Reconciling Self-Assessed with Psychometric Risk Tolerance: A New Framework for Profiling Risk among Investors

RECONCILING SELF-ASSESSED WITH PSYCHOMETRIC RISK TOLERANCE: A NEW FRAMEWORK FOR PROFILING RISK AMONG INVESTORS

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ABSTRACT

Financial advisors need to assess their clients' risk profile to properly manage their portfolio risk and comply with regulatory provisions. Assessing an investor's financial risk tolerance (FRT) is a challenge in the advisory process and none of the existing measures can be easily employed on a large scale. Previous literature has revealed a gap between self-assessed and psychometrically assessed measures of FRT (PA_FRT) but has not yet offered a solution to fill this gap. Thus, we propose a model that consistently estimates the PA_FRT by leveraging retail investors' self-assessment and other information typically submitted in standard bank questionnaires. Our model represents a promising tool for financial advisors looking to improve their customers' risk profiling.

JEL Classification: C81, C83, D14, D81, D83, G11.

Keywords: financial risk tolerance; investment behavior; investor's preferences; psychometric measures; self-assessment

1. Introduction

Financial risk tolerance (FRT) is a critical variable in the decision-making of not only financial advisors, but also policymakers and financial product/service suppliers who must align customers' asset allocation and financial planning choices with their risk preferences[1]. Both academics and practitioners know that assessing an investor's financial risk tolerance (FRT) is one of the main problems in the advisory process. Scholars have proposed several types of financial risk tolerance measures (see Roszkowski and Grable, 2005 for a review) which can be broken down into observed portfolio risk, self-assessment and psychometric questionnaires, but they all feature drawbacks and limitations.

Self-assessed measures of FRT typically suffer from biased self-perceptions (Onkivisit and Shaw, 1987; Prince, 1993; Hira and Mugenda, 1999; Lucarelli, Uberti and Brighetti, 2015), although practitioners prefer them for their simplicity and availability. Psychometric FRT measures, instead, provide a more acceptable, valid, and reliable assessment of a person's willingness to take financial risks (Grable and Lytton, 1999, 2003; Weber, Blais and Betz, 2002; Hallahan et al., 2004; Grable, Lyons and Wookaje, 2019; Beer and Wellman, 2021; Grable, Heo and Rabbani, 2021), but they are hardly applicable in the industry. Although psychometric questionnaires (like the 13-item instrument from Grable and Lytton (1999) that we employ in this paper) are concise enough in isolation, they would be practically too burdensome if added

[1] Regulators in Europe and the US have introduced provisions in order to protect investors: Since 2004, the European Markets in Financial Instruments Directive (MiFID) have required investment banks offering financial advice to assess the suitability of retail investors' portfolios; likewise, since 2010, the US FINRA rule 2111 states that investment firms and their associated persons must have a reasonable basis to believe that a recommended transaction or investment strategy involving securities is suitable for the customer. Assessing a client's risk profile is therefore a challenge that financial advisors must tackle in their daily activity, both to provide clients with high-quality services and to be compliant with regulatory provisions.

to the suitability questionnaires that regulation (e.g., MiFID 1&2 in the European Union countries) requires of financial advisors and intermediaries. A recent study from the Italian Financial Market Authority (Consob, 2022) reported that the number of questions in MiFID suitability questionnaires ranges from 21 to 66. Any further increase in the number of questions would need to be carefully considered to avoid exhausting surveys and unreliable results (see Jeong et al., 2023). Consob (2022) also found that the risk preference section of the MiFID questionnaires usually comprises a single question (often a self-assessment of one's risk tolerance); thus, there is room to improve customers' risk profiling in a way that is still time-efficient. However, none of the Financial Authorities in Europe or the US have provided clear guidelines for FRT assessment, outside of a recent revision of the MiFID (effective since 2018) that stressed the importance of correctly assessing clients' FRT in profiling questionnaires. Moreover, the ESMA (2022) noted the unreliability of self-assessed FRT[2] and portfolio risk[3] as standalone measures. As a result, investment firms employ different questionnaires – and then different algorithms – to assess their clients' FRT, giving rise to various approaches that are not externally validated and still rooted in poor practices (Consob, 2022).

While the previous literature has compared and contrasted psychometric vs self-assessed measures of FRT (Hallahan et al., 2004; Moreschi, 2005; Frey et al., 2017; Marinelli et al.,

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[2] ESMA (2022), Guidelines on certain aspects of the MiFID II suitability requirements. Paragraph 48: "*When assessing the risk tolerance of their clients through a questionnaire, firms should not only investigate the desirable risk-return characteristics of future investments, but they should also take into account the client's risk perception. To this end, whilst self-assessment for the risk tolerance should be avoided, explicit questions on the clients' personal choices in case of risk uncertainty could be presented. Furthermore, firms could for example make use of graphs, specific percentages or concrete figures when asking the client how he would react when the value of his portfolio decreases*".

[3] ESMA (2022) identifies "*Defining a client's risk tolerance solely based on the composition of such client's existing portfolio*" as a poor practice, see page 72.

2017; Grable et al., 2020), we make a step forward by translating those pros and cons into a tool that combines the timeliness of the self-assessed FRT (which is needed for the applicability in the industry) with the reliability and validity of psychometric tools. In other words, we leverage the correlation between self-assessed and psychometric FRT (62.7%) to develop a model that uses data on the former (which investors typically provide in risk profiling questionnaires) to estimate the latter, which is a more valid estimate of investors' FRT (Grable et al., 2020). Our psychometric-based estimation model provides a half-way solution by supplementing self-assessed FRT with a subgroup of G&L (1999) questions. This method can improve the risk-profiling quality without making the questionnaire too burdensome. The model demonstrates an excellent out-of-sample performance by using a set of questions and information that is parsimonious while still being sufficiently predictive. With this tool, financial advisors can better assess their clients' risk profile.

The remainder of this paper is organized as follows: In Section 2 we present the related literature; in Section 3 we introduce our sample and methodology; in Section 4 we discuss the obtained results, while Section 5 concludes.

2. Conceptual framework

2.1 The puzzle of risk profiling

As previously outlined, assessing an investor's financial risk tolerance is a difficult but necessary step in the advisory process.

The past literature had widely employed observed portfolio risk measures of FRT, while acknowledging their limitations. Such measures range from the ratio of risky assets to net investments (Schooley and Worden, 1996; Chang et al., 2004; Martin, 2011; Weber et al., 2013; Ehm et al., 2014), to the Value at Risk (VaR), which emphasizes the investment risk undertaken by the subject without needing to subjectively classify assets as risky versus non-risky (Marinelli et al., 2017). While these measures provide a proxy of FRT in terms of individuals'

actions in the natural environment in which they occur (Blume and Frien, 1975; Morin and Suarez, 1983; Schooley and Worden, 1996; Dorn and Huberman, 2005, 2010), they have several shortcomings: Risk-taking behaviors can be biased by financial constraints, investment goals, and the influence of the financial advisor or other people (Schoemaker, 1993; Foerster et al., 2017; Marinelli, Mazzoli and Palmucci, 2017). Furthermore, the lack of financial literacy that typically characterizes retail investors might prevent them from being fully aware of their portfolio's composition and associated risk (Guiso and Iappelli, 2005). Moreover, investment risk tolerance is critically related to portfolio risk, but the positive association between the two is moderated by investors' level of confidence in their financial knowledge (Yao and Rabbani, 2021).

Past literature has also used different types of FRT self-assessment. The most used example is the Federal Reserve Board's Survey of Consumer Finances (US SCF) question on risk appetite, which has been employed in many studies as the subjective measure of FRT (see among others, Sung and Hanna, 1996; Chaulk, Johnson and Bulcroft, 2003; Jianakoplos and Bernasek, 2006; Martin, 2011; Yao, Sharpe and Wang, 2011). Alternatively, Kapteyn and Teppa (2002) used the answers to the self-assessed risk question in the questionnaire submitted to the panel of CentERdata in the Netherlands; Dohmen, Falk, Huffman, and Sunde (2009) utilized the German Socioeconomic Panel for the same purpose. Roszkowski and Grable (2005) employed clients' self-ratings to test the degree of accuracy that financial advisors and clients have in estimating risk tolerance.

Financial planners and advisors frequently consider a client's self-assessed risk willingness when recommending investments; however, these self-assessed measures of FRT have been widely criticized. Some authors (Bonoma and Schlenker, 1978; Culter, 1995; Roszkowski, Davey, and Grable, 2005) have noted that the multidimensional nature of FRT should not, and possibly cannot, be measured by a single question. Moreover, self-assessed measures have

questionable reliability (Grable and Schumm, 2010): cognitive biases, inattention, social desirability, and strategic motives might induce respondents to distort their reported risk attitude (for a discussion, see Bertrand and Mullainathan, 2001). Self-perception have also been found to distort self-reported measures and thus need to be considered (Onkivisit and Shaw, 1987; Prince, 1993; Hira and Mugenda, 1999; Lucarelli, Uberti and Brighetti, 2015; Frey et al., 2017). Despite the aforementioned limitations, practitioners often rely on self-assessed FRT measures due to their simplicity and availability.

Psychometric measures, instead, provide a more valid and reliable assessment of a person's financial risk tolerance (Barsky, Juster, Kimball and Shapiro, 1997; Grable and Lytton, 1999, 2003; Weber, Blais and Betz, 2002; Hallahan et al., 2004; Rabbani and Grable, 2021). Such tools utilize intuitive questions that investors can answer more easily (Peters et al., 2006) and provide a measure of FRT that is stable over time (Van de Venter, Michayluk and Davey, 2012) and invariant to a subject's expectations about future outcomes (Nosic and Weber, 2007).

Scholars have proposed different psychometric questionnaires, but only a few have achieved wide application. Perhaps the most notable of these is the 13-item scale developed by Grable and Lytton (1999). Based on an initial 20-items questionnaire, it was reduced to 13 items following a component factor analysis which resulted in a refined version of the tool with a Cronbach alpha coefficient of 0.75, which indicated that the scale has a high level of internal reliability (Gilliam et al., 2010). A similar tool is the Survey of Financial Risk Tolerance (SOFRT), developed by Roszkowski and Grable (2005), which consists of 51 items that cover both cognitive and affective reactions to risk, alongside household and personal income information. Another widely employed psychometric questionnaire is FinaMetrica Ltd.'s Personal Financial Profiling system, which is a proprietary and commercial FRT metric featuring 25 validated questions. Despite their validity and reliability, psychometric questionnaires are hardly employed in the industry due to the concerns about making standard

risk profiling and suitability questionnaires too burdensome (see the discussion in the previous section).

2.2 (In)consistency between financial risk tolerance measures

The past literature has analyzed the relationships between the self-assessed FRT and the portfolio's risk, on the one hand, and between the self-assessed and psychometric measures of the FRT, on the other. On the first topic, some scholars have investigated the extent to which self-assessed financial risk tolerance coherently relates to investors' portfolio choices, but have often reached mixed results. Schooley and Worden (1996) analyzed the answers from the US Survey of Consumer Finance (SCF)—specifically comparing the reported willingness to take financial risk with the riskiness of household portfolios (proportion of risky assets)—and found coherence between both factors. Starting from a different perspective, Khan, Tan and Chong (2017) showed that past portfolio choices—and the subsequent past portfolio returns—might affect people's self-assessment of their risk attitude. However, Jianakoplos (2002) (using the same US SCF database) and Hermansson (2018) (in a sample of customers from a Swedish bank) reported only a weak relation between self-assessed FRT and risk-taking behavior. Exploring the nature of this gap, Marinelli et al. (2017) found that the inconsistency between self-assessed FRT and portfolio risk most often stems from the former being inconsistently translated into portfolio choices.

The second branch of the literature has explored the relationship between psychometric and self-assessed FRT measures, finding that they are somehow correlated. Hallahan et al. (2004) and Moreschi (2005) both compared the psychometric measure from the Pro-Quest questionnaire with a self-assessment FRT. Both sets of authors found that the correlation between measures is high (up to 79.2% in Hallahan, 2004), even if only a small portion of investors can correctly estimate their FRT (with many usually overestimating it). Moreover,

Moreschi (2005) provided evidence that demographic characteristics explain respondents' bias in self-assessing their own risk tolerance. More recently, Frey et al. (2017) revealed the existence of a gap between stated and psychometrically revealed preferences, suggesting that the former cannot be used to capture risk preferences. Similarly, Grable et al. (2020) compared and contrasted the concurrent, convergent, and predictive validity of a variety of risk tolerance tests and questionnaires, revealing a 44% correlation between psychometric and self-assessed FRT measures; they also demonstrated a superiority of psychometric tests. Finally, Rabbani and Grable (2021) analyzed the relationship between self-assessment bias and portfolio risk, finding that investors who underestimate their financial risk tolerance held portfolios that are less risky than those who are able to match their self-assessed risk tolerance to their psychometric score, but the opposite is not true for those overestimating their FRT.

3. Data and methodology

We performed our analysis on a sample of 2,348 investor clients of a large Italian bank[4]. In contacting these individuals, we asked them to fill in a questionnaire containing: a single question for the self-assessment of their FRT, the Grable and Lytton (1999) (G&L) questionnaire to score the client's FRT, other questions about the client's economic and financial situation, as well as some socio-demographic variables. In addition to this, the bank data warehouse provided us with information regarding portfolio characteristics, further socio-economic information, and all the answers included in the MiFID questionnaire.

Indeed, the two core variables of our empirical analysis are the self-assessed FRT (SA_FRT) and the score obtained by clients in the psychometrically assessed FRT (G&L questionnaire)

[4] The sampling was specifically aimed at ensuring that the overall sample was representative of the entire population of the bank's customers in terms of socio-demographic characteristics (geographical areas/cities, age), risk profile and financial knowledge. As we refer to a big Italian bank that serves many customers across Italy, our final sample should be representative of Italian retail investors.

(PA_FRT)[5]. Our goal is to use the former to estimate the latter, which scholars believe to be more representative of the investor's willingness to engage in a risky financial behavior (Grable et al., 2020). The Cronbach's Alpha of the G&L Questionnaire is 0.814 (higher than the 0.751 in G&L1999). Table 1 shows the descriptive statistics of these variables and of their gap (SA_FRT – PA_FRT). The self-assessed FRT (SA_FRT) is, on average, higher than the psychometrically assessed FRT (PA_FRT): The average (median) gap is 0.95 (1), which represents the extent of the overestimation. The gap is positive in 76% of cases, but the high correlation between the two measures (62.7%) suggests a grounding premise for our analysis. On the contrary, investors' portfolio risk (as measured in our dataset by the Value at Risk normalized in a 0-10 scale) was poorly correlated with both measures: 29.7% for SA_FRT and 29% for PA_FRT. This confirms the doubts in the literature, outlined in section 2.2, about portfolio risk being a reliable measure of investors' FRT.

[INSERT TABLE 1 AROUND HERE]

Regardless of how investor risk aversion is assessed, the past literature maintains a relatively high consensus on which investor characteristics explain financial risk tolerance (see Grable, 2020 for a recent and thorough review). Based on this literature, the variables that we selected in our database can be divided into five groups (a full explanation for each variable is presented in Table A1 in the Appendix): *Financial Literacy (FL), Social Factors (SF), Investing Behavior (IB), Investor's Preferences (IP),* and *Financial Situation (FS)*.

Financial Literacy variables are all taken from the MiFID questionnaire (and then self-reported by the client) except for *Financial Comprehension*, which is the score derived from two questions that we added to reveal the client's understanding of the basics of investing. The

[5] The PA_FRT score has been reparametrized in the scale from 0 to 10 to be comparable with the SA_FRT.

Social Factors and *Investing Behavior* variables are all taken from the bank's client database, except for the *financial advisor* question, which was valued at 1 if the investor relied on the bank's advisor when making investment decisions and zero otherwise. The *Investor's Preferences* and *Financial Situation* variables are all taken from the MiFID questionnaire, where they are mandatory dimensions. *Investor's Preferences* can be ascertained through two questions: the reason for investing ("*Investments for*") and how long the investment could be kept before being liquidated ("*Illiquidity Preference*").

[INSERT TABLE 2 AROUND HERE]

Table 2 shows the descriptive statistics of our sample, which likely represents the population of clients who receive advisory services from Italian banks. Our sample is quite old (63 years old on average and 51.4% are retired) and characterized by a medium-low level of formal education, even if they claim to read the financial press and have a medium-high level of knowledge regarding their investments. Most of the customer relationships in our sample are long-term, with 48% claiming that they delegate investment decisions to the bank's financial advisor. Meanwhile, 57.9% claim that they invest to profit from speculation and are willing to immobilize investments for more than six years on average. This might suggest a possible overestimation of people's risk tolerance, which would be consistent with the positive difference (on average) between the SA_FRT and PA_FRT (see Table 1).

Our main analysis is represented by equation [1], which consists of a model explaining the PA_FRT starting from the SA_FRT.

$$PA\_FRT_i = c + (\gamma_{SA\_FRT} \cdot SA\_FRT_i) + (\gamma_{FL} \cdot FL)_i + (\gamma_{SF} \cdot SF_i) + (\gamma_{IB} \cdot IB_i) + (\gamma_{IP} \cdot IP_i) + (\gamma_{FS} \cdot FS_i) + \epsilon_i \quad [1]$$

where γ_Z is the vector of coefficients of the explanatory variables in each Z set of variables, with Z ∈ [FL, SF, IB, IP, FS].

The set of explanatory variables in [1] is taken from those commonly used in the previous literature as determinants of investors' financial risk tolerance (see Grable, 2020, for a recent and thorough review). Table A3 in the Appendix provides a complete set of tests on their explicative power. We further strengthened our results by testing the predictive power of our model out of sample (bottom of Table 3).

The final goal of this paper is to provide financial advisors with a reliable and usable tool for easily predicting their clients' risk tolerance. Thus, we show the practical usability of our model by testing its predictive power on a further simplified model, where we employ the significant variables in Table 3 (equation [1]) and use them with SA_FRT and up to five items from the G&L questionnaire (introduced in the order suggested by the maximization of the model's R-squared) to predict the observed PA_FRT score (equation [2], Table 4).

$$PA\_FRT_i = c + (\gamma_{SA\_FRT} \cdot SA\_FRT_i) + (\gamma_{GLQ} \cdot GLQ_i) + (\gamma_{CONTROLS} \cdot CONTROLS_i) + \epsilon_i \quad [2]$$

where GLQ identifies the sub-set of questions from the Grable and Lytton (2003) questionnaire and CONTROLS encompass the significant control variables in equation [1]. The out-of-sample results can be found at the bottom of Table 4.

Our methodology clearly presents endogeneity issues: We make use of selected questions from the Grable and Lytton (1999) questionnaire to explain the PA_FRT, which is computed with the same items[6]. Indeed, we are intentionally cherry-picking questions because ours is not

[6] While our model presents endogeneity, we want to note that the literature on questionnaires commonly applies this kind of methodology to find the best set of items: The same G&L1999 that we employed in our paper used this method to reduce its original 100 items to 13. What we try to show in Table 4 is that, thanks to other information that the bank has including the SA_FRT, even just having a few of those 13 items we can produce a powerful model.

a predictive, but rather an applicative model to be employed out of sample, where we substitute the whole G&L questionnaire with a few items. In other words, our intention is not to find a new way to estimate the PA_FRT, but to give financial advisors and investment firms an easy way to reliably estimate their clients' FRT that leverages tools and data they commonly have on hand.

4. Empirical results

Table 3 shows the empirical estimation of equation [1]: The explanatory power of the model is quite high and equal to 44.9%. When we remove unnecessary variables (which do not help the fit of the model and possibly give rise to multicollinearity[7]), the model's explanatory power reduces slightly to 44.2%.

[INSERT TABLE 3 AROUND HERE]

In particular, the results in Table 3 (for the parsimonious model) show that financial literacy variables (all with positive coefficients) suggest an upward correction of the PA_FRT. Such a result is consistent with previous literature maintaining that financial risk tolerance increases with financial literacy (Van Rooij et al., 2011; Bannier and Neubert, 2016; Dimmock et al., 2016; and more recently Hermansson and Jonsson, 2021). The same upward correction is suggested for being male, consistent with the prevailing argument that men tend to be more risk tolerant than women (Guiso et al., 1996; Sung and Hanna, 1996; Powell and Ansic, 1997; Grable, 2000; Yao and Hanna, 2004; Brooks and Williams, 2021). Income is another variable that increases risk tolerance, as previously suggested by other authors (Schooley and Worden, 1996; Grable, 2000; Yook and Everett, 2003; Chang et al., 2004; Hallahan et al., 2004; Fan and

[7] In order to obtain a parsimonious model, we performed a stepwise regression with a p-value threshold for inclusion of 0.05.

Xiao, 2006). We also found a suggested upward correction based on the less investigated debt variable, indicating that more indebted investors tend to be more risk tolerant.

Age is the only variable that suggests a negative correction to the PA_FRT, which aligns with evidence of an inverse relationship between increasing age and risk tolerance (Yao and Hanna, 2004; Fan and Xiao, 2006). More specifically, the relationship between age and risk tolerance is not necessarily linear, as suggested by Hallahan et al. (2004), Grable et al. (2006), and Faff et al. (2009), and recently confirmed by Lippi and Rossi (2021).

At the bottom of Table 3, we provide the results of the cross-validation methodology. We used a subsample (25%) to estimate the model, and then used the holdout sample (the remaining 75% observations) to verify if the estimated PA_FRT is still able to explain the observed one. The R-squared obtained out-of-sample (43.4% versus 44.2% of the full model) confirmed our model's high predictive ability.

Table 4 shows the results for equation [2]. The SA_FRT alone (with control variables) accounted for up to 44.2% in explaining the PA_FRT; this percentage rose to 59.7% by adding a question on different combinations of profit and losses (question n.8 in the G&L questionnaire); up to 71% with the question involving the concept of certainty equivalent (n.9), and up to 77.6% with the question relating the word 'risk' to different investor emotions (n.6). Adding questions n.11 and n.3 from the G&L questionnaire increased the model's explicative power to 86.1%.

[INSERT TABLE 4 HERE]

At the bottom of Table 4, we provide the results from a K-fold cross validation test: The high R-squared obtained in this test is a further confirmation of our model's high predictive ability. Figure 1 graphically represents the behavior of the R-squared of our model when adding

an increasing number of G&L questions[8], until we saturate the model by including all G&L items and reaching the R-squared of 100%.

[INSERT FIGURE 1 AROUND HERE]

Ultimately, financial advisory firms may leverage our findings in the following way: They can first estimate a model, as in equation [1] (like the parsimonious one in Table 3), on a subsample of their clients by asking them to fill out a full psychometric questionnaire. Next, they can use the estimated model to calculate the PA_FRT of the whole population of their clients. To improve the applicability of the model, they could pose a few psychometric questions to all of their clients (as in Table 4). In summary, our model's good out-of-sample performance suggests that using a small number of G&L items can produce a reliable estimation of the FRT_PA.

5. Conclusions

In this paper, we highlighted the limitations of using self-assessed and portfolio-based measures to assess investors' FRT. On that basis, we proposed a psychometric-based framework where investors' self-assessment can be used to produce an accurate estimation of their actual FRT.

Thanks to the high explanatory power of our model, we provide financial advisors with new insights on how to gauge their clients' FRT. With our findings, firms can leverage the information gleaned from standard risk profiling questionnaires - commonly a part of regulatory compliance (e.g., MiFID in EU countries) - to design more practical tools for estimating a client's FRT. First, our proposed methodology can help enhance the quality of financial

[8] The items from the Grable and Lytton (1999) questionnaire are added in the sequential order for maximizing the R-squared of the model.

advisory services, especially considering the poor observed correlation between PA_FRT and the actual portfolio risk. Second, our methodology could support firms' regulatory compliance in countries where risk profiling is mandatory. Finally, we want to note that our framework is not necessarily limited to Grable and Lytton's (1999) questionnaire: Practitioners could achieve similar results with any other validated psychometric questionnaire.

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Table 1 – Descriptive statistics of dependent variables

This table shows the descriptive statistics of each of the dependent variable employed in the model. SA_FRT is the "Self-Assessed Financial Risk Tolerance"; PA_FRT is the psychometrically assessed (Grable and Lytton questionnaire) Financial Risk Tolerance"; the Gap is the difference between SA_FRT and PA_FRT. Portfolio Risk is measured by the Value at Risk normalized in a 0-10 scale. The detailed explanation for all dependent variables is provided in the Appendix (Table A1).

	Obs.	Min	Mean	Median	Max	Std. Dev.
SA_FRT	2348	0	4.341	4	10	1.666
PA_FRT	2348	0	3.391	3.226	10	1.814
SA_FRT - PA_FRT Gap	2348	-2.839	0.952	1	4.677	1.475
SA_FRT - PA_FRT Gap Size (abs value)	2348	0.065	1.429	1.161	4.677	1.040
Portfolio Risk	2348	0	4.482	4.463	8.041	0.925
Correlation SA_FRT – PA_FRT	0.627					
Correlation SA_FRT – Portfolio Risk	0.297					
Correlation PA_FRT – Portfolio Risk	0.290					

Table 2 – Descriptive statistics of explanatory variables divided into 5 groups.

This table shows the descriptive statistics of each of the explanatory variables employed in the model. Correlations with SA_FRT (Self-Assessed Financial Risk Tolerance), PA_FRT (psychometrically assessed (Grable and Lytton questionnaire) Financial Risk Tolerance) and their Gap (difference between SA_FRT and PA_FRT) ares also reported. The detailed explanation of all explanatory variables is provided in the Appendix (Table A1).

	Obs.	Min	Mean	Median	Max	Std. Dev.	Correlation with SA_FRT	Correlation with PA_FRT
Financial Comprehension	2348	0	1.468	2	2	0.721	0.124***	0.157***
Experience	2348	0	0.358	0.34	1	0.17	0.221***	0.241***
Knowledge	2348	0.044	0.51	0.491	1	0.14	0.318***	0.308***
Education	2348	1	1.873	2	4	0.782	0.175***	0.223***
Financial Studies	2348	0	0.088	0	1	0.283	0.152***	0.154***
Financial Practice	2348	0	0.091	0	1	0.288	0.162***	0.142***
Financial Press	2348	0	0.672	1	1	0.469	0.144***	0.138***
Gender	2348	0	0.6	1	1	0.49	0.143***	0.151***
Age	2348	22	62.963	64	99	13.093	-0.206***	-0.265***
Family	2348	0	0.277	0	1	0.448	0.059***	0.057***
Retired	2348	0	0.514	1	1	0.5	-0.194***	-0.238***
Recent investments (amount)	2348	0	1.883	2	4	0.815	0.022	0.055***
Recent investments (number)	2348	0	1.343	1	3	0.755	0.199***	0.191***
Number of financial assets in Ptf	2348	1	11.557	9	35	8.377	0.216***	0.186***
Ptf Value (log)	2348	7.77	12.07	11.99	15.83	0.73	0.019	-0.006
Financial Advisor	2348	0	0.48	0	1	0.5	-0.032	-0.017
Customer relationship	2348	1	4.567	5	5	0.683	-0.016	-0.05**
Investments for Income	2348	0	0.756	1	1	0.43	-0.232***	-0.188***
Investments for Speculation	2348	0	0.579	1	1	0.494	0.197***	0.188***

Investments for Insurance	2348	0	0.024	0	1	0.154	-0.018	-0.036*
Illiquidity Preference	2348	1	6.019	5.8	12	1.937	0.217***	0.198***
Income level	2348	1	2.072	2	4	0.716	0.174***	0.236***
Saving capacity	2348	1	1.734	2	3	0.637	0.118***	0.141***
Total financial assets	2348	0	2.25	2	4	0.615	0.063***	0.034*
Financial Liabilities	2348	0	0.085	0	2	0.292	0.131***	0.174***

Table 3 – PA_FRT model

This table shows the results of the PA_FRT explanatory models (Equation 1, full model and parsimonious). The detailed explanation of all dependent and explanatory variables is provided in the Appendix (Table A1). The parsimonious model has been obtained with a stepwise regression estimation with a p-value threshold for inclusion equal to 0.05.

	Full Model		Parsimonious Model	
SA_FRT	0.574***	(27.558)	0.593***	(30.578)
Financial Comprehension	0.127***	(3.042)	0.133***	(3.196)
Experience	0.593***	(2.886)	0.954***	(5.403)
Knowledge	0.428	(1.595)		
Education	0.096**	(2.330)	0.111***	(2.713)
Financial Studies	0.120	(1.136)		
Financial Practice	-0.168	(-1.477)		
Financial Press	0.047	(0.759)		
Gender	0.204***	(3.367)	0.187***	(3.121)
Age	-0.010	(-0.536)	-0.015***	(-6.137)
Age2	-0.000	(-0.052)		
Family	0.034	(0.521)		
Retired	-0.052	(-0.605)		
Recent investments (amount)	0.073	(1.630)		
Recent investments (number)	-0.006	(-0.118)		
Number of financial assets in ptf	0.013***	(2.722)		
Ptf Value (log)	-0.132**	(-2.398)		
Financial Advisor	0.050	(0.854)		
Customer relationship	-0.030	(-0.686)		
Investments for Income	0.034	(0.468)		
Investments for Speculation	0.098	(1.538)		
Investments for Insurance	-0.259	(-1.508)		
Illiquidity Preference	0.012	(0.734)		
Income level	0.168***	(3.259)	0.164***	(3.552)
Saving capacity	-0.006	(-0.106)		
Total financial assets	-0.037	(-0.632)		
Financial Liabilities	0.339***	(3.151)	0.350***	(3.359)
Constant	1.622*	(1.931)	0.513**	(2.274)
Observations	2,348		2,348	
R-squared	0.449		0.442	
R-squared Out-of-Sample	0.445		0.434	

R-squared out-of-sample refers to the average R-square obtained in 100 random sample draws (split: 75:25%, i.e. 1761:587 observations).
****, **, * denote statistical significance at 1%, 5%, and 10% respectively. T-Statistics are reported in parentheses.*

Table 4 – PA_FRT model with SA_FRT and endogenous Grable and Lytton questions

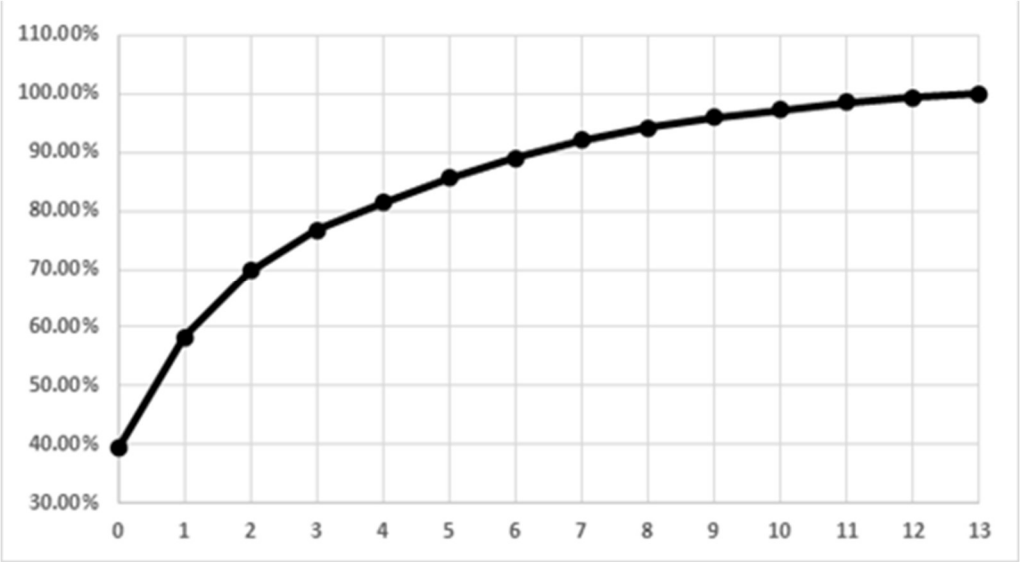
This table shows the results of the PA_FRT estimation models. Model from (3) to (6) show results depending on the number of G&L (1999) items included. A detailed explanation of all the dependent and the other explanatory variables is provided in the Appendix (Table A1). .

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
SA_FRT		0.593***	0.415***	0.341***	0.267***	0.223***	0.206***
		30.578	23.108	22.394	19.614	18.225	18.576
Financial Comprehension	0.206***	0.133***	0.073**	0.064**	0.058**	0.039*	0.036*
	4.267	3.196	2.120	2.178	2.311	1.734	1.806
Experience	1.609***	0.954***	0.520***	0.497***	0.527***	0.465***	0.421***
	7.661	5.403	3.470	3.838	4.661	4.690	4.797
Education	0.198***	0.111***	0.041	0.070**	0.074***	0.062***	0.028
	3.964	2.713	1.151	2.334	2.854	2.680	1.360
Age	-0.026***	-0.015***	-0.009***	-0.009***	-0.007***	-0.005***	-0.002*
	-9.408	-6.137	-4.506	-5.187	-4.518	-3.861	-1.678
Gender	0.356***	0.187***	0.073	0.072*	0.058	0.045	0.069**
	5.127	3.121	1.440	1.663	1.542	1.324	2.278
Income Level	0.187***	0.164***	0.116***	0.079**	0.052*	0.056**	0.072***
	3.384	3.552	2.894	2.323	1.779	2.160	3.105
Financial Liabilities	0.543***	0.350***	0.190**	0.041	0.039	0.039	0.061
	4.100	3.359	2.145	0.550	0.583	0.658	1.153
Profits vs Losses (Item N. 8)			0.967***	0.792***	0.712***	0.660***	0.601***
			26.666	25.675	26.243	26.817	27.716
Certainty Equivalent Lottery (Item N. 9)				1.465***	1.339***	1.277***	1.179***
				29.565	30.570	32.649	33.959
Emotions (Item N. 6)					0.639***	0.599***	0.535***
					23.131	24.235	24.611
Heritage (Item N. 11)						0.449***	0.421***
						23.829	25.195
Job loss and planned trip (Item N. 3)							0.445***
							24.583
Constant	1.295***	0.513**	-0.460**	-1.608***	-2.328***	-2.759***	-3.216***
	4.313	2.274	-2.384	-9.491	-15.848	-21.274	-27.540
Observations	2,348	2,348	2,348	2,348	2,348	2,348	2,348
R-squared	0.224	0.442	0.597	0.710	0.776	0.821	0.861
R-squared Out-of-Sample	0.219	0.436	0.592	0.707	0.776	0.820	0.860

R-squared out-of-sample refers to the average R-square obtained in 100 random sample draws (split: 75:25, i.e. 1761:587 observations);
****, **, * denote statistical significance at 1%, 5%, and 10% respectively. T-Statistics are reported in parentheses.*

Figure 1 - PA_FRT estimation improvements with additional G&L (1999) items

The figure shows the estimation improvements, as measured by the R-square of the model in equation [3], obtained by adding an increasing number of items in the model.



APPENDIX

Table A1 – Explanation of dependent and explanatory variables

Variables	Explanation
SA_FRT	It is the "Self-Assessed Financial Risk Tolerance" and corresponds to the answer to the question: "On a scale from zero to ten, where zero is not at all willing to take risks and ten is very willing to take risks, what number would you be on the scale"
PA_FRT	It is the "Grable and Litton- Financial Risk Tolerance" and corresponds to the Score computed as suggested in Grable and Lytton (1999), parametrized on a scale from zero to ten.
Financial Comprehension	The score obtained by answering two right or wrong questions
Experience	The self-declared investment experience of investors
Knowledge	The self-declared investment knowledge of investors
Education	The educational level
Financial Studies	Dummy for past financial studies
Financial Practice	Dummy for past financial practice
Financial Press	Dummy for reading the financial press
Sex	Male or Female
Age	Age
Family	Dummy for having a family
Retired	Dummy for being retired
Recent investments (amount)	Five levels representing increasing values of recent investments
Recent investments (number)	Four levels representing increasing number of recent investments
Number of financial assets in Ptf	Number of financial assets in portfolio
Ptf Value (log)	Natural logarithm of the portfolio value
Financial Advisor	Dummy for investors declaring they rely on a financial advisor's recommendation in investment decisions.
Customer relationship	Five levels representing increasing ranges of customer relationship in years.
Investments for Income	Dummy for clients declaring they invest to increase their income
Investments for Speculation	Dummy for clients declaring they invest for speculative reasons
Investments for Insurance	Dummy for clients declaring they need insurance instruments
Illiquidity Preference	Represents the self-declared investment horizon's preference of the investor
Income level	Four levels representing increasing income levels
Saving capacity	Three levels representing increasing saving capacity levels
Total financial assets	Five levels representing increasing values of total financial assets
Financial Liabilities	Three levels representing increasing values of financial liabilities

Table A2 – Correlation Matrices within the five groups of explanatory variables

This table shows the correlation matrices within the groups variables: Financial Literacy (FL), Social Factors (SF), Investing Behavior (IB), Investor's Preferences (IP), and Financial Situation (FS).

	Financial Literacy	V1	V2	V3	V4	V5	V6
V1	Financial Comprehension	1					
V2	Experience	0.05	1				
		-0.010					
V3	Knowledge	0.11	0.42	1			
		0.000	0.000				
V4	Education	0.11	0.08	0.2710	1		
		0.000	0.000	0.000			
V5	Financial Studies	0.10	0.08	0.2970	0.2240	1	
		0.000	0.000	0.000	0.000		
V6	Financial Practice	0.10	0.09	0.4170	0.1670	0.3730	1
		0.000	0.000	0.000	0.000	0.000	
V7	Financial Press	0.03	0.08	0.1490	0.1540	0.0400	-0.0410
		-0.104	0.000	0.000	0.000	-0.053	-0.049
	Social Factors	V8	V9	V10	V11		
V8	Sex	1					
V9	Age	0.0150	1				
		-0.462					
V10	Age^2	0.0080	0.9920	1			
		-0.702	0.000				
V11	Family	0.0290	-0.1640	-0.1650	1		
		-0.160	0.000	0.000			
V12	Retired	0.0190	0.7090	0.7000	-0.1860		
		-0.350	0.000	0.000	0.000		

	Investing Behavior	V13	V14	V15	V16	V17
V13	Recent investments (amount)	1				
V14	Recent investments (number)	0.5140	1			
		0.000				
V15	Number of financial assets in Ptf	0.1120	0.3840	1		
		0.000	0.000			
V16	Portfolio Value (log)	0.3180	0.2700	0.5330	1	
		0.000	0.000	0.000		
V17	Financial Advisor	-0.0050	-0.0100	0.1340	0.0480	1
		-0.816	-0.621	0.000	-0.020	
V18	Customer relationship	0.0390	-0.0020	0.0910	0.0920	0.0020
		-0.057	-0.915	0.000	0.000	-0.941
	Investor's Preferences	V19	V20	V21		
V19	Investments for Income	1				
V20	Investments for Speculation	-0.4040	1			
		0.000				
V21	Investments for Insurance	-0.0460	0.0220	1		
		-0.027	-0.276			
V22	Illiquidity Preference	-0.1820	0.1840	0.0260		
		0.000	0.000	-0.201		
	Financial Situation	V23	V24	V25		
V23	Income level	1				
V24	Saving capacity	0.4700	1			
		0.000				
V25	Total financial assets	0.1890	0.2410	1		
		0.000	0.000			
V26	Financial Liabilities	0.1300	0.0020	-0.0940		
		0.000	-0.922	0.000		

Table A3 – Grable and Lytton FRT (PA_FRT) explained with Financial Literacy, Social Factors, Investing Behavior, Investor's Preferences, Financial Situation

This table shows the estimation of the model in Equation 1, as in Table 3, but using separately the groups of variables identified as independent variables.

	Financial Literacy		Social Factors		Investing Behavior		Investor's Preferences		Financial Situation		Full Model	
Financial Comprehension	0.272***	(5.420)									0.201***	(4.201)
Experience	1.498***	(6.449)									0.777***	(3.116)
Knowledge	2.222***	(6.937)									1.328***	(4.224)
Education	0.299***	(6.146)									0.145***	(2.846)
Financial Studies	0.286**	(2.278)									0.277**	(2.207)
Financial Practice	0.075	(0.560)									-0.082	(-0.624)
Financial Press	0.296***	(3.948)									0.169**	(2.317)
Sex			0.570***	(7.935)							0.414***	(5.933)
Age			0.031	(1.419)							0.011	(0.512)
Age2			-0.000***	(-2.730)							-0.000	(-1.257)
Family			-0.106	(-1.274)							-0.090	(-1.175)
Retired			-0.409***	(-3.879)							-0.189*	(-1.866)
Recent investments (amount)					0.016	(0.295)					0.038	(0.757)
Recent investments (number)					0.342***	(5.296)					0.054	(0.895)
Number of financial assets in ptf					0.049***	(8.825)					0.032***	(5.770)
Ptf Value (log)					-0.395***	(-6.311)					-0.271***	(-4.179)
Financial Advisor					-0.137*	(-1.879)					0.040	(0.581)
Customer relationship					-0.146***	(-2.594)					0.000	(0.008)
Investments for Income							-0.488***	(-5.028)			-0.170*	(-1.895)
Investments for Speculation							0.416***	(5.087)			0.179**	(2.382)
Investments for Insurance							-0.571**	(-2.206)			-0.374	(-1.587)
Illiquidity Preference							0.146***	(7.199)			0.049**	(2.471)
Income level									0.490***	(8.493)	0.147**	(2.409)
Saving capacity									0.140**	(2.154)	-0.009	(-0.155)
Total financial assets									-0.001	(-0.010)	0.027	(0.381)
Financial Liabilities									0.924***	(7.036)	0.499***	(3.729)
Constant	0.532***	(3.317)	3.261***	(4.827)	7.832***	(10.529)	2.652***	(16.128)	2.056***	(11.912)	3.879***	(3.948)
Observations	2,348		2,348		2,348		2,348		2,348		2,348	
R-squared	0.151		0.103		0.073		0.075		0.078		0.233	

The detailed explanation of all dependent and explanatory variables is provided in the Appendix.

****, **, * denote statistical significance at 1%, 5%, and 10% respectively. T-Statistics are reported in parentheses.*

ONLINE APPENDIX

Grable and Lytton (1999) Questionnaire:

1. In general, how would your best friend describe you as a risk taker?

    a. A real gambler

    b. Willing to take risks after completing adequate research

    c. Cautious

    d. A real risk avoider

2. You are on a TV game show and can choose one of the following, which would you take?

    a. $1,000 in cash

    b. A 50% chance at winning $5,000

    c. A 25% chance at winning $10,000

    d. A 5% chance at winning $100,000

3. You have just finished saving for a "once-in-a-lifetime" vacation. Three weeks before you plan to leave, you lose your job. You would:

    a. Cancel the vacation

    b. Take a much more modest vacation

    c. Go as scheduled, reasoning that you need the time to prepare for a job search

    d. Extend your vacation, because this might be your last chance to go first-class

4. If you unexpectedly received $20,000 to invest, what would you do?

    a. Deposit it in a bank account, money market account, or an insured CD

    b. Invest it in safe high quality bonds or bond mutual funds

    c. Invest it in stocks or stock mutual funds

5. In terms of experience, how comfortable are you investing in stocks or stock mutual funds?

    a. Not at all comfortable

    b. Somewhat comfortable

    c. Very comfortable

6. When you think of the word "risk," which of the following words comes to mind first?

    a. Loss

    b. Uncertainty

    c. Opportunity d. Thrill

7. Some experts are predicting prices of assets such as gold, jewels, collectibles, and real estate (hard assets) to increase in value; bond prices may fall, however, experts tend to agree that government bonds are relatively safe. Most of your investment assets are now in high interest government bonds. What would you do?

    a. Hold the bonds

    b. Sell the bonds, put half the proceeds into money market accounts, and the other half into hard assets

c. Sell the bonds and put the total proceeds into hard assets

d. Sell the bonds, put all the money into hard assets, and borrow additional money to buy more

8. Given the best and worst case returns of the four investment choices below, which would you prefer?

a. $200 gain best case; $0 gain/loss worst case

b. $800 gain best case; $200 loss worst case

c. $2,600 gain best case; $800 loss worst case

d. $4,800 gain best case; $2,400 loss worst case

9. In addition to whatever you own, you have been given $1,000. You are now asked to choose between:

a. A sure gain of $500

b. A 50% chance to gain $1,000 and a 50% chance to gain nothing

10. In addition to whatever you own, you have been given $2,000. You are now asked to choose between:

a. A sure loss of $500

b. A 50% chance to lose $1,000 and a 50% chance to lose nothing

11. Suppose a relative left you an inheritance of $100,000, stipulating in the will that you invest ALL the money in ONE of the following choices. Which one would you select?

a. A savings account or money market mutual fund

b. A mutual fund that owns stocks and bonds

c. A portfolio of 15 common stocks

d. Commodities like gold, silver, and oil

12. If you had to invest $20,000, which of the following investment choices would you find most appealing?

a. 60% in low-risk investments, 30% in medium-risk investments, 10% in high-risk investments

b. 30% in low-risk investments, 40% in medium-risk investments, 30% in high-risk investments

c. 10% in low-risk investments, 40% in medium-risk investments, 50% in high-risk investments

13. Your trusted friend and neighbor, an experienced geologist, is putting together a group of investors to fund an exploratory gold mining venture. The venture could pay back 50 to 100 times the investment if successful. If the mine is a bust, the entire investment is worthless. Your friend estimates the chance of success is only 20%. If you had the money, how much would you invest?

a. Nothing

b. One month’s salary

c. Three month’s salary

d. Six month’s salary