retamero and Galesic, 2010; Lipkus, 2007) due to varying levels of *graph literacy* – the ability to understand and interpret graphical information (Freedman and Shah, 2002; Galesic and Garcia-Retamero, 2011; Kutner *et al.*, 2006).

The increasing emphasis on patient involvement in health decisions (Barry, 1999; Hanson, 2008) has stimulated research into graph literacy within this context. Overall, studies show that health-related graphs aid in understanding information about the risks and benefits of screenings, lifestyles and medical treatments (Ancker *et al.*, 2006; Garcia-Retamero and Cokely, 2011; Garcia-Retamero and Galesic, 2010; Lipkus, 2007) and that individual differences in graph literacy are crucial for developing effective risk communication and decision-support systems (Okan *et al.*, 2012a, 2012b; Cokely *et al.*, 2012). Focusing on decision aids, van Weert *et al.* (2021) investigated the influence of graph literacy, using the Galesic and Garcia-Retamero (2011) scale, on preference for graph format. They found that graph literacy significantly impacts knowledge scores and preferences, with age also being a significant factor. Their study also underlined the relevance of age as a crucial variable in affecting graph preferences. Durand *et al.* (2020) observed that individuals with lower educational attainment and socioeconomic status have substantially lower graph literacy, which may limit their ability to benefit from graphical information. Indeed, socioeconomic variables play a critical role in graph literacy.

Graphs are also recognized as significant informational cues in decision-making in B&F. The presentation of financial information in graphical form to investors is prevalent among financial service providers, agents and consumer finance websites (Raghubir and Das, 2010). Furthermore, most providers allow their users to change the visual representation of data according to their interests (Duclos, 2015). Graphs about the performance of stocks, bonds, commodities and foreign exchange markets facilitate retail investors in making investment decisions while also affecting their perception of risk (Raghubir and Das, 2010). Very few studies have investigated graphs in B&F and their relationship with individuals' behavior. Hubbard *et al.* (2016) tested the role of the format of financial education tools in understanding the concept of compound interest. They found that text formats and volumetric graphs were more effective than line graphs, which did not show any improvement in comprehension. Building on this experimental evidence, Lusardi *et al.* (2017) compared various forms of educational content delivery and noted that interactive visual tools using graphs to explain key concepts related to risk and risk diversification were less effective compared to video and brochure formats that did not include graphical aids. Overall, these studies have observed no influence of graphs in improving knowledge. One possible reason is the graphic format fails to enhance individuals' knowledge may be that subjects differ in their ability to read and interpret the information displayed through graphs related to the B&F domain, i.e. FGL. This paper aims to investigate individual differences in FGL, studying its determinants and exploring its link with actual FB.

Only two studies in the literature have measured subjects' ability to interpret graphs within the financial domain. In a 2020 survey, the Bank of Italy included two questions featuring graphs in a questionnaire designed to measure financial knowledge. The discriminatory capacity of these two questions was higher than the other indicators used by the Organisation for Economic Cooperation and Development (OECD) (D'Alessio *et al.*, 2021). Porzak *et al.* (2021) analyzed FL with a focus on debt literacy and a further set of literacies: numerical, graphic and linguistic. The researchers noted that numeracy affects debt literacy, but no significant relationship was found between debt and graph literacy. Although these studies represented advancements in measuring graph literacy within B&F, they are not without limitations. In the first study, FGL was measured with only two questions, and no analysis of its determinants was performed. In the second study, the measurement of the ability to understand graphs was based on a self-reported measure, was not contextualized to the B&F field and was not explored concerning sociodemographic and socioeconomic variables. On the basis of the previous literature and given the absence of studies on FGL and its determinants, this study aims to investigate the determinants of FGL, answering the following research question:

RQ1. What is the impact of sociodemographic and socioeconomic variables on FGL?

Previous studies conducted outside the financial context highlighted that visual aids such as icon arrays and bar graphs effectively improve patients' understanding and satisfaction (for a systematic literature review, see Zipkin *et al.*, 2014). The rationale behind the effectiveness of graphs relies on the consideration coming from different decision domains, according to which graphs represent an appealing way to present quantitative information because they exploit rapid, automatic visual perception skills (Ancker *et al.*, 2006; Cleveland and McGill, 1985). This occurs because graphs manage to reduce cognitive load (Mayer and Moreno, 2003) and consequently increase the likelihood that information is understood (Paivio, 1990). In the financial domain, relying on data from a laboratory experiment, Dull and Tegarden (1999) found that participants' accuracy in financial reporting improved when relying on three-dimensional visuals. Nonetheless, different studies report the absence of a positive effect of graphs on behavior, suggesting that they are not superior in the several studies over tables in financial judgments (Chan, 2001; Tang *et al.*, 2014; Volkov and Laing, 2012).

In attempting to uncover the influence of different literacies on FB, previous research has extensively examined the different types of literacy and their impact on financial decision-making. FL has often been associated with an increase in individuals' ability to make informed financial decisions as well as a better understanding of the functioning of financial products (Andarsari and Ningtyas, 2019; Lusardi and Tufano, 2015) and plan for long-term financial choices (Grohmann, 2018; Lusardi and Mitchell, 2007). Individual FL has been explored by analyzing different features. Sekita *et al.* (2022) observe a positive and statistically significant relationship between deposit literacy, risk literacy, debt literacy and wealth accumulation. Lusardi and Tufano (2015) reported a link between low levels of debt literacy and over-indebtedness, whereas Van Ooijen and Van Rooij (2016) identified a higher propensity to take out traditional mortgages by homeowners with low-debt literacy. Kurowski (2021) showed that individuals with high scores in both financial and debt literacy are less affected by over-indebtedness and Sekita *et al.* (2022) identified a positive impact of debt literacy on wealth accumulation. Galariotis and Monne (2023) demonstrated that individuals with low levels of debt literacy tend to exhibit a greater likelihood of relying on credit, holding more credit products, having multiple types of consumer credit in recent years and preferring lower settlement options for debt repayment. Another type of literacy, credit

literacy, has been found to be correlated with FB (Courchane *et al.*, 2008; Lyons *et al.*, 2007), as individuals with lower scores are more prone to over-indebtedness and progressive impoverishment (Mutsonziwa and Fanta, 2019). Similarly, evidence indicates that insurance literacy directly and positively impacts the intention toward insurance products (Weedige *et al.*, 2019). In 2023, Bongini *et al.* uncovered that in addition to sociodemographic and socioeconomic factors, insurance literacy plays a crucial role in shaping decisions related to insurance purchases, whereas Boes and Liu (2023) observed that individuals' objective knowledge about the health insurance system is associated with better health plan decisions.

Based on extensive research indicating a connection between individual literacy levels and FB, including studies that link higher knowledge levels with increased engagement in FB, alongside evidence of increased use of financial tools among retail customers, we propose the following hypothesis:

H1. A higher score in FGL is associated with more active FB.

3. Methods

3.1 Participants

A web-based questionnaire was administered by Dynata, a research and market analysis company, in November 2022 to a representative sample of the Italian adult population aged 18–82. A total of 502 respondents – 261 females (M_{age} = 45.14 years, SD_{age} = 14.37) and 241 males (M_{age} = 48.88 years, SD_{age} = 14.90) – completed the survey. Concerning geographical area, 130 participants were from Northwest, 96 from Northeast, 101 from Center and 175 from the South. The sample had a good educational level: 233 persons had at least a high school diploma, 57 attended a university program and 173 had successfully achieved a university degree or a doctoral diploma. The marital status most represented was married (65.54%), followed by single (27.89%) and widower/divorced (6.57%). Approximately, one out of four participants (24.70%) declared an annual income of less than 15,000 euros, 32.07% fall within the 15–28 bracket, 34.06% in the 29–55 and 9.16% in the 56–75 range. A majority of respondents (63.75%) were employed; the remaining were inactive and not seeking employment (27.89%) or unemployed seeking (8.37%). Descriptive statistics are displayed in Table 1.

3.2 Questionnaire

A questionnaire was developed and organized into different sections. The first section of the questionnaire contained six items to collect the following sociodemographic and socioeconomics information: gender, age, geographical area, education, employment status and income.

The second section measures FGL through a questionnaire consisting of 13 items developed by Galesic and Garcia-Retamero (2011) for the medical sector and transposed, in this study, item by item, to the B&F domain. For each question, a score of 1 is assigned if the subject answered correctly, 0 otherwise. The FGL score is the sum of the number of correct answers provided by each participant for the 13 questions. During the administration of the questionnaire, it was not possible for participants to advance from one question to the next without answering, nor was it foreseen, in line with the original work of Galesic and Garcia-Retamero (2011) from which the scale is taken, the possibility of answering "I don't know". The FGL questionnaire is displayed in Appendix.

In this section of the questionnaire, Lusardi's "Big Five" questionnaire was used to measure the individual level of FL.

Table 1. Sample descriptive characteristics

Sociodemographic characteristic	Full sample	
	n	%
Gender		
Male	241	48.01
Female	261	51.99
Region		
Northwest	130	25.90
Northeast	96	19.12
Center	101	20.12
South and islands	175	34.86
Age		
18–24	42	8.37
25–34	76	15.14
35–44	98	19.52
45–54	96	19.12
Over 55	190	37.85
Education		
Elementary/secondary/high school	272	54.18
University students	57	11.35
University degree	115	22.91
PhD/postdegree master	58	11.55
Marital status		
Single	140	27.89
Widow/widower/divorced	33	6.57
Married/cohabitant	329	65.54
Income[1]		
Less than 15	124	24.70
15–28	161	32.07
29–55	171	34.06
56–75	46	9.16
Employment status		
Employed	320	63.75
Unemployed seeking	42	8.37
Unemployed not seeking	140	27.89

Notes: $n = 502$; [1]in thousands of euros annually
Source: Authors' own creation

Section 3 of the survey aimed at assessing FB. Most studies measured FB on a one-item scale (Mouna and Anis, 2017; Gathergood, 2012; Lusardi, 2012; Rha *et al.*, 2006; Sivaramakrishnan *et al.*, 2017; Van Rooij *et al.*, 2011), whereas we measured subjects' FB across different B&F contexts. We asked subjects whether they have ever purchased stocks or mutual fund shares, purchased bonds or government securities, opened a bank account, bought an insurance policy, held a credit card, held a prepaid card, used mobile payment tools, bought cryptocurrencies or initial coin offerings (ICOs), planned how to manage income, expenses and any savings, took note of personal expenses, saved money for recurring expenses, noted down deadlines to avoid late payments of recurring expenses and

relied on automatic debiting from the checking account for recurring expenses. Respondents were asked to answer "Yes" or "No", and a score of 1 was assigned if the subject answered "Yes" and 0 otherwise. The FB score is the sum of the number of times the subject declares "Yes" for the 13 questions.

3.3 Econometric models

To verify the determinants of the ability to understand financial graphs, an ordinary least squares (OLS) regression was carried out considering FGL as a dependent variable, according to the following equation:

$$FGL_i = \alpha_0 + \beta'_1 X_{1i} + \varepsilon \quad (1)$$

where X_1 is the vector of the following variables: gender, age, level of education, geographical area, marital status, level of income and employment status. In addition, considering that the dependent variable can be interpreted as a counting variable, which takes integer values starting from zero, the analysis was performed using a Poisson regression model.

To analyze the relationship between FGL and FB, an OLS regression model was used where FB is the dependent variable and FGL is the main independent one. Sociodemographic and socioeconomic variables are included as controls in the model, specified by the following equation:

$$FB_i = \alpha_0 + \beta'_1 FGL_{1i} + \beta'_2 X_{1i} + \varepsilon \quad (2)$$

where X_1 is the vector of control variables. The basic model is subsequently enriched by adding FL as a control variable.

In the models related to equations (1) and (2), no multicollinearity problems were detected (the value of variance inflation factors (VIFs) is constantly below the threshold values). In the OLS regressions, the presence of heteroskedasticity has led to the use of models with robust standard errors.

As further checks, the analysis on the link between FGL and FB was conducted using FB as a dummy variable (0 for values below the median of 7; 1 otherwise) and by developing three logit regressions (one that includes as independent variable FGL, one for FL and one that considers FGL and FL simultaneously). In addition, the analysis was conducted using three separate OLS regressions, where FGL and FL were included as dummy variables. In the first model, FGL is assigned a value of 0 if the score is below 9 (the median value) and 1 otherwise. In the second model, FL is assigned a value of 0 if the score is below 3 (the median value) and 1 otherwise. In the third model, FGL and FL are simultaneously included as dummy variables.

4. Results

4.1 Financial graph literacy, financial literacy, financial behavior descriptive statistics and correlations

Descriptive statistics for the FGL scale (Cronbach's alpha = 0.78), FL and FB are shown in Table 2. The data revealed that, on average, the subjects answered seven or eight out of 13 FGL questions correctly, with a mean value of 8.39 (SD = 2.81; min = 0, max = 13; Q1 = 7, Q3 = 10). Only 10 subjects (about 2% of the sample) answered all the questions correctly. The average FL score of the sample was 2.89 (SD = 1.27; min = 0, max = 5; Q1 = 1, Q3 = 4).

Table 2. Other descriptive statistics and correlations

Variable	*n*	*M*	Median	SD	1	2	3
1. FB	502	7.37	7	2.45	–		
2. FGL	502	8.39	9	2.81	0.24***	–	
3. FL	502	2.89	3	1.27	0.26***	0.40***	–

Note: ***$p < 0.01$
Source: Authors' own creation

The average number of FB items flagged by subjects was 7.37 (SD = 3.26; Q1 = 6, Q3 = 9); only 15 and 6 subjects declared engaging in 12 and 13 behaviors, respectively.

4.2 Econometric analyses

Table 3 displays the results on the determinants of FGL. Gender, geographical area, level of education and income are relevant variables in affecting FGL. Specifically, female participants have significantly lower FGL scores than males ($B = -0.621$, $p < 0.05$), revealing women's lower ability in reading and understanding financial graphs than men. Individuals from the South of Italy show lower FGL ($B = -1.140$, $p < 0.01$) compared to those from the Northwest. The level of education has a significant and positive relationship with the FGL. University students ($B = 1.261$, $p < 0.01$), university graduates ($B = 0.685$, $p < 0.05$) and PhD ($B = 1.250$, $p < 0.01$) demonstrate better skills in interpreting financial charts compared to individuals with only a high school diploma. Finally, participants with an income between 15,000 and 28,000 euros show lower FGL ($B = -0.727$, $p < 0.05$) compared to the lower income bracket (less than 15,000 euros). These findings are corroborated by a Poisson regression analysis, which confirms the results of the OLS analysis with robust standard errors. Overall, these results allow us to answer our research question on the analysis of the determinants of FGL.

Table 4 presents the results of the empirical strategy, which tested for a statistically significant relationship between FGL and FB. Results show a positive relationship between our main independent variable, i.e. FGL and FB ($B = 0.169$, $p < 0.01$), thus confirming the research hypothesis. When controlling for FL, the positive relationship between FGL and FB remains significant ($B = 0.107$, $p < 0.05$); the analysis reveals a positive and statistically significant relationship between FL and FB ($B = 0.369$, $p < 0.01$). Subjects older than 55 years exhibit less financially active behavior compared to those aged 18–24 ($B = -0.883$, $p < 0.05$). Conversely, participants with an income between 56,000 and 75,000 euros display more active FB ($B = 1.155$, $p < 0.05$) compared to those with an income below 15,000 euros. Finally, the effect sizes for those seeking employment ($B = -1.216$, $p < 0.01$) and the unemployed ($B = -0.909$, $p < 0.01$) are significantly lower than the effect for employed participants. The variation in the *R-squared* indicates a significant improvement in Model 3 when including the FGL variable compared to the model with only FL (Model 2). Figure 1 graphically shows that the median value of FB is higher for individuals with higher levels of FGL. This confirms that individuals with greater FGL exhibit more active FB.

To strengthen the analysis, alternative measures for the dependent and key independent variables were used in the empirical strategy. Table 5 synthesizes the results of logit regression models employing a binary indicator that equals 1 if the FB measure exceeds its median value. The FGL variable retains its significant coefficients when considered individually in Model 1 ($B = 0.148$, $p < 0.01$) and simultaneously with FL in Model 3 ($B =$

Table 3. Determinants of FGL

Variables	Regression (robust)			Poisson	
	B	*β*	SE	*B*	SE
Gender[1]	−0.621**	−0.110**	0.254	−0.075**	0.032
Age[2]					
25–34	−0.428	−0.055	0.559	−0.049	0.073
35–44	0.009	0.001	0.508	0.003	0.071
45–54	0.392	0.055	0.508	0.047	0.070
More than 55	−0.367	−0.063	0.454	−0.044	0.067
Geographical area[3]					
Northeast	0.096	0.013	0.343	0.012	0.046
Center	−0.556	−0.079	0.343	−0.065	0.046
South and the islands	−1.140***	−0.193***	0.323	−0.138***	0.041
Education[4]					
University students	1.261***	0.142***	0.338	0.149***	0.050
University degree	0.685**	0.103**	0.319	0.084**	0.040
PhD-postdegree master	1.250***	0.142***	0.421	0.149***	0.053
Marital status[5]					
Widow/er-divorced	−1.233**	−0.109**	0.622	−0.156**	0.075
Married-cohabitant	−0.302	−0.051	0.324	−0.036	0.042
Income[6]					
15–28	−0.727**	−0.121**	0.366	−0.091**	0.046
29–55	0.156	0.026	0.366	0.017	0.048
56–75	−0.120	−0.012	0.549	−0.015	0.066
Employment status[7]					
Unemployed seeking	0.123	0.012	0.411	0.015	0.062
Unemployed not seeking	0.476	0.076	0.333	0.058	0.040
Constant	9.211***		0.551	2.221***	0.073
Observations		502		502	
R square		0.116			

Notes: Reference category = [1]male; [2]18–24; [3]North-West; [4]elementary-secondary/high school; [5]single; [6]less than 15 (in thousands of euros); [7]employed. ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$
Source: Authors' own creation

0.100, $p < 0.05$). In Model 2, the positive impact of FL is confirmed ($B = 0.392$, $p < 0.01$). Table 6 presents the results of three OLS regressions where the key independent variables – FGL and FL – are dichotomized. These findings confirm the crucial role of the FGL indicator in explaining FB. Notably, FGL_dummy exhibits positive and significant coefficients in both Model 1 ($B = 0.887$, $p < 0.01$) and Model 3 ($B = 0.784$, $p < 0.01$), contributing to a substantial increase in the *R-squared* from Model 2 (which considers FL_dummy only) to the complete model (Model 3).

5. Discussion

In recent decades, access to financial markets has become easier, and the number of financial products and their complexity have increased; nowadays, individuals should make decisions by analyzing vast information. One way through which information is summarized and

Table 4. Regressions on financial behavior (robust errors)

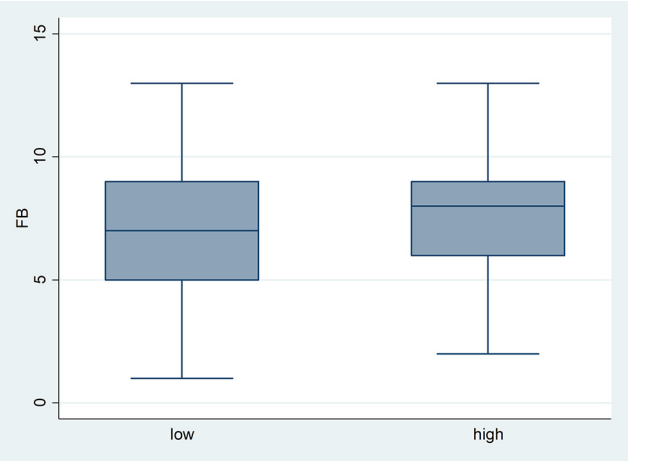
Variables	Model 1			Model 2			Model 3		
	B	*β*	SE	*B*	*β*	SE	*B*	*β*	SE
FGL	0.169***	0.194***	0.039				0.107**	0.123**	0.042
FL				0.463***	0.240***	0.085	0.369***	0.191***	0.092
Gender[1]	−0.271	−0.055	0.215	−0.157	−0.032	0.216	−0.135	−0.027	0.215
Age[2]									
25–34	−0.101	−0.015	0.505	−0.162	−0.024	0.460	−0.118	−0.017	0.465
35–44	−0.599	−0.097	0.493	−0.690	−0.112	0.459	−0.672	−0.109	0.461
45–54	−0.464	−0.075	0.499	−0.703	−0.113	0.459	−0.683	−0.110	0.459
More than 55	−0.566	−0.112	0.465	−0.998**	−0.198**	0.431	−0.883**	−0.175**	0.435
Geographical area[3]									
Northeast	0.129	0.021	0.305	0.090	0.014	0.301	0.091	0.015	0.301
Center	−0.321	−0.052	0.295	−0.246	−0.040	0.299	−0.221	−0.036	0.297
South and the islands	−0.348	−0.068	0.283	−0.299	−0.058	0.283	−0.226	−0.044	0.279
Education[4]									
University students	0.531	0.069	0.337	0.624*	0.081*	0.328	0.513	0.067	0.326
University degree	0.293	0.050	0.266	0.307	0.053	0.263	0.254	0.044	0.263
PhD-postdegree master	0.295	0.039	0.377	0.424	0.055	0.371	0.307	0.040	0.376
Marital status[5]									
Widow/er-divorced	0.255	0.026	0.554	0.128	0.013	0.541	0.244	0.025	0.549
Married-cohabitant	0.355	0.069	0.286	0.290	0.056	0.283	0.325	0.063	0.281
Income[6]									
15–28	0.024	0.005	0.301	−0.008	−0.002	0.301	0.051	0.010	0.298
29–55	0.431	0.083	0.325	0.491	0.095	0.325	0.468	0.091	0.319
56–75	1.244***	0.147***	0.474	1.121**	0.132**	0.460	1.155**	0.136**	0.454

(*continued*)

Table 4. Continued

Variables	Model 1			Model 2			Model 3		
	B	*β*	SE	*B*	*β*	SE	*B*	*β*	SE
Employment status[7]									
Unemployed seeking	−1.296***	−0.147***	0.409	−1.184***	−0.134***	0.409	−1.216***	−0.138***	0.406
Unemployed not seeking	−0.927***	−0.170***	0.268	−0.861***	−0.158***	0.263	−0.909***	−0.167***	0.262
Constant	6.380***		0.613	6.610***		0.544	5.894***		0.607
Observations		502			502			502	
R-squared		0.169			0.183			0.194	
ΔR square					0.014*** (respect Model 1)			0.025*** (Model 1); 0.011*** (Model 2)	

Notes: Reference category: [1]male; [2]18–24; [3]North-West; [4]elementary/secondary/high school; [5]single; [6]less than 15 (in thousands of euros); [7]employed; ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$
Source: Authors' own creation



Note: "Low" and "high" refer to FGL scores indicating values below and above the median value
Source: Authors' own creation

Figure 1. Box plot of FB for low and high levels of FGL

visualized is through graphs. The economic literature has revealed that extracting relevant information from graphs can be a difficult task even in very simple situations, such as when subjects are asked to identify, in a histogram, the percentage of sales of one of the most purchased films (Vila and Gomez, 2016). Previous studies in the health domain have shown that people differ in their graph literacy (Garcia-Retamero and Galesic, 2010; Nayak *et al.*, 2016; Okan *et al.*, 2012a, 2012b; van Weert *et al.*, 2021). The present study expands the literature on graph literacy, investigating whether subjects differ in their ability to read and understand financial information conveyed through graphs, the determinants of FGL and its relationship with FB.

Given the proliferation of digital solutions and the need to summarize a large amount of information available on financial markets, the graphical format is likely to become even more relevant in affecting behavior. The present research shows a positive relationship between FGL and FB. Previous studies reveal that FL is positively related to financial decisions (Andarsari and Ningtyas, 2019; Grohmann, 2018; Lusardi and Mitchell, 2007; Lusardi and Tufano, 2015). Research has demonstrated that various forms of literacy – such as credit, deposit, debt and insurance literacy – play a crucial role in influencing and promoting FB. This study advances the literature showing that also FGL is crucial in shaping actual FB; that is, a higher score of the FGL indicator is associated with a higher propensity that subjects to purchase banking or financial products or actively manage and track their financial resources; results are robust even controlling for FL. These findings align with existing literature in the health domain, demonstrating that graphs assist individuals in comprehending information more effectively (Ancker *et al.*, 2006; Garcia-Retamero and Cokely, 2011; Garcia-Retamero and Galesic, 2010; Lipkus, 2007). We thus enrich the literature by providing evidence of the importance of this literacy in the financial domain, which deserves special attention because it is a high-involvement service context characterized by high personal relevance (Vlaev *et al.*, 2009; Zhang *et al.*, 2021).

Table 5. Logit regressions on dummy financial behavior (robust errors)

Variables	Model 1			Model 2			Model 3		
	B	SE	ME	*B*	SE	ME	*B*	SE	ME
FGL	0.148***	0.0375	0.029***				0.100**	0.041	0.020**
FL				0.392***	0.085	0.078***	0.311***	0.093	0.061***
Gender[1]	−0.133	0.210	−0.027	−0.0428	0.213	−0.008	−0.0280	0.215	−0.005
Age[2]									
25–34	−0.464	0.475	−0.084	−0.561	0.448	−0.095	−0.513	0.457	−0.086
35–44	−1.159**	0.470	−0.227***	−1.249***	0.445	−0.231***	−1.255***	0.454	−0.232***
45–54	−0.378	0.477	−0.068	−0.599	0.455	−0.102	−0.593	0.461	−0.101
More than 55	−0.673	0.441	−0.125	−1.059**	0.429	−0.192***	−0.974**	0.433	−0.175**
Geographical area[3]									
Northeast	0.393	0.318	0.076	0.359	0.316	0.0692	0.364	0.322	0.070
Center	−0.125	0.296	−0.026	−0.0643	0.306	−0.013	−0.0296	0.305	−0.006
South and the islands	−0.214	0.267	−0.044	−0.167	0.268	−0.034	−0.105	0.270	−0.021
Education[4]									
University students	0.129	0.349	0.026	0.229	0.347	0.046	0.113	0.345	0.022
University degree	0.158	0.256	0.032	0.183	0.256	0.037	0.137	0.261	0.027
PhD-postdegree master	0.285	0.384	0.057	0.396	0.388	0.078	0.289	0.400	0.056
Marital status[5]									
Widow/er-divorced	0.122	0.505	0.026	−0.0188	0.499	−0.004	0.104	0.516	0.021
Married-cohabitant	0.421	0.280	0.086	0.367	0.286	0.074	0.410	0.290	0.082
Income[6]									
15–28	−0.0266	0.282	−0.006	−0.0673	0.281	−0.014	−0.005	0.284	−0.001
29–55	0.178	0.305	0.037	0.228	0.310	0.047	0.203	0.307	0.041
56–75	1.103**	0.467	0.201**	0.986**	0.445	0.182**	1.046**	0.459	0.190**

(*continued*)

Table 5. Continued

Variables	Model 1			Model 2			Model 3		
	B	SE	ME	*B*	SE	ME	*B*	SE	ME
Employment status[7]									
Unemployed seeking	−1.538***	0.395	−0.332***	−1.476***	0.402	−0.315***	−1.516***	0.401	−0.319***
Unemployed not seeking	−0.777***	0.253	−0.165***	−0.721***	0.248	−0.151***	−0.782***	0.253	−0.162***
Constant	−0.141	0.566		0.127	0.509		−0.544	0.582	
Observations		502			502			502	
Wald chi-square		67.07***			71.92***			75.63***	
Pseudo *R*-squared		0.119			0.127			0.136	

Notes: Reference category = [1]male; [2]18–24; [3]Northwest; [4]elementary/secondary/high school; [5]single; [6]less than 15 (in thousands of euros); [7]employed; ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$

Source: Authors' own creation

Table 6. Regressions on financial behavior (robust errors) – dichotomous FGL and FL

Variables	Model 1			Model 2			Model 3		
	B	*β*	SE	*B*	*β*	SE	*B*	*β*	SE
DFGL	0.887***	0.180***	0.215				0.784***	0.159***	0.222
DFL				0.707***	0.137***	0.228	0.534**	0.103**	0.233
Gender[1]	−0.224	−0.046	0.215	−0.284	−0.058	0.218	−0.172	−0.035	0.216
Age[2]									
25–34	−0.211	−0.031	0.508	−0.211	−0.031	0.488	−0.235	−0.034	0.490
35–44	−0.696	−0.113	0.498	−0.716	−0.116	0.484	−0.775	−0.125	0.483
45–54	−0.520	−0.084	0.509	−0.616	−0.099	0.491	−0.671	−0.108	0.492
More than 55	−0.645	−0.128	0.469	−0.858*	−0.170*	0.459	−0.817*	−0.162*	0.458
Geographical area[3]									
Northeast	0.051	0.008	0.308	0.132	0.021	0.306	0.052	0.008	0.308
Center	−0.361	−0.059	0.295	−0.338	−0.055	0.300	−0.309	−0.051	0.297
South and the islands	−0.452	−0.088	0.282	−0.438	−0.085	0.289	−0.384	−0.075	0.281
Education[4]									
University students	0.530	0.069	0.336	0.710**	0.092**	0.340	0.529	0.069	0.334
University degree	0.260	0.045	0.268	0.385	0.066	0.267	0.259	0.044	0.267
PhD-postdegree master	0.377	0.049	0.373	0.486	0.063	0.372	0.376	0.049	0.373
Marital status[5]									
Widow/er-divorced	0.118	0.012	0.551	0.069	0.007	0.538	0.127	0.013	0.549
Married-cohabitant	0.341	0.066	0.286	0.296	0.057	0.289	0.330	0.064	0.285
Income[6]									
15–28	0.053	0.010	0.303	−0.061	−0.012	0.306	0.064	0.012	0.302
29–55	0.498	0.096	0.328	0.486	0.094	0.333	0.515	0.100	0.325
56–75	1.288***	0.152***	0.482	1.167**	0.137**	0.490	1.237***	0.146***	0.479

(*continued*)

Table 6. Continued

Variables	Model 1			Model 2			Model 3		
	B	*β*	SE	*B*	*β*	SE	*B*	*β*	SE
Employment status[7]									
Unemployed seeking	−1.191***	−0.135***	0.414	−1.182***	−0.134***	0.419	−1.131***	−0.128***	0.417
Unemployed not seeking	−0.934***	−0.171***	0.268	−0.879***	−0.161***	0.271	−0.948***	−0.174***	0.267
Constant	7.397***		0.523	7.532***		0.519	7.153***		0.518
Observations		502			502			502	
R-squared		0.164			0.152			0.173	
ΔR square					−0.012***			0.009*** (Model 1); 0.021*** (Model 2)	

Notes: Reference category = [1]male; [2]18–24; [3]Northwest; [4]elementary/secondary/high school; [5]single; [6]less than 15 (in thousands of euros); [7]employed; ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$
Source: Authors' own creation

Previous studies in the health domain on graph literacy have revealed that graph literacy varies depending on sociodemographic and socioeconomic variables. This study further contributes to the literature by highlighting the main determinants of graph literacy in the financial domain. We observe that women, people from the South and the Islands of Italy, less educated subjects, widows/widowers and divorced people display a lower level of FGL. These findings thus enrich the general literature on graph comprehension that has highlighted the existence of gender differences so that male individuals tend to perform better than the female gender (Åberg-Bengtsson, 1999; Lowrie and Diezmann, 2011; van Weert *et al.*, 2021). Our results show that males display higher FGL, confirming previous findings. We also identify a positive role of educational level on FGL, although this finding only partially aligns with research on graph comprehension, which indicates that the impact of educational attainment is controversial (Nayak *et al.*, 2016; van Weert *et al.*, 2021). Moreover, although previous studies reveal a negative relationship between age and graph literacy, our findings indicate that age does not significantly impact FGL.

Our findings also contribute to the determinants of the literacies related to the financial domain, such as FL, which has developed in the past decade. The literature on FL reveals that variables such as age and gender are relevant demographic determinants, so young people and older adults tend to show lower levels of FL than people of intermediate age (Lusardi and Tufano, 2015; Van Rooij *et al.*, 2011), as well as women compared to men (Chen and Volpe, 1998; Lusardi and Mitchell, 2011). Our results support the existence of gender differences in FGL but do not find age to be a significant factor. Some studies demonstrate that education and income are relevant determinants of FL in the Italian context (Fornero and Monticone, 2011; Nicolini *et al.*, 2013). Our findings align with the research that underpins the relevance of education, but we find a controversial role of the income level. Finally, we align with Cucinelli *et al.* (2019), who reveals the importance of the local context in affecting FL.

6. Conclusion

Nowadays, individuals have easier access to financial markets and are exposed to an abundance of financial products and services whose complexity has increased over the past. Regulatory authorities are interested in fostering informed decision-making and supporting individuals in taking control of their financial decisions. The present empirical investigation shows that subjects differ in their ability to read and process financial information presented in a graphical format. This skill – largely overseen by academics, authorities and managers – is crucial in affecting financial decisions. The present analysis shows the influence of gender, geographical area, level of education, marital status and income on FGL, which, in turn, is related to actual FB.

Results are relevant in highlighting vulnerable categories of subjects since their lower ability to process graphs in B&F relates to their lower participation in financial markets and a minor availability of banking products. Consumer protection authorities can thus consider proposing to financial intermediaries to adapt the presentation of financial information in a graphical format that meets the specific needs of their customers. Regulations could require financial institutions to present key information in standardized, easy-to-understand graphical formats. Developing guidelines for the presentation of financial data in product brochures, statements and online platforms can help achieve this goal; standardized graphs can reduce confusion and improve comprehension among consumers, leading to more informed financial decisions.

This evidence is also important for the B&F industry as it demonstrates that attention should be paid to the communication format when drafting documents that support financial

decision-making, such as disclosure documents. This research contributes to the literature that investigates the influence of the layout of the presentation of information on financial decisions (Ceravolo *et al.*, 2019; Walther, 2015), highlighting how, in subsequent studies, it may be important to consider the moderating or mediator role of FGL.

These findings are relevant to national educational policy. Providing graphical knowledge and financial education to more vulnerable categories could enhance financial well-being as the inability to make informed decisions can get people into serious financial trouble, affecting their lives and those of their families and the rest of the economy. This paper underlines the importance for policymakers to consider this skill since the diffusion of digital solutions and alternative financial services, which largely exploit graphical format, can even exacerbate wealth inequality.

The results of this study are significant as they can inform various interventions or activities, such as training programs and policies, which might influence the relationship between graph literacy and FB. Individuals could benefit from FGL workshops that teach basic and advanced financial concepts using visual aids like graphs and charts. These workshops could be held in community centers, schools and workplaces, with special sessions tailored to different education levels. By enhancing participants' understanding of financial graphs, these workshops can help individuals make more informed financial decisions, such as budgeting, investing and saving.

Furthermore, the disparity in financial graph comprehension across different regions in Italy deserves special attention. Although addressing this issue is challenging, introducing FL and graph comprehension programs in schools, particularly in the southern regions and islands, could be beneficial in the medium to long term. Schools can integrate FL, with a strong emphasis on interpreting graphs and charts, into the standard curriculum from an early age. Early exposure to financial graphs can build a foundation of financial competence, leading to better FB in adulthood. Developing online content and platforms to provide materials and courses on FL, including modules specifically dedicated to understanding and interpreting financial graphs, can also be beneficial. This can be achieved through collaboration with educational institutions and financial organizations to offer these resources for free or at a subsidized cost.

This study has limitations. First, although the Italian adult population provides a rich context for examining the determinants of FGL, the findings may not be generalizable to other cultural or economic settings. Replicating this survey in various countries would enable cross-country comparisons and enhance the robustness of the results. Second, the data collection relied on self-reported measures, which could introduce response biases, and used a cross-sectional design at a single point in time. Using alternative data collection methods, such as behavioral experiments or longitudinal studies, could help mitigate these biases, capture temporal changes and better ascertain causal relationships.

Further development of this study might also try to link FGL to a specific phase of financial decision-making, such as that of visual information processing, revealed by the subjects' oculomotor parameters, which has been shown to influence financial decision-making (Ceravolo *et al.*, 2021; Hüsser and Wirth, 2014). Therefore, future research could exploit the eye-tracking methodology to understand whether specific features of the layout of the financial documents could support graph comprehension.

References

Åberg-Bengtsson, L. (1999), "Dimensions of performance in the interpretation of diagrams, tables, and maps: some gender differences in the Swedish scholastic aptitude test", *Journal of Research in Science Teaching*, Vol. 36 No. 5, pp. 565-582, doi: 10.1002/(SICI)1098-2736(199905)36:5<565::AID-TEA4>3.0.CO;2-L.

Almujamed, H.I., Fifield, S. and Power, D. (2013), "An investigation of the role of technical analysis in Kuwait", *Qualitative Research in Financial Markets*, Vol. 5 No. 1, pp. 43-64, doi: 10.1108/17554171311308959.

Ancker, J.S., Senathirajah, Y., Kukafka, R. and Starren, J.B. (2006), "Design features of graphs in health risk communication: a systematic review", *Journal of the American Medical Informatics Association*, Vol. 13 No. 6, pp. 608-618, doi: 10.1197/jamia.M2115.

Andarsari, P.R. and Ningtyas, M.N. (2019), "The role of financial literacy on financial behavior", *JABE (Journal of Accounting and Business Education)*, Vol. 4 No. 1, pp. 24-33, doi: 10.26675/jabe.v4i1.8524.

Bank of Italy (2020), "L'alfabetizzazione finanziaria degli italiani: i risultati dell'indagine della banca d'Italia del 2020", QEF, No. 588.

Barry, M.J. (1999), "Involving patients in medical decisions: how can physicians do better?" *JAMA*, Vol. 282 No. 24, pp. 2356-2357, doi: 10.1001/jama.282.24.2356.

Beattie, V. and Jones, M.J. (2002), "Measurement distortion of graphs in corporate reports: an experimental study", *Accounting, Auditing and Accountability Journal*, Vol. 15 No. 4, pp. 546-564, doi: 10.1108/09513570210440595.

Boes, S. and Liu, Y. (2023), "Do individuals with better health insurance system knowledge make better decisions about their health plans?" *Applied Economics*, pp. 1-17, doi: 10.1080/00036846.2023.2295303.

Bongini, P., Cucinelli, D. and Soana, M.G. (2023), "Insurance holdings: does individual insurance literacy matter?" *Finance Research Letters*, Vol. 58, p. 104511, doi: 10.1016/j.frl.2023.104511.

Ceravolo, M.G., Farina, V., Fattobene, L., Leonelli, L. and Raggetti, G. (2019), "Presentational format and financial consumers' behaviour: an eye-tracking study", *International Journal of Bank Marketing*, Vol. 37 No. 3, pp. 821-837, doi: 10.1108/IJBM-02-2018-0041.

Ceravolo, M.G., Farina, V., Fattobene, L., Leonelli, L. and Raggetti, G. (2021), "Anchoring effect in visual information processing during financial decisions: an eye tracking study", *Journal of Neuroscience, Psychology, and Economics*, Vol. 15 No. 1, pp. 19-30, doi: 10.1037/npe0000153.

Chan, S.Y. (2001), "The use of graphs as decision aids in relation to information overload and managerial decision quality", *Journal of Information Science*, Vol. 27 No. 6, pp. 417-425, doi: 10.1177/016555150102700607.

Chen, H. and Volpe, R.P. (1998), "An analysis of personal financial literacy among college students", *Financial Services Review*, Vol. 7 No. 2, pp. 107-128, doi: 10.1016/S1057-0810(99)80006-7.

Cleveland, W.S. and McGill, R. (1985), "Graphical perception and graphical methods for analyzing scientific data", *Science*, Vol. 229 No. 4716, pp. 828-833.

Cokely, E.T., Galesic, M., Schulz, E., Ghazal, S. and Garcia-Retamero, R. (2012), "Measuring risk literacy: the Berlin numeracy test", *Judgment and Decision Making*, Vol. 7 No. 1, pp. 25-47, doi: 10.1017/S1930297500001819.

Courchane, M., Gailey, A. and Zorn, P. (2008), "Consumer credit literacy: what price perception?" *Journal of Economics and Business*, Vol. 60 Nos 1/2, pp. 125-138, doi: 10.1016/j.jeconbus.2007.08.003.

Cucinelli, D., Trivellato, P. and Zenga, M. (2019), "Financial literacy: the role of the local context", *Journal of Consumer Affairs*, Vol. 53 No. 4, pp. 1874-1919, doi: 10.1111/joca.12270.

D'Alessio, G., De Bonis, R., Neri, A. and Rampazzi, C. (2021), "Financial literacy in Italy: the results of the Bank of Italy's 2020 survey", *Politica Economica*, Vol. 37 No. 2, pp. 215-252.

Diacon, S. and Hasseldine, J. (2007), "Framing effects and risk perception: the effect of prior performance presentation format on investment fund choice", *Journal of Economic Psychology*, Vol. 28 No. 1, pp. 31-52, doi: 10.1016/j.joep.2006.01.003.

Duclos, R. (2015), "The psychology of investment behavior: (De) biasing financial decision-making one graph at a time", *Journal of Consumer Psychology*, Vol. 25 No. 2, pp. 317-325, doi: 10.1016/j.jcps.2014.11.005.

Dull, R.B. and Tegarden, D.P. (1999), "A comparison of three visual representations of complex multidimensional accounting information", *Journal of Information Systems*, Vol. 13 No. 2, pp. 117-131, doi: 10.2308/jis.1999.13.2.117.

Durand, M.A., Yen, R.W., O'Malley, J., Elwyn, G. and Mancini, J. (2020), "Graph literacy matters: examining the association between graph literacy, health literacy, and numeracy in a Medicaid eligible population", *Plos One*, Vol. 15 No. 11, p. e0241844, doi: 10.1371/journal.pone.0241844.

Feeney, A., Hola, A.K., Liversedge, S.P., Findlay, J.M. and Metcalf, R. (2000), "How people extract information from graphs: evidence from a sentence-graph verification paradigm", in Anderson, M., Cheng, P. and Haarslev, V. (Eds), Theory and application of diagrams: First international conference, Diagrams 2000, *Berlin*, Springer-Verlag, pp. 149-161, doi: 10.1007/3-540-44590-0_16.

Fornero, E. and Monticone, C. (2011), "Financial literacy and pension plan participation in Italy", *Journal of Pension Economics and Finance*, Vol. 10 No. 4, pp. 547-564, doi: 10.1017/S1474747211000473.

Freedman, E.G. and Shah, P. (2002), "Toward a model of knowledge-based graph comprehension", in Hegarty, M., Meyer, B. and Narayanan, N.H. (Eds), *Diagrammatic Representation and Inference*, Springer-Verlag, Berlin, pp. 8-31, doi: 10.1007/3-540-46037-3_3.

Galariotis, E. and Monne, J. (2023), "Basic debt literacy and debt behavior", *International Review of Financial Analysis*, Vol. 88, p. 102673, doi: 10.1016/j.irfa.2023.102673.

Galesic, M. and Garcia-Retamero, R. (2011), "Graph literacy: a cross-cultural comparison", *Medical Decision Making*, Vol. 31 No. 3, pp. 444-457, doi: 10.1177/0272989X10373805.

Garcia-Retamero, R. and Galesic, M. (2010), "Who profits from visual aids: overcoming challenges in people's understanding of risks", *Social Science and Medicine*, Vol. 70 No. 7, pp. 1019-1025, doi: 10.1016/j.socscimed.2009.11.031.

Garcia-Retamero, R. and Cokely, E.T. (2011), "Effective communication of risks to young adults: using message framing and visual aids to increase condom use and STD screening", *Journal of Experimental Psychology: Applied*, Vol. 17 No. 3, pp. 270-282, doi: 10.1037/a0023677.

Garcia-Retamero, R. and Cokely, E.T. (2013), "Communicating health risks with visual aids", *Current Directions in Psychological Science*, Vol. 22 No. 5, pp. 392-399, doi: 10.1177/0963721413491570.

Garcia-Retamero, R. and Cokely, E.T. (2017), "Designing visual aids that promote risk literacy: a systematic review of health research and evidence-based design heuristics", *Human Factors: The Journal of the Human Factors and Ergonomics Society*, Vol. 59 No. 4, pp. 582-627, doi: 10.1177/0018720817690634.

Gathergood, J. (2012), "Self-control, financial literacy and consumer over-indebtedness", *Journal of Economic Psychology*, Vol. 33 No. 3, pp. 590-602, doi: 10.1016/j.joep.2011.11.006.

Grohmann, A. (2018), "Financial literacy and financial behavior: evidence from the emerging Asian middle class", *Pacific-Basin Finance Journal*, Vol. 48, pp. 129-143, doi: 10.1016/j.pacfin.2018.01.007.

Hanson, J.L. (2008), "Shared decision making: have we missed the obvious?" *Archives of Internal Medicine*, Vol. 168 No. 13, pp. 1368-1370, doi: 10.1001/archinte.168.13.1368.

Hubbard, E., Matthews, P. and Samek, A. (2016), "Using online compound interest tools to improve financial literacy", *The Journal of Economic Education*, Vol. 47 No. 2, pp. 106-120, doi: 10.1080/00220485.2016.1146097.

Huber, C. and Huber, J. (2019), "Scale matters: risk perception, return expectations, and investment propensity under different scalings", *Experimental Economics*, Vol. 22 No. 1, pp. 76-100, doi: 10.1007/s10683-018-09598-4.

Hüsser, A. and Wirth, W. (2014), "Do investors show an attentional bias toward past performance? An eye-tracking experiment on visual attention to mutual fund disclosures in simplified fund

prospectuses", *Journal of Financial Services Marketing*, Vol. 19 No. 3, pp. 169-185, doi: 10.1057/fsm.2014.20.

Kurowski, Ł. (2021), "Household's overindebtedness during the COVID-19 crisis: the role of debt and financial literacy", *Risks*, Vol. 9 No. 4, p. 62, doi: 10.3390/risks9040062.

Kutner, M., Greenberg, E., Jin, Y. and Paulsen, C. (2006), *The Health Literacy of America's Adults: Results from the 2003 National Assessment of Adult Literacy (NALS)*, Department of Education, National Center for Education Statistics, Washington, DC.

Lewandowsky, S. and Spence, I. (1989), "Discriminating strata in scatterplots", *Journal of the American Statistical Association*, Vol. 84 No. 407, pp. 682-688, doi: 10.1080/01621459.1989.10478821.

Lipkus, I.M. (2007), "Numeric, verbal, and visual formats of conveying health risks: suggested best practices and future recommendations", *Medical Decision Making*, Vol. 27 No. 5, pp. 696-713, doi: 10.1177/0272989X07307271.

Lowrie, T. and Diezmann, C.M. (2011), "Solving graphics tasks: Gender differences in middle-school students", *Learning and Instruction*, Vol. 21 No. 1, pp. 109-125, doi: 10.1016/j.learninstruc.2009.11.005.

Lusardi, A. (2012), "Numeracy, financial literacy, and financial decision-making", *Technical Report National Bureau of Economic Research*, doi: 10.3386/w17821.

Lusardi, A. and Mitchell, O.S. (2007), "Baby boomer retirement security: the roles of planning, financial literacy, and housing wealth", *Journal of Monetary Economics*, Vol. 54 No. 1, pp. 205-224, doi: 10.1016/j.jmoneco.2006.12.001.

Lusardi, A. and Mitchell, O.S. (2011), "Financial literacy and retirement planning in the United States", *Journal of Pension Economics and Finance*, Vol. 10 No. 4, pp. 509-525, doi: 10.1017/S147474721100045X.

Lusardi, A. and Tufano, P. (2015), "Debt literacy, financial experiences, and overindebtedness", *Journal of Pension Economics and Finance*, Vol. 14 No. 4, pp. 332-368, doi: 10.1017/S1474747215000232.

Lusardi, A., Samek, A., Kapteyn, A., Glinert, L., Hung, A. and Heinberg, A. (2017), "Visual tools and narratives: new ways to improve financial literacy", *Journal of Pension Economics and Finance*, Vol. 16 No. 3, pp. 297-323, doi: 10.1017/S1474747215000323.

Lyons, A.C., Rachlis, M. and Scherpf, E. (2007), "What's in a score? Differences in consumers' credit knowledge using OLS and quantile regressions", *Journal of Consumer Affairs*, Vol. 41 No. 2, pp. 223-249, doi: 10.1111/j.1745-6606.2007.00079.x.

Mayer, R.E. and Moreno, R. (2003), "Nine ways to reduce cognitive load in multimedia learning", *Educational Psychologist*, Vol. 38 No. 1, pp. 43-52, doi: 10.1207/S15326985EP3801_6.

Mouna, A. and Anis, J. (2017), "Financial literacy in Tunisia: Its determinants and its implications on investment behavior", *Research in International Business and Finance*, Vol. 39, pp. 568-577, doi: 10.1016/j.ribaf.2016.09.018.

Munzner, T., Johnson, C., Moorhead, R., Pfister, H., Rheingans, P. and Yoo, T.S. (2006), "NIH-NSF visualization research challenges report summary", *IEEE Computer Graphics and Applications*, Vol. 26 No. 2, pp. 20-24, doi: 10.1109/MCG.2006.44.

Mutsonziwa, K. and Fanta, A. (2019), "Over-indebtedness and its welfare effect on households: evidence from the Southern African countries", *African Journal of Economic and Management Studies*, Vol. 10 No. 2, pp. 185-197, doi: 10.1108/AJEMS-04-2018-0105.

Nayak, J.G., Hartzler, A.L., Macleod, L.C., Izard, J.P., Dalkin, B.M. and Gore, J.L. (2016), "Relevance of graph literacy in the development of patient-centered communication tools", *Patient Education and Counseling*, Vol. 99 No. 3, pp. 448-454, doi: 10.1016/j.pec.2015.09.009.

Nicolini, G., Cude, B.J. and Chatterjee, S. (2013), "Financial literacy: a comparative study across four countries", *International Journal of Consumer Studies*, Vol. 37 No. 6, pp. 689-705, doi: 10.1111/ijcs.12050.

Okan, Y., Garcia-Retamero, R., Cokely, E.T. and Maldonado, A. (2012a), "Individual differences in graph literacy: overcoming denominator neglect in risk comprehension", *Journal of Behavioral Decision Making*, Vol. 25 No. 4, pp. 390-401, doi: 10.1002/bdm.751.

Okan, Y., Garcia-Retamero, R., Galesic, M. and Cokely, E.T. (2012b), "When higher bars are not larger quantities: on individual differences in the use of spatial information in graph comprehension", *Spatial Cognition and Computation*, Vol. 12 Nos 2/3, pp. 195-218, doi: 10.1080/13875868.2012.659302.

Paivio, A. (1990), *Mental Representations: A Dual Coding Approach*, Oxford University Press, Oxford.

Perdana, A., Robb, A. and Rohde, F. (2018), "Does visualization matter? The role of interactive data visualization to make sense of information", *Australasian Journal of Information Systems*, Vol. 22, doi: 10.3127/ajis.v22i0.1681.

Porzak, R., Cwynar, A. and Cwynar, W. (2021), "Improving debt literacy by 2/3 through four simple infographics requires numeracy and not focusing on negatives of debt", *Frontiers in Psychology*, Vol. 12, p. 621312, doi: 10.3389/fpsyg.2021.621312.

Potrich, A.C.G., Vieira, K.M. and Kirch, G. (2015), "Determinants of financial literacy: analysis of the influence of socioeconomic and demographic variables", *Revista Contabilidade and Finanças*, Vol. 26 No. 69, pp. 362-377, doi: 10.1590/1808-057x201501040.

Raghubir, P. and Das, S.R. (2010), "The long and short of it: why are stocks with shorter runs preferred?" *Journal of Consumer Research*, Vol. 36 No. 6, pp. 964-982, doi: 10.1086/644762.

Rha, J.Y., Montalto, C.P. and Hanna, S.D. (2006), "The effect of self-control mechanisms on household saving behavior", *Journal of Financial Counseling and Planning*, Vol. 17, pp. 3-16.

Sekita, S., Kakkar, V. and Ogaki, M. (2022), "Wealth, financial literacy and behavioral biases in Japan: the effects of various types of financial literacy", *Journal of the Japanese and International Economies*, Vol. 64, p. 101190, doi: 10.1016/j.jjie.2021.101190.

Sivaramakrishnan, S., Srivastava, M. and Rastogi, A. (2017), "Attitudinal factors, financial literacy, and stock market participation", *International Journal of Bank Marketing*, Vol. 35 No. 5, pp. 818-841, doi: 10.1108/IJBM-01-2016-0012.

Spiegelhalter, D., Pearson, M. and Short, I. (2011), "Visualizing uncertainty about the future", *Science*, Vol. 333 No. 6048, pp. 1393-1400, doi: 10.1126/science.1191181.

Suwa, M. and Tversky, B. (2002), *External Representations Contribute to the Dynamic Construction of Ideas*, Springer, pp. 341-343, doi: 10.1007/3-540-46037-3_33.

Tang, F., Hess, T.J., Valacich, J.S. and Sweeney, J.T. (2014), "The effects of visualization and interactivity on calibration in financial decision-making", *Behavioral Research in Accounting*, Vol. 26 No. 1, pp. 25-58, doi: 10.2308/bria-50589.

Tversky, B. (2001), "Spatial schemas in depictions", *Spatial Schemas and Abstract Thought*, Vol. 79, p. 111, doi: 10.7551/mitpress/6392.003.0006.

van Ooijen, R. and van Rooij, M.C.J. (2016), "Mortgage risks, debt literacy and financial advice", *Journal of Banking and Finance*, Vol. 72, pp. 201-217, doi: 10.1016/j.jbankfin.2016.05.001.

Van Rooij, M., Lusardi, A. and Alessie, R. (2011), "Financial literacy and stock market participation", *Journal of Financial Economics*, Vol. 101 No. 2, pp. 449-472, doi: 10.1016/j.jfineco.2011.03.006.

van Weert, J.C., Alblas, M.C., van Dijk, L. and Jansen, J. (2021), "Preference for and understanding of graphs presenting health risk information: the role of age, health literacy, numeracy and graph literacy", *Patient Education and Counseling*, Vol. 104 No. 1, pp. 109-117, doi: 10.1016/j.pec.2020.06.031.

Vila, J. and Gomez, Y. (2016), "Extracting business information from graphs: an eye tracking experiment", *Journal of Business Research*, Vol. 69 No. 5, pp. 1741-1746, doi: 10.1016/j.jbusres.2015.10.048.

Vlaev, I., Chater, N. and Stewart, N. (2009), "Dimensionality of risk perception: Factors affecting consumer understanding and evaluation of financial risk", *Journal of Behavioral Finance*, Vol. 10 No. 3, pp. 158-181, doi: 10.1080/15427560903167720.

Volkov, A. and Laing, G. (2012), "Assessing the value of graphical presentations in financial reports", *Australasian Accounting, Business and Finance Journal*, Vol. 6 No. 3, pp. 85-108.

Walther, T. (2015), "Key investor documents and their consequences on investor behaviour", *Journal of Business Economics*, Vol. 85 No. 2, pp. 129-156, doi: 10.1007/s11573-014-0724-6.

Wang, D., Guo, D. and Zhang, H. (2017), "Spatial temporal data visualization in emergency management: a view from data-driven decision", Proceedings of the 3rd ACM SIGSPATIAL International Workshop on the Use of GIS in Emergency Management, pp. 1-7.

Weedige, S.S., Ouyang, H., Gao, Y. and Liu, Y. (2019), "Decision making in personal insurance: impact of insurance literacy", *Sustainability*, Vol. 11 No. 23, p. 6795, doi: 10.3390/su11236795.

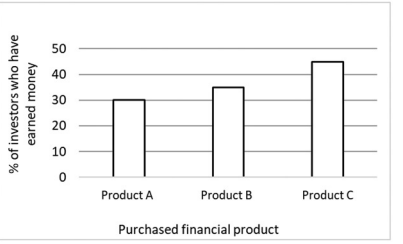
Zhang, L., Pentina, I. and Fan, Y. (2021), "Who do you choose? Comparing perceptions of human vs robo-advisor in the context of financial services", *Journal of Services Marketing*, Vol. 35 No. 5, pp. 634-646, doi: 10.1108/JSM-05-2020-0162.

Zipkin, D.A., Umscheid, C.A., Keating, N.L., Allen, E., Aung, K., Beyth, R., Kaatz, S., Mann, D.M., Sussman, J.B., Korenstein, D., Schardt, C., Nagi, A., Sloane, R. and Feldstein, D.A. (2014), "Evidence-based risk communication: a systematic review", *Annals of Internal Medicine*, Vol. 161 No. 4, pp. 270-280, doi: 10.7326/M14-0295.

Appendix

The Financial Graph Literacy Scale

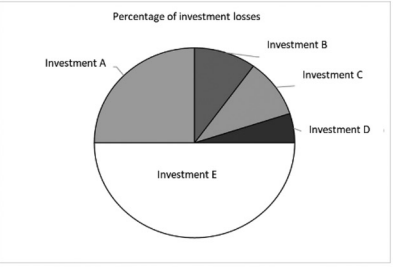
Here is some information on the earnings associated with certain financial products.



Q1. What percentage of investors have earned money with product B? _____%

Q2. What is the difference between the percentage of investors who earned money with Product C and the percentage of investors who earned money with Product A? _____%

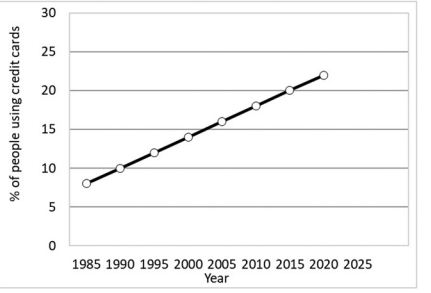
Below is some information on the losses suffered in the investments.



Q3. Of all the losses suffered in the investments, what is the approximate percentage of losses due to investment A? _____%

Q4. Approximately what percentage of losses is due to investments B, C and D overall? _____%

Below is some information on the use of credit cards.



Q5. Approximately what percentage of people used their credit card in 2015? _____%

Q6. In what period did credit cards' use increase the most?

From 1990 to 1995……1

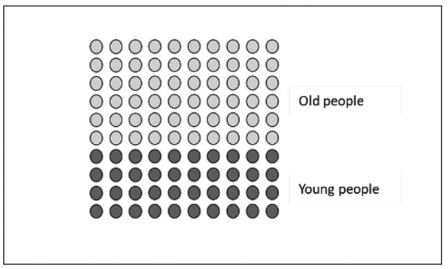
From 2015 to 2020……2

The increase was the same in both periods.....3

I don't know...…...…...4

Q7. In your opinion, what percentage of people will use their credit card in 2025? _____%

The image below shows the number of young and old people who have been victims of cyber scams using payment services.

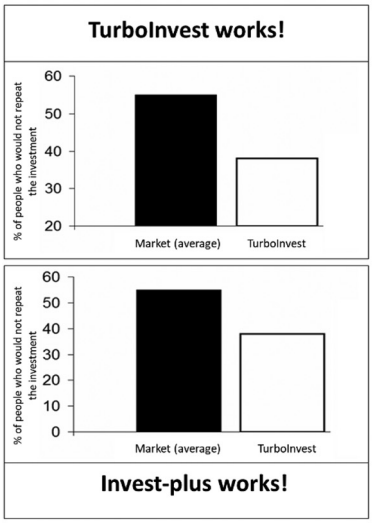


Q8. Out of 100 people who have been victims of cyber scams, how many are young?

_____ young people

Q9. Among the 100 people who are victims of cyber scams, how many more old people than young people are there?
_____ old people

Q10. In a financial newspaper you have found two advertisements, one on page 5, the other on page 12. Each of them is about an investment product and mentions the percentage of dissatisfied customers who would not repeat the investment.



Compared to the market average, which investment product registered a higher number of dissatisfied investors?

TurboInvest.....1

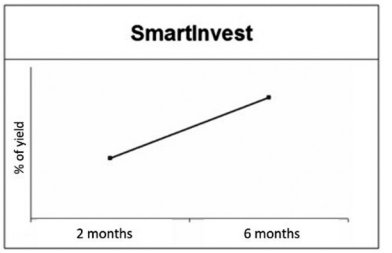
Invest-plus.....2

They achieved the same result……..3

I don't know.....…….4

QRFM

Q11. In a financial newspaper you have found two advertisements, one on page 14, the other on page 16. Each of them is about an investment product and mentions the percentage return registered 2 and 6 months after they were issued.



Which investment product lead to the best result?

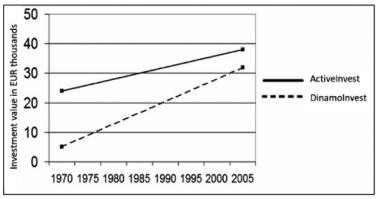
SmartInvest.....1

Profit+.....2

They achieved the same result……..3

I don't know…..……...4

Q12. Below is some information about two investment products.



Between 1980 and 1990, which investment achieved the greatest increase in investment value?

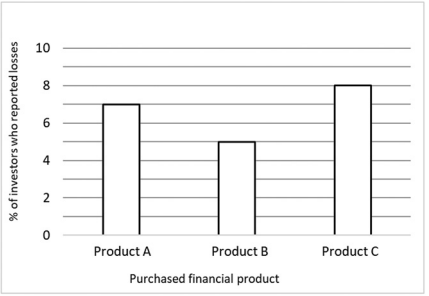
ActiveInvest 1

DinamoInvest.....2

They achieved the same result……..3

I don't know……....4

Here is some information on the earnings associated with some financial products.



Q13. What percentage of investors have reported losses with Product B? _____%

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