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Financial Literacy**

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Gender Differences and Measurement error in financial literacy

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Abstract

We study gender differences in stock market participation, pension planning, and financial fragility. We examine how our estimates change when we properly control for financial literacy. Measuring people financial literacy with precision is a very difficult task and our proxies generally contain a random error. We show that this error hinders our ability to correctly estimate gender differences in financial behaviors such as, the participation to the stock market and pension planning. Most notably, we also show that gender differences in financial fragility completely disappear when we account for measurement error in our proxies for financial knowledge. Our results suggest that surveys and economic experiments aiming at capturing financial literacy should be designed to alleviate the measurement error generally contained in our proxies.

Keywords: Financial Literacy, Stock Market Participation, Retirement Planning, Financial Resilience
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1 Introduction

In the last decade life expectancy has been steadily increasing¹. The ability to smooth consumption over time through saving, investment and effective retirement planning has then become a priority, particularly for women as they tend to live longer and are less likely to participate to financial markets (Van Rooij et al. (2011)). Financial literacy can influence financial decisions (Kaiser et al. (2021)), facilitates effective investing (Lusardi and Mitchell (2014), Bucher-Koenen et al. (2021a)) and explains part of the difference between men and women in the participation to the financial markets (Almenberg and Dreber (2012)). Unfortunately, measuring with precision people knowledge about earnings, expenditures, savings, investments, and long-term financial planning is a very difficult task and our measures of financial literacy generally contain a measurement error. We study whether this measurement error hinders our ability to estimate gender differences in the participation to financial markets, retirement planning and, ultimately, financial soundness.

Gillen et al. (2019), show that the effect of measurement error is pervasive as it spills over to variables correlated with the mis-measured proxy. Therefore, when we control for financial knowledge in our regression models, measurement error may also bias the parameters estimated on the variables correlated with financial literacy. As outlined in Bottazzi and Lusardi (2021) financial literacy strongly correlates with gender as women generally display lower level of financial knowledge than men. This correlation coupled with the error in our measures of financial knowledge may hinder our ability to consistently estimate the gender gap in financial decisions such as the participation to financial markets, effective retirement planning and, ultimately, financial resilience. The underpinning intuition is straightforward. Measurement error engenders a bias in the coefficient estimated not only on financial literacy, the mis-measured variable, but also on the variables correlated with financial literacy such as gender. Specifically, measurement error distorts the financial literacy coefficient downward. The effect is then partly picked up by gender. As an example, if we estimate the gender gap in the participation to the financial markets and we control for financial literacy, measurement error may attenuate the effect of financial literacy and inflate the gender gap.

We deal with measurement error in financial literacy using the IV strategy proposed by Gillen et al. (2019). Specifically, we select two variables with the same information content and a random error. We then use a two stage model to partial out the random component and retain the information content free of measurement error. More specifically, we use data from the first and second waves of the survey on the economic and financial conditions of Italian households, realized by the Italian National Committee for Financial Literacy (EDUFIN Committee). We follow the approach proposed by Gillen et al. (2019) and

¹see <https://data.worldbank.org/indicator/SP.DYN.LE00.IN>

adjust for measurement error by instrumenting our measures of financial literacy variables with the answers given by the *same* person to the *same* question in the previous wave of the survey.

We show that measurement error substantially attenuates the effect of financial literacy on the participation to the financial markets, retirement planning and financial fragility. All our coefficients estimated with our instrumental variable approach in fact are larger than the same coefficient estimated through OLS. When we turn our attention to financial behavior, we show that the presence of measurement error in our variable capturing financial literacy may lead us to substantially overestimate the gender gap in the participation to the stock market and on retirement planning. The gender gap estimated through OLS is about 10% larger than the gap estimated through our instrumental variable model. In a similar fashion we show that the gap in terms of retirement planning is about 20% lower in our IV models compared to our OLS estimates. Most notably, we also show that the gender gap in terms of financial fragility largely vanishes when we adjust for measurement error. While our OLS models estimate a large negative gap between men and women in terms of financial fragility, this difference becomes not statistically distinguishable from zero when we control for measurement error.

Our contribution to the existing literature is twofold. First we contribute to the literature on financial literacy showing how measurement error could undermine our understanding of the gender gap in the participation to the stock market, retirement planning and most notably financial resilience. The problem of measurement error is not new in financial literacy and has been widely discussed in the existing literature (Lusardi and Mitchell (2014)). However, to the best of our knowledge, this is the first paper discussing the effect that this measurement error may have on our understanding of the gender gap in important and widely debated financial decisions such as the participation to the financial markets (Van Rooij et al. (2011)), retirement planning and financial resilience. Our results also have important implications for the design of surveys related to financial literacy. We underline the importance of introducing at least two questions capturing for financial literacy in a survey. Note that the two measures could be either in the same survey or repeated over time to the same respondents (Gillen et al. (2019)). Several Central banks in developed countries attempted to measure financial literacy distributing a questionnaire to the general population. The guidelines for designing this surveys have been produced by the OECD to limit heterogeneity and to allow researchers to have samples that spans across countries. Our results provide some guidance to the design of these surveys to facilitate researchers and analysts to treat measurement error, naturally present in survey data. The reminder of the paper is structured as follows. In Section 2 we propose a review of the literature on financial literacy and measurement error. In section 3 we discuss our methodology. Section 4 and 5

discuss our data and our main results. Section 6 concludes.

2 Literature Review

The issue of measurement error is especially prominent in the social sciences and researchers are aware of the difficulties about measuring concepts such as attitudes and ability (Cernat (2021)). Measurement error is, together with omitted variable, simultaneity and selection, a potential source of bias in the coefficients estimated with a regression (Wooldridge (2010)). However, as outlined by Hill et al. (2021), many empirical papers discuss endogeneity in a generic way, as a broad and ambiguous concept, without a clear diagnosis of the specific mechanisms producing the bias in their estimates. This is a significant problem, since many of the methods to address endogeneity only apply to specific cases. The most common solution applied by researchers in the attempt to eliminate any bias from the estimated coefficients is the Instrumental Variable (IV) approach. Relying on instrumental variables requires a clear theoretical justification. Furthermore, the instrumental variable needs to have a strong correlation with the endogenous variable, in order to avoid the problem known as 'weak instrument' that could make 'the cure for endogeneity worse than the disease' (Semadeni et al. (2014)). Measurement error is identified as the source of parameters' bias in 1.5% of the 384 articles reviewed by Hill et al. (2021). However, as underlined in Kennedy (2008) 'yet rather than indicating a lack of a problem, the rarity may be due to the fact that, most econometric models work best with the assumption of zero measurement error' (Hill et al. (2021), p 115). The empirical literature dealing with financial literacy is largely relying on household-based surveys, which are notoriously subject to measurement error for a variety of different reasons (Bound et al. (2001)). In these studies, financial literacy is measured by the percentage of correct answers respondents give on financial questions. These empirical analyses, called by Fernandes et al. (2014) 'measured financial literacy' studies are more frequent than the experimental and quasi-experimental studies assessing the effects of financial education interventions on economic decisions (the so-called 'manipulated financial literacy' studies).

These 'measured financial literacy' studies are likely affected by measurement error. As outlined by Lusardi and Mitchell (2014) in their review, 'any given set of financial literacy measures can only proxy for what individuals need to know to optimise behaviour in intertemporal models of financial decision making. Moreover, measurement error is a concern, as well as the possibility that answers might not measure 'true' financial knowledge' (page 11). It is worth noting that the distortion engendered by measurement error is pervasive (Gillen et al. (2019)) and may spill over to other variables correlated with financial literacy. This

may be particularly problematic when we try to estimate the gender gap on important financial decisions and we need to control for financial literacy. Bottazzi and Lusardi (2021) show that gender strongly correlates with financial literacy as women generally report a lower level of knowledge than men in financial matters. Gender differences in financial literacy are large, persistent and widespread across surveys and countries (Bottazzi and Lusardi, 2021; Lee et al., 2022; Lusardi and Mitchell, 2014; Tinghög et al., 2021). Gender differences in financial literacy are a global phenomenon, worldwide, 35% of men are financially literate compared with 30% of women (Klapper and Lusardi (2020)). Women seem to be less financially literate than men both in advanced economies and in emerging economies. Italy also has a very wide gender gap in financial literacy: 45% of Italian men are financially literate, whereas only 30% of women are (Hasler and Lusardi, 2017; Sconti, 2022). Similar findings also emerge from young people (Lusardi et al. (2010)). Studies of financial literacy in high school and college, as Chen and Volpe (2002), reveal gender differences in financial literacy even in early life. This gap may be explained by well known differences in self-confidence (Anderson et al., 2017; Bucher-Koenen et al., 2017; Cueva et al., 2019; Kramer, 2016), and risk tolerance (Alam et al., 2022; Booth et al., 2014; Brooks et al., 2019; Comeig et al., 2022; Horn et al., 2022; Schmidt et al., 2021) between men and women.

Measurement error may hinder the interpretation of our estimates of the gender gap in the participation to the stock market, retirement planning and financial fragility. The lower participation of women to the stock market when compared to men is an empirical regularity and has been shown in several prominent studies (Haliassos and Bertaut, 1995; Jacobsen et al., 2014; Van Rooij et al., 2011). Women seem also to be more vulnerable than men in their retirement planning (Binswanger and Carman, 2012; Gallo et al., 2018). Lusardi and Mitchell (2008) show that women are less likely to plan for the retirement compared to men. This evidence is also widespread around the globe (Hasler and Lusardi (2017)). Previous studies have also outlined that these differences in investing and saving ultimately lead to gender differences in financial fragility. A significantly higher percentage of women than men tend to struggle with access to emergency funds (Lusardi and Mitchell (2008)). Hasler and Lusardi (2017) examine the financial fragility of American households and find that over 40% of women would struggle in raising \$ 2,000 within a month, whereas the percentage of financially fragile men is reported to be below 30%. We cannot avoid to control for financial literacy in estimating the gender difference in the participation to the financial market, retirement planning and financial resilience. These differences have, in fact, been found to be, at least in part, driven by financial knowledge. Almenberg and Dreber (2015) show that controlling for financial literacy in estimating the difference between men and women in the participation to the stock market is very important as financial

knowledge absorbs a large portion of the gap. Similarly controlling for financial knowledge is very important in estimating the gender gap in retirement planning (Brown and Graf (2013)) and financial fragility Hasler and Lusardi (2017). Unfortunately controlling for financial literacy may induce a bias in our estimates that arises from measurement error. We contribute to the existing literature by examining how our understanding of gender differences in investing, saving, and financial fragility change when we adjust our estimate for measurement error as suggested by Gillen et al. (2019).

3 Measurement error in financial literacy

Survey data generally contain random errors that can arise from many different sources. When we use questionnaires to retrieve a proxy for financial literacy answers may be subject to random variation in participants' attention and focus, as well varying willingness to reveal true information about someone financial situation. This measurement error is known to generate a downward bias and will affect our estimates of the correlations between financial literacy and important financial decisions such as the participation to financial markets. Consider model (1):

$$Y = \beta^* X^* + \tilde{\epsilon} \tag{1}$$

Assume that we can only observe $X = X^* + \eta$ a noisy measure of X^* , financial literacy. This imprecise measurement is known to generate a downward bias in our coefficients even if the measurement error is independent from the error term in the main regression model. To see this we can rewrite (1) as:

$$Y = \beta X + \epsilon \tag{2}$$

Under standard assumptions, the coefficient on financial literacy with measurement error (X) can be written as:

$$\beta = \frac{COV(Y, X)}{VAR(X)} = \frac{COV(\beta^* X^* + \tilde{\epsilon}, X^* + \eta)}{VAR(X^* + \eta)} = \beta^* \frac{VAR(X^*)}{VAR(X^*) + VAR(\eta)} < \beta^* \tag{3}$$

We can address the problem arising from measurement error employing the approach proposed by Gillen et al. (2019), named Obviously Related Instrumental Variables (ORIV). More specifically, we can leverage multiple estimates of financial knowledge in our surveys to treat measurement error. To see this assume that you have another variable X^b that also correlates with financial knowledge and has its own independent measurement error $X^b = X^* + \eta^b$. If we also assume that $VAR(\eta^b) = VAR(\eta)$ and $\mathbb{E}[\eta^b, \eta] = \mathbb{E}[\eta^b] = \mathbb{E}[\eta] = 0$

We can then write:

$$CORR(X, X^b) = \frac{COV(X, X^b)}{\sigma(X)\sigma(X^b)} = \frac{VAR(X^*)}{VAR(X^*) + VAR(\eta)} \quad (4)$$

The result in equation (4) is very useful as it can be used to approximate the bias generated by measurement error by examining the correlation between the two measures of the same underlying parameter and to adjust coefficients biased by measurement error. More specifically, if we use X^b as an instrument for X , we obtain a simple two-stage least square model as:

$$Y = \alpha + \beta_1(\gamma_0 + \gamma_1 X^b) + \epsilon \quad (5)$$

The first stage coefficient of X^b on X is then $\gamma_1 = \frac{COV(X, X^b)}{VAR(X^b)}$. Therefore, the coefficient estimated in the second step of our two-stage regression model is:

$$\beta_1 = \frac{COV(\alpha^* + \beta_1^* X^* + \epsilon^*, \gamma_0 + \gamma_1 X^b)}{VAR(\gamma_0 + \gamma_1 X^b)} = \frac{\beta_1^* \gamma_1 VAR(X^*)}{\gamma_1^2 VAR(X^b)} = \frac{\beta_1^* \gamma_1 VAR(X^*)}{\gamma_1 \frac{COV(X, X^b)}{VAR(X^b)} VAR(X^b)} = \frac{\beta_1^* \gamma_1 VAR(X^*)}{\gamma_1 VAR(X^*)} \xrightarrow{p} \beta_1^* \quad (6)$$

4 Data

Our data are drawn from the first and second waves of the survey on the economic and financial conditions of Italian households, realized by the Italian National Committee for Financial Literacy (EDUFIN Committee). The first wave was devoted to financial fragility and financial resilience during the COVID pandemic, involving 5,009 individuals responsible for households' financial decisions, through on line interviews conducted between May and June 2020. The second wave of the survey was carried out one year later, between May and June 2021. As a result, we have a panel of 4,027 households with information for both 2020 and 2021. Consistently with our aim to study the relationship between financial literacy and important economic decisions, we consider three different outcome variables. First, following Van Rooij et al. (2011), we consider the participation in the stock market. As outlined by the authors, studying this relationship may contribute to explain why many households do not hold stocks in their portfolio (i.e., the so-called "stock-holding" puzzle), which is probably due also to a lack of knowledge about asset pricing and the workings of stock exchanges. In Italy, the amount of household per capita financial investments continues to be lower than the euro area average (2,330 and 3,160, euro respectively), as shown in the last edition of

the CONSOB Report on financial investments of Italian Households (2021). Despite the interest in equity markets and online trading is growing, Italian households are still characterized by a strong preference for liquidity (weighting for more than 30% of total financial assets) and the most widespread assets remain bank and postal savings (43%), followed by Italian government bonds (25%) and mutual funds (24%). More in details, we use the answer to question n. 24 asking what financial instruments are held by the interviewed, specifically focusing on the item related to "listed and unlisted shares". As we can see from the descriptive statistics reported in Table 1 and Table 2, stocks are held only by the 17% of respondents, with a statistically significant difference between men and women (19.39% against 12.82%), which is consistent with previous studies dealing with gender gap in stock market participation (e.g., Van Rooij et al. (2011); Bucher-Koenen et al. (2021b)). Second, following several studies (for the case of Italy, see Fornero and Monticone (2011); Ricci and Caratelli (2017)), we consider retirement planning. The issue of retirement planning is particularly important in Italy, since many reforms in the last thirty 30 years have lead to lower public pensions for future generations and an increasing important role for voluntary pension plans. Despite the growing importance of voluntary pension schemes, the most recent data (COVIP, 2022) show a coverage rate lower than the 35% of the total workforce, with worrying evidence of gender and generation gaps. In details, we use the answer to question n. 24 asking what financial instruments are held by the interviewed, considering the item related to "pension funds". As we can see from the descriptive statistics reported in Table 1 and Table 2 , pension funds are held only by the 27% of respondents, with a statistically significant difference between men and women (29.46% against 22.39%), which is consistent with previous literature dealing with gender gap in precautionary savings and retirement planning (e.g., Anderson et al. (2017)). Finally, we consider financial resilience (see Klapper and Lusardi (2020)), whose importance has greatly increased as a result of the pandemic. For this outcome variable, we use the answer to the question n. 16, asking: "If an unforeseen need arises, how confident do you feel that you can come up with 2,000 euro within a month?" and consider as resilient respondents answering to be sure about remedy 2,000 euro in a month or feeling they are likely to manage. As we can see from the descriptive statistics reported in Table 1 and Table 2 , most Italian households are resilient with a large portion of respondents (i.e., 72.36%) feeling pretty confident about the ability to come up with 2,000 euro in a month. As for previous outcome variables, we find a statistically significant difference between men and women (76.22% against 65.67%), which is consistent with previous literature dealing with financial resilience (e.g., Hasler et al. 2018).

In order to study the relationship between financial decisions and financial literacy, we use two different measures of financial literacy, both calculated either for 2020 and 2021. The first measure is based on the

respondents' self-assessment of their own level of financial literacy. More specifically, we consider the answer to the question n. 32 asking respondents to assign a score between 1 and 10 to their level of financial literacy. The level of self-assessed financial literacy slightly decreased in 2021 compared to 2020 (5.8684 versus 5.3953) and show a higher value for men rather than women (5.6580 against 4.9403). As we can see from Figure 1, for all scores lower than 6, which can be considered as an important threshold signalling a sufficient level of self-assessed financial knowledge, the density is higher for women with respect to men, while for scores equal or higher than 6 the situation is reversed. It is particularly evident the large frequency of women attributing to themselves the lower possible value of financial literacy (i.e., 1). Furthermore, looking at the distribution by age groups, shown in Figure 2, it is evident that all age groups tend to concentrate on average rather than extreme values. As a second measure, we use an observed measure of financial literacy, based on the number of correct answers to four different questions regarding basic notions such as inflation and purchasing power, interest compounding, the risk-return relationship and the concept of diversification. The average score is very similar across the two waves of the survey (about 2.85 out of 4) and still shows an advantage for men with respect to women (3.0168 against 2.5611). Differences between men and women are highly statistically significant, showing that financial literacy, despite the measure used, is strongly correlated with gender. As we can see from Figure 3, people realizing a score equal to zero, i.e., answering incorrectly to all questions dealing with basic financial concepts, are more frequently women than men. The same happens for medium-low scores, equal to 1 and 2, while for medium-high scores, equal to 3 and 4, the situation is reversed. In addition, looking at the distribution by age groups, shown in Figure 4, it is evident that people aged 18-44 have a lower level of financial literacy with respect to other respondents, as suggested by several previous studies highlighting the fragility of young people (e.g., Lusardi et al., 2010)

5 Results

5.1 The error in Financial Literacy measures

We begin our analysis by examining the error in our measures of financial literacy. Table 3 reports the correlations between our variable observed financial literacy obtained from answers recorded in 2021 and the same variable obtained from answers given by the same respondents in 2020. The first row shows that the correlation between our observed financial literacy measures is 63% suggesting a rather large bias in our estimates². In order to ascertain that this error is random and evenly spread across respondents with varying

² In the simulations reported in Gillen et al. (2019), a similar error generates a bias of about 20% in the dummy correlated with the variable measured with error. Similar estimates result also in our main results reported in Table 4

characteristics in the last five columns of Table 3 we reestimate the correlation focusing on specific subgroups. Column 3 shows the correlation between the two measures for women only. The reported correlation is still 63% suggesting that gender does not have any effect on the correlation between the two measures. When we estimate the correlation on subsamples based on age groups, we obtain very similar results. Hence, this first evidence shows that the correlation between our first two measures of financial literacy does not depend on the respondent's characteristics. In panel B of Table 3 we estimate the correlation between our two measures of Self-assessed Financial literacy one obtained in 2020 and the second obtained in 2021. Results are very similar to the ones reported in Panel A. The correlation between the two measures is 63% and shows a minor variation based on gender. When we look at age subgroups, though, there seems to be some slight increase in the correlation between the two measures when we move from individuals aged between 18 to 44 to the group of respondents with older than 65. Interestingly this path is not present in the Observed Financial literacy. This evidence suggests that respondents' opinion on their own skills and knowledge becomes more persistent as they grow older. This effect is, in any case, rather small in size and it is unlikely to create identification problems in our main results.

5.2 Gender gap and Financial Literacy measures

Table 4 report our main results. In the first panel we study the effect that measurement error in financial literacy has on the gender gap in the participation to the stock market (Van Rooij et al. (2011) Lusardi and Mitchell (2014)). In line with the evidence reported in (Almenberg and Dreber (2012)), the first model shows that controlling for financial literacy has a strong impact on the gender gap. When we control for financial literacy in the first column of Table 4 the gender gap moves from -0.0657 as reported in Table 2 to -0.0389. Interestingly the decrease is somehow less pronounced when we control for financial literacy using our measure of observed financial literacy. In order to ascertain that the effect we report in the first model is not driven by age or other individual characteristics, In the last four models of Table 4 we use age group, profession and municipality fixed effects. The gender gap reported in column (3) where we use our measure of self-assessed financial literacy moves very slightly. In column (4) however, our measure observed Financial literacy becomes not statistically significant and the gender gap returns to a level very close to the one reported in Table 2. This evidence may be partly generated by the relatively small clusters of observations defined by our fixed effects coupled with the coarseness of our measure for observed financial literacy which as outlined in Table 1 ranges between 1 to 4 while the measure for self-assessed financial literacy ranges between 1 and 10 with higher level of granularity. Most importantly, column 5 shows that the gender gap

moves substantially from -0.0432 in model (3) to -0.0347 in model (5), where we adjust for measurement error instrumenting self-assessed financial literacy observed in 2021 with the same variable observed in 2020 recording a reduction of approximately 20%. The effect is purely generated by the adjustment operated on our measure of financial literacy which as expected substantially increases in size moving from 0.0737 in model (3) to 0.0970 in model (5).

In panel B of Table 4 we examine the effect of measurement error in our measure of financial literacy on the gender gap in terms of retirement planning. Adding a measure of financial literacy in the first row of the second panel in Table 4 again reduces substantially the gender difference in terms of retirement planning which moves from -0.0707 as reported in Table 2 to -0.0478. This evidence reemphasizes the importance of controlling for financial literacy in estimating the gender gap. Gender gap is also reduced when we use our measure of observed financial literacy to control for financial knowledge. The gender gap further reduces when we use fixed effects. The distance between man and women, however, reaches its minimum when we adjust for measurement error in the last two models. In the last two columns of panel B in Table 4 the coefficient on financial literacy increases in size suggesting that our instrumental variable approach is effective in reducing measurement error. In the last row, the increase in our financial knowledge coefficients is accompanied by a strong decrease of the estimated gender gap that moves to 0.0508 from the 0.0628 in the OLS model with a decrease of approximately 20%.

In panel C of Table 4 we examine the effect of measurement error in our measures of financial literacy on respondents' financial fragility. Similarly to Panel A and B of Table 4, the gender gap substantially decreases when we control for financial literacy. The difference between men and women in terms of financial fragility, in fact moves from 0.1055 in Table 2 to -0.0797 and -0.0585 in the first and second column of Table 4 respectively. Interestingly, using age group, profession and municipality fixed effects further reduces the gender gap moving bringing it to -0.0642 and -0.0493 in the third and fourth columns of Table 4 respectively. The largest drop is, however, reported in the last two columns of Table 4 when we use the instrumental variable approach suggested by Gillen et al. (2019) to adjust for measurement error. More specifically, the coefficient in column (5) drops substantially to -0.0494 with a 23% decrease when compared to the coefficient reported in column(3). Most notably, the gender gap estimated in in column (6) when we use our measure of observed financial literacy, completely vanishes and the effect of the indicator variable women on financial fragility becomes not statistically distinguishable from zero. This shift is accompanied with a large increase of the observed financial literacy proxy which moves from 0.1275 in column (4) to 0.1947 in column(6). Hence, overall our evidence strongly support our hypothesis that controlling for measurement error in our proxies

for financial literacy substantially reduces the gender gap in investing, saving and ultimately on financial fragility.

6 Conclusions

Financial literacy may improve people living standards by facilitating the access to financial markets, adequate saving and ultimately financial resilience. However, identifying the impact of financial literacy on important investment decisions may be difficult. In order to improve our understanding of the role played by financial knowledge in determining investors behaviour we would need a precise measure of financial literacy. Unfortunately, measuring how knowledgeable people are on earnings, expenditures, savings, investments, and long-term financial planning is very difficult. Our measures generally rely on questionnaires that are naturally affected by measurement error due to random factors such as varying level of effort or attention exerted by respondents. This measurement error may lead researchers to underestimate the importance of financial literacy in modern market economies and undermine our understanding of the gender gap in financial decisions. Financial literacy strongly correlates with gender as women tend to display lower level of financial knowledge than men. This correlation may hinder our ability to estimate the difference between men and women in their financial behavior if we control for financial literacy. We use an instrumental variable approach specifically designed to overcome measurement error and show that the the attenuation bias engendered by the random error in our measures of financial knowledge had led analysts to overestimate the gender gap in important financial decisions such as the participation to the financial markets, retirement planning and financial fragility. Overall our results suggest that measurement error in survey data attenuates the effect of financial literacy on financial decisions and hinders the interpretation of the magnitude of our estimates of the gender gap in financial decisions.

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Table 1: Summary Statistics

This table shows the summary statistics of all variables used in the analysis

	count	mean	sd	max	min
Stock Market Participation	4027	0.1699	0.3756	1.0000	0.0000
Retirement planning	4027	0.2687	0.4433	1.0000	0.0000
Financial resilience	4027	0.7236	0.4473	1.0000	0.0000
Observed Financial literacy	4027	2.8500	1.2894	4.0000	0.0000
Self-assessed Financial literacy	4027	5.3953	2.1076	10.0000	1.0000
Observed Financial literacy 2020	4027	2.8388	1.2761	4.0000	0.0000
Self-assessed Financial literacy 2020	4027	5.8684	1.9292	10.0000	1.0000
Women	4027	0.3660	0.4818	1.0000	0.0000
Age	4027	49.8614	11.8644	89.0000	18.0000
Age Group 18-44	4027	0.3432	0.4748	1.0000	0.0000
Age Group 45-64	4027	0.5312	0.4991	1.0000	0.0000
Age Group 65+	4027	0.1257	0.3315	1.0000	0.0000

Table 2: Difference in mean based on gender

This table shows the difference in mean between men and women and its statistical significance on all our dependent variables.

	Men	Women	Difference	p-value
Stock Market Participation	0.1939	0.1282	0.0657	0.0000
Retirement planning	0.2946	0.2239	0.0707	0.0000
Financial resilience	0.7622	0.6567	0.1055	0.0000
Observed Financial literacy	3.0168	2.5611	0.4558	0.0000
Self-assessed Financial literacy	5.6580	4.9403	0.7178	0.0000
Observations	4027			

Table 3: Measurement error in financial literacy

This table reports the correlations between our measures of financial literacy. As outlined in the correlations below allow us to approximate the measurement error in the answers of the respondents in our survey.

	Observed Financial literacy					
	Full Sample	Men	Women	Age Group 1 18-44	Age Group 2 45-64	Age Group 3 65+
Panel A	(1)	(2)	(3)	(4)	(5)	(6)
Observed Financial literacy 2020	0.6327*** (0.0129)	0.6105*** (0.0189)	0.6361*** (0.0192)	0.6137*** (0.0212)	0.6306*** (0.0173)	0.6581*** (0.0469)
Observations	4,026	2,552	1,474	1,382	2,139	505
R-squared	0.4004	0.3778	0.4054	0.3854	0.3929	0.4135
	Self-assessed Financial literacy					
	Full Sample	Men	Women	Age Group 1 18-44	Age Group 2 45-64	Age Group 3 65+
Panel B	(1)	(2)	(3)	(4)	(5)	(6)
Self-assessed Financial literacy 2020	0.6395*** (0.0138)	0.6417*** (0.0198)	0.6108*** (0.0200)	0.5546*** (0.0214)	0.6727*** (0.0198)	0.7175*** (0.0313)
Observations	4,026	2,552	1,474	1,382	2,139	505
R-squared	0.4090	0.4136	0.3809	0.3406	0.4316	0.4975

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4: Gender differences financial literacy and measurement error

This table shows the effect of adjusting for measurement error on the gender gap in our dependent variables. In Panel A we examine the effect of gender gap on stock market participation. In panel B we study the effect of measurement error on retirement planning while in Panel C we analyze how the difference between men and women in terms of financial fragility changes when we adjust for measurement error in our measure for financial literacy. Fixed effects are reported below each column. Singleton observations are left out of the sample in the fixed effects models. Standard errors are clustered at municipality level.

Panel A		Stock Market Participation					
	(1)	(2)	(3)	(4)	IV (5)	IV (6)	
Women	-0.0389*** (0.0117)	-0.0606*** (0.0117)	-0.0432*** (0.0153)	-0.0671*** (0.0153)	-0.0347** (0.0149)	-0.0654*** (0.0146)	
Self-assessed Financial literacy	0.0789*** (0.0060)		0.0737*** (0.0078)		0.0970*** (0.0096)		
Observed Financial literacy		0.0146*** (0.0056)		0.0089 (0.0067)		0.0147 (0.0128)	
Observations	4,026	4,026	3,183	3,183	3,183	3,183	
Panel B		Retirement Planning					
	(1)	(2)	(3)	(4)	IV (5)	IV (6)	
Women	-0.0478** (0.0185)	-0.0628*** (0.0190)	-0.0350 (0.0238)	-0.0528** (0.0251)	-0.0319 (0.0238)	-0.0508** (0.0251)	
Self-assessed Financial literacy	0.0675*** (0.0064)		0.0604*** (0.0075)		0.0691*** (0.0120)		
Observed Financial literacy		0.0225*** (0.0066)		0.0136* (0.0077)		0.0200* (0.0121)	
Observations	4,026	4,026	3,183	3,183	3,183	3,183	
Panel C		Financial resilience					
	(1)	(2)	(3)	(4)	IV (5)	IV (6)	
Women	-0.0797*** (0.0158)	-0.0585*** (0.0139)	-0.0642*** (0.0196)	-0.0493*** (0.0172)	-0.0494** (0.0210)	-0.0292 (0.0180)	
Self-assessed Financial literacy	0.0766*** (0.0075)		0.0647*** (0.0092)		0.1054*** (0.0169)		
Observed Financial literacy		0.1339*** (0.0072)		0.1275*** (0.0088)		0.1947*** (0.0132)	
Constant	0.7530*** (0.0083)	0.7453*** (0.0081)					
Observations	4,026	4,026	3,183	3,183	3,183	3,183	
Age group Fixed Effects	No	No	Yes	Yes	Yes	Yes	
Profession Fixed Effects	No	No	Yes	Yes	Yes	Yes	
Municipality Fixed Effects	No	No	Yes	Yes	Yes	Yes	
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1							

Table 5: Variables Description

This table reports the content and meaning of all variables used in the analysis

Variable	Description	Question number
Stock Market Participation	This variable takes the value of one if the respondent has an exposure to stock and zero otherwise.	24
Retirement Planning	This variable takes the value of one if the respondent participates in a pension funds and zero otherwise	24
Financial resilience	This variable takes the value of one if the respondent could easily overcome financial hardship if needed.	16
Observed Financial literacy	This variable takes values between one and five depending on the correct answers the respondent gave on questions about compounding, inflation, diversification and risk-reward tradeoff.	33.2, 33.3 33.4, 35.5
Self-assessed Financial literacy	This variable takes values between one and ten depending on how respondents assess their own financial literacy.	32
Observed Financial literacy 2020	This variable takes values between one and four depending on the correct answers the respondent gave on questions about compounding, inflation, diversification and risk-reward tradeoff in 2020.	43, 44 45 48
Self-assessed Financial literacy 2020	This variable takes values between one and ten depending on how respondents assess their own financial literacy in 2020.	41
Women	Respondent's gender	Gender
Age group	Three groups as reported in survey 18-44. 44-64. 65+	Age
Profession	Twenty different professions were listed in the survey those include but are not limited to entrepreneurs, manger, employee, retired	Profession

Figure 1 :Frequencies of Self-assessed Financial literacy by gender

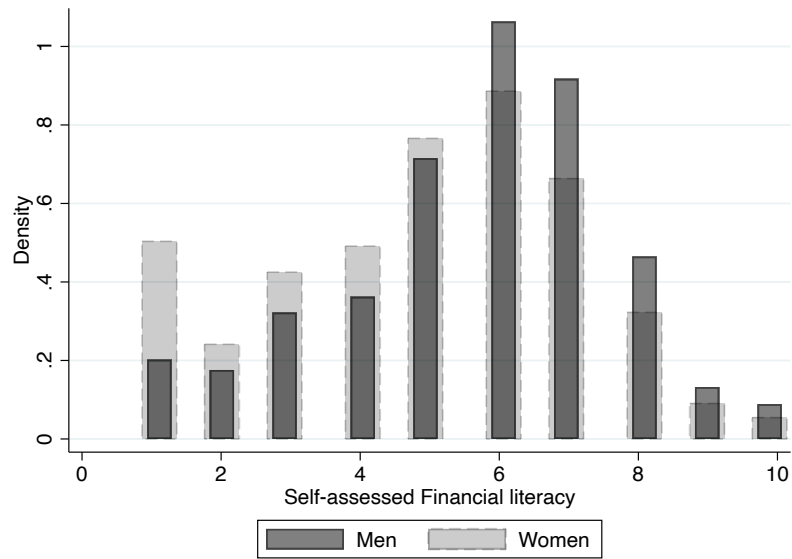


Figure 2:Frequencies of Self-assessed Financial literacy by age group

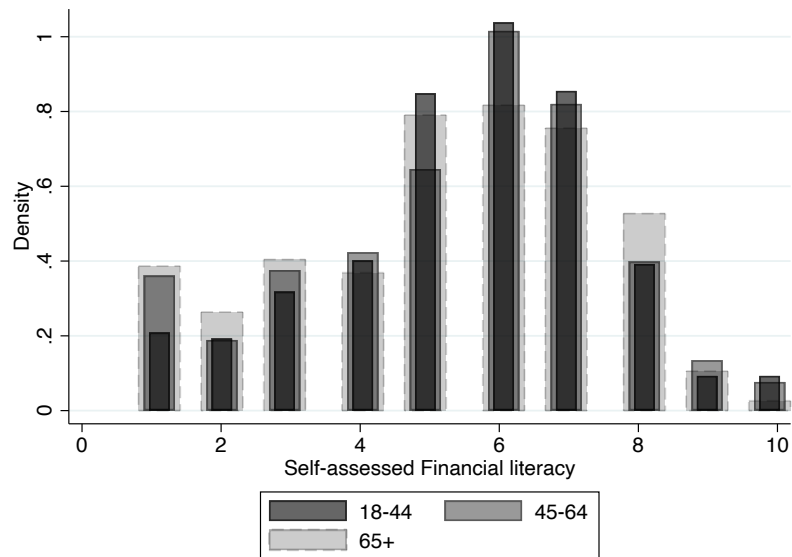


Figure 3: Frequencies of Observed Financial literacy by gender

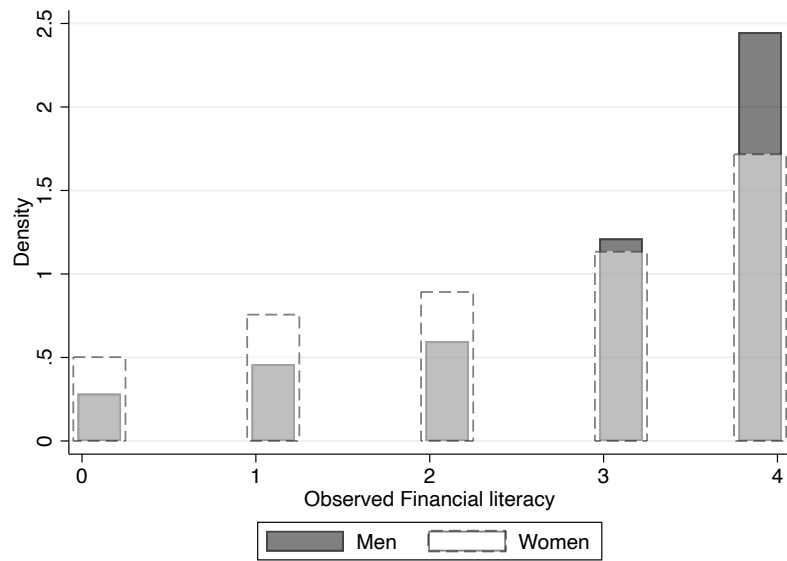
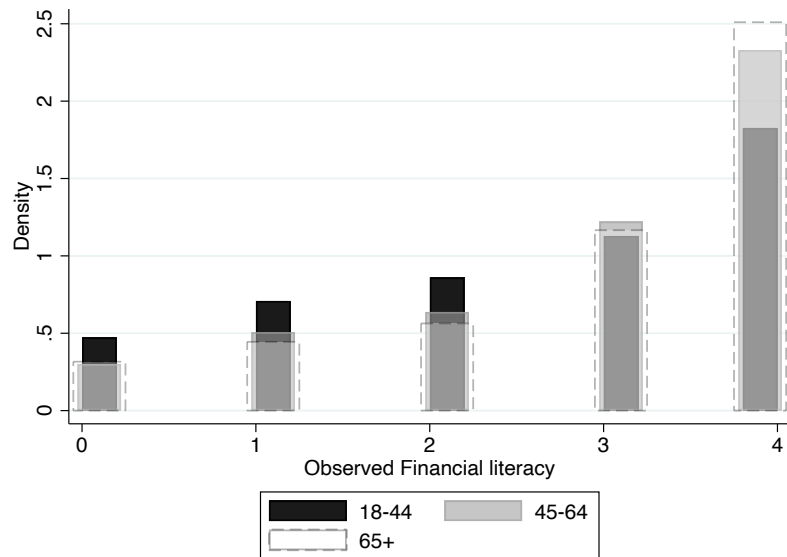


Figure 4: Frequencies of Observed Financial literacy by age group





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