

# Locus of Control and Investment in equity\*

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## Abstract

We show that a person's internal economic locus of control is an important determinant of investment in equity, over and beyond risk and time preferences. Household heads with a strong internal economic locus of control are more likely to hold equity and hold a larger share of equity in their investment portfolio. We show that the impact of locus of control remains when we control for a large number of possible confounders such as subjective and objective financial literacy, overconfidence, optimism, social preferences, and other personality traits. We argue that this impact is driven by a link between internal locus of control and a lower perception of the risk of investing in equity. Those with a strong internal economic locus of control perceive less variance in equity, making these investments more attractive.

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# 1 Introduction

Financial participation in the stock market is relatively common. In the Netherlands, about a quarter of all household were stocks or mutual funds holders in 2005 (Van Rooij et al., 2011). Although stock holding declined following the 2008 credit crisis,<sup>1</sup> the widespread participation of household investors in the stock market requires that we better understand the determinants of their investment behavior. The models of portfolio choice—both static and through the life cycle—that guide our understanding in this matter underline risk and time preferences as key determinants of individual investment behavior (e.g., Merton, 1969; Samuelson, 1969; Bodie et al., 1992; Cocco et al., 2005; Gomes and Michaelides, 2005; Benzoni et al., 2007). Recent studies show that characteristics such as social preferences and financial literacy also play an important role (e.g., Hong et al., 2004; Guiso et al., 2008; Van Rooij et al., 2011). A rapidly growing literature in behavioral finance has further identified optimism and overconfidence as drivers of investment behavior (e.g., De Bondt, 1998; Barber and Odean, 2001; Puri and Robinson, 2007). A growing literature suggests that other aspects of personality are equally important for various economic outcomes (e.g., Heckman et al., 2006; Borghans et al., 2008; Almlund et al., 2011). In particular, internal locus of control (i.e., the extent to which a person believes that the outcomes in his or her life are due to personal efforts, as opposed to the result of luck, change, fate, or the intervention and influence of others (Rotter, 1966)) has been shown to be important in a wide range of economic situations, such as the labor market (e.g., Bowles et al., 2001a,b; Coleman and DeLeire, 2003; Heineck and Anger, 2010; Caliendo et al., 2015), the credit market (Tokunaga, 1993), as well as entrepreneurship (Evans and Leighton, 1989) and savings (Cobb-Clark et al., 2013). However, its role in financial investment decisions has largely be ignored. Data constraints are one of the major reasons for this gap in research gap; economic preferences, personality traits, and investment decisions are seldom jointly observed in one dataset.

This paper focuses on a person’s internal economic locus of control as a determinant of investment decisions in equity. An internal economic locus of control captures the perception that outcomes are due to personal efforts specifically in the case of economic outcomes such as the creation of wealth (Furnham, 1986). We use representative household data from the Dutch National Bank Household Survey (DHS) to test the hypotheses that having an internal economic locus of control, over and beyond risk and time preferences, positively relates to the decision to participate in equity, as well as the share of risky

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<sup>1</sup><http://www.dnb.nl/nieuws/nieuwsoverzicht-en-archieef/dnbulletin-2013/dnb298773.jsp>

investments in a household’s total portfolio. Our main results show that a one standard deviation increase in internal locus of control increases the probability of participating in equity by about 2.4 percentage points and increases the portfolio share of equity by 1.3 percentage points. These magnitudes are economically important, since they correspond to around 7% of their unconditional means.

We further conjecture and provide evidence that the positive relationship between having an internal economic locus of control and investing in equity is driven by the negative influence of internal locus of control on the subjective perception of risk in risky investments, thereby increasing the willingness of household heads to invest in equity. An important body of literature in social psychology, clinical psychology, medicine, and management supports this mechanism. If a person’s internal economic locus of control is indeed related to the perceived risk in equity, then an internal economic locus of control will be positively related to the decision to participate in equity as well as to the portfolio share of equity, over and beyond one’s willingness to take risks.<sup>23</sup>

We address several potential identification concerns in our estimation. First, we show that our main results are not driven by household’s financial literacy or experience in investing in equity. Second, we present evidence that the association between internal locus of control and equity investments are not due to internal locus of control acting as a proxy for risk and time preferences, personality traits as measured by overconfidence, optimism, trust, and Big Five. Third, we address the possible impact of measurement error in our measure of locus of control and show that this does not affect our estimates. We finally show that our main results are robust to the use of alternative definitions of our internal locus of control and equity measures.

Our findings contribute to the literature on the behavioral and psychological drivers of

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<sup>2</sup>Note that even though internal locus of control captures the extent to which a person believes to be in control of his or her own future, the concept is silent about which actions (or lack thereof) one must undertake to achieve this control. In our setting, this means that locus of control cannot predict whether an investor “in control” would be more active or passive in the stock market. This is one of the key differences between the effects of locus of control and overconfidence in an investor model. In our data, we cannot measure to what extent individuals are more active stock traders.

<sup>3</sup>To support the hypothesis that the effect of locus of control affects investment in equity through the perception of risk, we use a selection of households that invest in financial options. We focus on financial options because they are a particular financial asset in that their value is *increasing* in the risk of their underlying asset. Thus, if internal locus of control is associated with lower risk perception, household heads with a strong internal locus of control will be more likely to buy or sell financial options, since they will consider them as overvalued by the market. We find evidence of such behavior in our data: household heads with an internal locus of control are indeed more likely to sell financial options. Although we also find a positive relation between internal locus of control and the likelihood to buy options, this relation is not statistically significant, which could be due to small sample sizes.

individual financial investment, such as De Bondt (1998), Barber and Odean (2001) and Puri and Robinson (2007). This literature is primarily focused on the impact of overconfidence and optimism on individual investment decisions, but largely ignores other personality traits such as locus of control, that are better established in personality psychology and can add to our understanding of individual investment from a different perspective.<sup>4</sup> We further contribute to our understanding of personality-driven investment behavior, not only by assessing the impact of locus of control but also by developing and testing a hypothesis that clarifies how its impact can be understood within the classical risk-return paradigm in investment.

The remainder of the paper is structured as follows. Section 2 describes our data and the construction of the variables used in this study. Section 3 establishes the main relation between internal locus of control and investment in equity. Section 4 provides extensive evidence of the identification of our main effects. Section 5 argues in favor of the link between locus of control and risk perception, and provides additional evidence for this link found in our data. Section 6 shows the robustness of our main results. Section 7 concludes.

## 2 The DNB Household Survey (DHS)

For this study we use information from all the waves (1994-2015) of the Dutch National Bank Household Survey (DHS), an annual panel survey of Dutch households designed to be representative of the Dutch population over the age of 16.<sup>5</sup> We make a number of sample restrictions. We restrict our sample to household heads between the ages of 25 and 80 who are neither studying full time, looking for employment for the first time, or solely living on disability benefits. We aggregate households by only using the information provided by persons responsible for the household finances. These respondents are in charge of reporting the household's asset holdings in the survey. We also keep only people reporting to be the household head or his/her partner. Finally, we only keep households which report a positive amount of financial wealth and who report some cash holdings.

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<sup>4</sup>Two exceptions are the studies of McInish (1982) and Durand et al. (2008), who view personality traits in a financial investment context. These studies, however, face data limitations (e.g., selective samples), and do not analyze the effect of personality on the intensive margins of equity investment. Renneboog and Spaenjers (2012) use the DHS to investigate the relation between religion and investment behavior and include a measure of locus of control as a control variable in their analyzes, but do not investigate further.

<sup>5</sup>For a detailed description of the DHS, see Kapteyn and Teppa (2011) or visit the CenterERdata website at [www.centerdata.nl](http://www.centerdata.nl).

Our estimation sample includes only households for which we have data on financial assets, measures of economic locus of control and economic preferences, as well as other essential socioeconomic characteristics used as control variables. Our main estimation sample thus includes 2,947 households, for a total of 16,184 household–year observations.

We define participating in equity as holding a positive amount in at least one of the following financial products: mutual funds and mutual fund accounts, stocks and shares, open put or call option positions, and substantial stock holdings (excluding private equity holdings in their own company). To calculate household total financial wealth, we add up the total value of the household’s risky asset holdings, equity, bonds, savings, and current account balances, savings certificates, insurance policies, growth funds, own private equity, and other savings. The two main dependent variables for our analyzes are a dummy variable for investors in equity, and the portfolio share of equity (i.e., the value of equity as a proportion of the household’s total financial wealth).<sup>6</sup>

Each year between 2005 and 2007, and every two years afterwards, the DHS included a block of 13 statements measuring internal economic locus of control, which are a subset of the items from the validated scale of Furnham (1986).<sup>7</sup> As mentioned above, economic locus of control measures the extent to which a person believes that the economic outcomes in his or her life are due to personal effort, as opposed to the result of luck, fate, or the intervention and influence of others. These 13 statements measure the survey respondents’ agreement (each on a seven-point Likert scale) with the importance of their own actions for their financial wealth creation in various situations.

We construct a time-invariant measure of internal locus of control by first taking the mean of the 13 statements for each person by year, reversing the appropriate items so that higher scores correspond to people with a stronger internal locus of control (i.e., those who believe their economic outcomes are determined by their own efforts) and lower scores to people with an external economic locus of control (i.e., those who believe their economic outcomes are determined by factors out of their control), and then taking the

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<sup>6</sup>All our monetary variables are measured in nominal Euros. Our results are robust to definitions of equity that exclude bonds, mixed mutual funds, and substantial stock holdings or that include non-residential real estate. Most of our results also hold when we define risky asset investors as those holding equity in excess of €1,000 or €10,000.

<sup>7</sup>This scale is especially designed by Furnham (1986) for the study of the role of locus of control in economic decisions. As Dohmen et al. (2011) show, domain-specific scales for traits and preferences are the best predictors of behaviour in a specific domain. Van Daalen et al. (2008) provide evidence on the reliability and cross-cultural validity of Furnham’s statements, whereas Plunkett and Buehner (2007) show that internal economic locus of control measured by the Furnham scales is positively correlated with internal locus of control measured by the Rotter scales.

time average of these reversed means for each person.<sup>8</sup> This approach implicitly assumes that locus of control is stable for each individual in our sample. The assumption that locus of control is stable over time for the people in our sample is made based on existing evidence that shows that locus of control forms during childhood and stabilizes during adolescence (Sherman, 1984; Cobb-Clark and Schurer, 2013a).<sup>9</sup> We do, however, verify and relax this assumption in Section 6, and particularly Table A.4. The unstandardized internal locus of control distribution is bell shaped and spreads across the entire possible range of scores, with a mean of 4.6 and a variance of 0.48. To ease the interpretation of our results, we standardize this index by subtracting its sample mean and dividing it by its standard deviation, although our results are robust to different constructions of this index.

The DHS also includes information on peoples’ risk and time preferences. To measure risk preferences, the survey asks people to state their agreement with six statements regarding their preferences for risk in various financial decisions—therefore measuring risk preferences in the financial domain. Using earlier waves of the DHS, both Warneryd (1996) and Kapteyn and Teppa (2011) show that risk preferences measured this way relate to investment behaviour and to risk preferences elicited using lottery choices (e.g., Barsky et al., 1997). The survey questionnaire includes 12 questions measuring patience and the extent to which individuals consider the future consequences of their current decisions from Strathman et al. (1994).<sup>10</sup> Using previous waves of the DHS, Borghans and Golsteyn (2006) show that these patience questions are closely related to subjective discount rates elicited through hypothetical choices between current and future consumption. We construct standardized indices for risk aversion (where higher scores indicate less willingness to take risks) and patience (where higher scores indicate more

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<sup>8</sup>The full list of items is reported in the Appendix. Even though both locus of control and economic locus of control were originally devised as multi-dimensional personality traits, it is common to operationalize them through internal-external reduction, just as we do (Rotter, 1990). This is common practice in the literature (e.g., McInish, 1982; Coleman and DeLeire, 2003; Cebi, 2007; Cobb-Clark and Schurer, 2013a).

<sup>9</sup>Throughout the paper, and in particular in Section 6, we explicitly account for possible correlates of locus of control. One caveat we cannot address is the possible correlation between locus of control and self-esteem. Judge et al. (2002) suggest that there might be a mild correlation between self-esteem and the standard measures of locus of control, and self-esteem has been shown to be correlated with wealth and the holdings of financial assets (Chatterjee et al., 2009). Our data does not include a measure of self-esteem, yet the items measuring economic locus of control are sufficiently different from the classical measures of self-esteem (the Rosenberg scale) to alleviate some of the concerns for omitted variable bias. Furthermore, self-esteem cannot explain the behavioral mechanism described in Section 5.

<sup>10</sup>We find that our measure of internal economic locus of control is negatively correlated to risk aversion and positively correlated to patience, which is consistent with previous literature (e.g., McInish, 1982; Plunkett and Buehner, 2007).

patience or, equivalently, a lower intertemporal discount rate) similarly to the way we constructed the internal locus of control index.<sup>11</sup>

We control for an extensive set of individual and household socio-demographic characteristics that have been shown to be important for household investment decisions and that may be correlated with internal locus of control. Our analyzes include individual characteristics of the household head such as a quadratic term for age, gender, high school and university education, marital status, household composition, household size, and the occupation of the head of the household. We also include household characteristics such as total household net income, and household wealth. All regressions include year and region dummies to control for common shocks that uniformly affect all households in the same region at the same time (such as aggregate market return variations). Table A.1 in the the Appendix shows summary statistics of all the main variables in our analyzes for our main estimation sample.

### **3 The impact of locus of control on risky asset investment decisions**

Table 1 reports OLS coefficients of linear probability models explaining the probability to invest in equity under various specifications: raw correlation (Column (1)), after controlling for socio-demographic characteristics of the household head and the household (Column (2)), after controlling for risk aversion and patience (Column (3)), and after controlling for household income and household wealth (Columns (4)). The raw relation (Column (1)) suggests that a one standard deviation increase in internal locus of control results in a 7.3 percentage point higher probability to invest in equity. Controlling for socio-demographic characteristics (Column (2)) reduces the marginal effects by about 1 percentage point.

More important is whether internal locus of control is a determinant of investment in equity over and beyond risk and time preferences. The emphasis on these two economic preferences is based on the many theoretical models that motivate their role in individual portfolio choice (e.g., Samuelson, 1969; Svensson, 1989). Moreover, strong correlations have been found between these two variables and internal locus of control, which is shown for time preferences by Plunkett and Buehner (2007) and suggested for risk aversion by

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<sup>11</sup>See the Appendix for a full list of the items used to construct the internal locus of control, financial risk aversion, and patience indices.

McInish (1982). Column (3) shows that controlling for economic preferences results in a further decrease of the marginal effect of locus of control by an additional 1.3 percentage points compared to Column (2), but it still remains highly significant at the 1 percent-level. We further find that the likelihood of holding equity is decreasing with risk aversion and increasing with patience.<sup>12</sup> This is consistent with most portfolio models and with the majority of empirical studies on stock market participation.<sup>13</sup>

Since equity holdings strongly depends on household income and wealth, and savings are related to internal locus of control (Cobb-Clark et al., 2013), the model in Column (4) additionally controls for household income and household wealth. These variables are essential for explaining equity participation and have become standard in the household portfolio literature. Adding these controls could, however, potentially introduce endogeneity in our model since equity holdings could themselves co-determine other sources of household wealth and these other sources of household wealth are likely to be influenced also by peoples' internal locus of control. Column (4) shows that the probability to hold equity, as could be expected, increases with household income and household wealth. The addition of these two variables to our model results in an additional reduction of the marginal effect of locus of control. Nevertheless, the relation still remains highly statistically significant: a one standard deviation increase in locus of control is associated with a 2.4 percentage point higher likelihood to invest in equity. This marginal effect is relatively large as it corresponds to about one third of the unconditional effect reported in Column (1), and 8.3% of the share of households in our data who hold equity. The impact of one standard deviation increase in locus of control on risky asset participation is smaller than the effects found in the literature of a one standard deviation increase in trust (Guiso et al., 2008) or financial literacy (Van Rooij et al., 2011) on the likelihood to invest in equity, but similar to the impact of a one standard deviation in numeracy (Christelis et al., 2010).

The availability of information on the portfolio share of equity as a proportion of the household's total financial wealth allows us not only to look at the impact of internal locus of control on equity investments in the extensive margins, but also on the intensive margins of risky assets investments. We replicate the analysis reported in Column (4) of

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<sup>12</sup>As a robustness test, we take the largest value of risk aversion as reported by the household head in the period he/she is observed in the data and find a similar negative relation with the likelihood of holding equity.

<sup>13</sup>With respect to the control variables, the relations are as expected from the literature. Age and education are positively related to holding equity, while female household heads are less likely to hold equity. The latter can fully be explained by differences in risk preferences between males and female.

Table 1 where we replace probability to invest in equity by the portfolio share of equity as the dependent variable. Because 70% of all households do not hold equity, we estimated a fractional regression to account for the participation hurdle at zero. Table 2 shows the results of this exercise. We find results very similar to those reported in Table 1. The internal locus of control is significantly positively correlated to the share of wealth invested in equity, and negatively correlated to cash holdings. We find that a one standard deviation increase in internal economic locus of control is associated with a 1.3 percentage points increase in the portfolio share of equity. This is about 11 percent of the average share of equity for households in our data.

## 4 Potential confounders

In this section we consider several possible identification issues for our results: *i)* that the impact of the role of locus of control on investments in equity is explained by financial literacy, *ii)* that overconfidence is the main driver behind the relationship between locus of control and the probability to invest in equity, and *iii)* that the relation between internal locus of control and investments in equity is not simply capturing unobserved differences in other personality traits.

### 4.1 Financial literacy

Financial literacy plays an important role in portfolio choices as financial knowledge increases the likelihood of investing in the stock market (Van Rooij et al., 2011). It is therefore important to control for it when locus of control is correlated to financial literacy. Our data include both a self-assessment and an objective assessment of financial literacy, and internal locus of control is indeed positively correlated with both. The subjective self-assessment of financial literacy is based on the following survey question: “*How knowledgeable do you consider yourself with respect to financial matters?*”. Respondents could answer using a 4-points scale from 1 “not knowledgeable” to 4 “very knowledgeable”. This question is asked in the DHS since 2004. Objective literacy is measured by a set of five basic literacy questions and 10 advanced literacy questions. We measure overall financial literacy, basic literacy, and advanced literacy via using total number of correct answers for all questions, the basic questions, and the advanced questions, respectively.<sup>14</sup>

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<sup>14</sup>The complete set of questions for objective financial literacy can be found in Van Rooij et al. (2011, p. 452-454). These questions are only asked in 2004-2005. To maximize power we take the time-constant

In Table 3, we add controls for financial literacy to our basic specification as presented in Column (1) of Table 1. Because the literacy questions are not available in all waves of the DHS, the number of observations is lower in Table 3 than in Table 1. Column (1) of Table 3 shows that controlling for subjective literacy does not change our main results. We still find that internal locus of control is positively and significantly related to the likelihood of investing in equity. The same holds if we control for the total financial literacy score as can be shown from Column (2), although including the total financial literacy score does reduce the size of the marginal effect to 0.035. The first two columns further show that subjective literacy and the total financial literacy score is significantly positively related to investing in equity; individuals who report to be more knowledgeable are more likely to invest in equity. Column (3) presents the results of an estimation in which distinct measures for basic literacy and advanced literacy are introduced and shows that the marginal effect of our internal locus of control measure remains highly significant. Also, advanced literacy is significantly positively related to the likelihood of investing in equity, but there is no significant relationship between basic financial literacy and equity investments. Adding controls for socio-economic characteristics of the household head (Column (4)) and economic preferences (Column (5)) hardly affects the magnitude of the marginal effect of locus of control, and it does not affect its significance. In the last column of Table 3 the marginal effect of locus of control decreases in size and becomes insignificant when we control for household income and wealth. However, the marginal effect is not statistically different from our main effect reported in Column (4) of Table 1 [ $p = 0.220$ ], and the drop in statistical significance is mostly caused by the increased imprecision of our estimates due to a considerable drop in the sample size (42% larger standard errors) rather than a drop in the size of the estimated effect. This result can thus solely be explained by the addition of wealth and income, and not by financial literacy, which indicates that the latter is not a confounder for our main results. We further should mention that since the addition of other sources of household wealth are possibly influenced by peoples' internal locus of control, it is likely that we here therefore also underestimate the marginal effect of locus of control on equity investments.

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average of these questions for each respondent across years, though our main results hold if we only use the 2004-2005 data. We thank Maarten van Rooij for making these data available to us.

## 4.2 Overconfidence

So far we have interpreted our results based on the assumption that our measure of internal locus of control unambiguously captures this underlying personality trait. Barber and Odean (2001) and Malmendier and Tate (2005), however, show that overconfidence is significantly related to investment decisions. If locus of control and overconfidence are related to each another, than overconfidence is a potential confounding factor in our analyzes. Omitting overconfidence in our analyzes might then lead to an overestimation of the marginal effect of locus of control when the latter would capture unobserved differences in overconfidence. To test whether this is the case, we construct a measure of overconfidence by first regressing the subjective financial literacy on objective financial literacy. The relation between subjective and basic objective literacy is well approximated by a quadratic fit as can be seen from Figure 1, and indicates that both measures of literacy are highly and non-linearly correlated. However, there is substantial heterogeneity across individuals in this relation, allowing us to take the individual average of the residuals of this regression as our time-invariant measure of the degree of overconfidence.<sup>15</sup> We then add this measure of overconfidence as an additional regressor in our analyzes.

Column (1) of Table 4 documents the relationship between our overconfidence measure and investments in equity and shows that overconfidence is significantly positively associated with a stronger likelihood to invest in equity. Controlling for overconfidence does not alter our main conclusion, as can be seen from Columns (2-5) of the table. Overconfidence does not explain away the relation we find between locus of control and the likelihood of investing in equity. In Columns (4) and (5), overconfidence is even statistically insignificant while the marginal effect of locus of control is similar to that reported in Column (4) of Table 1.<sup>16</sup>

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<sup>15</sup>Subjective financial literacy is asked in 2004-2015 and is therefore time-varying, so even though our measure of objective financial literacy is time-constant, our procedure yields a time-varying measure of overconfidence. Our results hold if we construct an efficient index of overconfidence by taking the time-constant average of all individual overconfidence measures over time.

<sup>16</sup>Gervais and Odean (2001) further conjecture that overconfidence decreases with investor experience, as more experience helps investors to better recognize their abilities. If locus of control is related to overconfidence, then it should also be decreasing with experience. To check whether this is the case, we regress experience in investing in equity on internal locus of control. In these models, we use a time-varying measure of internal locus of control that is calculated as the individual-specific yearly mean of the 13 items. The use of a time varying measure – instead of the time-invariant measure – allows that locus of control can decrease with experience. We measure investor experience by counting the cumulative number of years households have been holding equity. Table A.2 reports several model specifications of regressions of the number of years of experience with investments in equity on internal locus of control. Columns (1) and (2) show that locus of control actually increases with additional years of experience as an investor. This alone suggests that locus of control is not likely to be a proxy for overconfidence. When

### 4.3 Optimism, trust, and Big Five

Several personality studies further show a positive correlation between internal locus of control and optimism (e.g., Guarnera and Williams, 1987; Hoorens and Buunk, 1993), while Puri and Robinson (2007) showed that people who are more optimistic are more likely to invest in stocks. Therefore, it is important to check that the relation between internal locus of control and investments in equity is not simply capturing unobserved differences in optimism. To control for optimism, we use the index constructed from Scheier et al. (1994) Life Orientation Test, revisited (LOT-R). This is a validated standard measure of optimism, also used in household portfolio analyzes of the DHS by Guiso et al. (2008).<sup>17</sup> Column (1) of Panel A in Table 5 shows that the relation between optimism and the likelihood of investing in equity is only weakly significant in our data. Columns (2)-(5) show and that the inclusion of optimism does not affect the marginal effect of internal locus of control. This suggests that internal locus of control is not simply acting as a proxy for optimism.

In addition, Guiso et al. (2008) argued there is a positive relation between social preferences (i.e., trust) and the likelihood to participate in equity, implying that failing to control for trust could result in an overestimation of the marginal effect of locus of control when both are correlated. There is evidence of such a correlation in the literature (Albanese et al., 2013). In the DHS, trust is measured using the same question as in the World Values Survey: “*Generally speaking, would you say that most people can be trusted or that you have to be very careful in dealing with people?*”. Following Guiso et al. (2008), we code trust as a dummy for answering “Most people can be trusted” to this question, as opposed to “You can never be too careful when dealing with others”.<sup>18</sup> In Column (1) of Panel B in Table 5 shows that trust is positively related to the likelihood to invest in equity. But more important, controlling for trust in the analyzes does not affect the marginal effect of locus of control (Columns (2)-(5)).

We finally consider whether internal locus of control is acting as a proxy for other

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we control for the first occurrence of locus of control measured in the first year an individual is observed in the data (Column (3)) or individual fixed effects (Column (4)) we find no relation between years of experience as an equity investor and locus of control. This indicates that locus of control is constant over time, but more importantly that it does not decrease with experience the way overconfidence would.

<sup>17</sup>The items and measurement methodology for the LOT-R can be found in Scheier et al. (1994, p.1073). These questions are only asked in 2003. To maximize power we take the time-constant average of these questions for each respondent across years. We thank Luigi Guiso for making the data for optimism and trust available to us.

<sup>18</sup>*ibid.* We again take the time-constant value of this question to maximize power. Our conclusions hold if we only use the 2003 data.

personality traits (Panel C in Table 5). To rule out this possibility, we use a 50-item measure of the Big Five personality traits. The Big Five (Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism) are a comprehensive, data-driven inventory of five overarching traits considered to measure individuals' personality (Goldberg, 1993). The Big Five have been the most commonly used tool to measure personality for decades and there is widespread agreement within personality research about the five underlying dimensions and their content (Barrick et al., 2003; Durand et al., 2008). Each dimension of the Big Five is measured through 10 items from Goldberg (1999) which we aggregate in a standardized index analogous to the way we aggregate the internal locus of control items.<sup>19</sup> Column (1) of Panel C in Table 5 shows that some of the personality traits are indeed correlated with investments in equity. Columns (2)-(5) indicate that the marginal effect of internal locus of control is not affected by inclusion of the Big Five in the analysis.

In sum, in all models reported in Column (5) of Table 5 the marginal effect of internal locus of control is similar to the one reported in Column (4) of Table 1. This suggests that internal locus of control does not capture other aspects of personality or social trust.

## 5 Underlying Mechanism: subjective perception of risk

In this section we argue that a likely mechanism underlying our main findings is that household heads with an internal locus of control have a lower perception of the variance of the returns to risky asset investments compared to those with an external locus of control. This induces these households to have higher participation rates in equity. The link between locus of control and the perception of risk is intuitive: people who believe they are in control of their outcomes are more likely to think that they can influence these outcomes for their benefit. The *ex ante* outcome variance, which captures fundamental uncertainty, should then be perceived as less pronounced for people with an internal locus of control.

Evidence from several studies provides support for this hypothesized mechanism, starting with the extensive work of Paul Slovic on risk perception and its drivers (in particular,

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<sup>19</sup>The complete 50-item Big Five questionnaire is included in the 2005, 2009, 2013, and 2014 waves of the DHS, but under the classical assumption that these personality traits are stable over time, we take their overall mean as a time-constant measure for them.

see Slovic (1992)). Following his work, there was a surge of research into locus of control and risk perception predominantly in the domain of health. For the perception of several types of health risks, Hoorens and Buunk (1993) show that students with an internal locus of control perceive themselves to be at lower risk than their peers.<sup>20</sup> Cull et al. (1999) further show that women with an external locus of control tend to overestimate the chance of getting breast cancer. In a large sample of patients at risk of cardiovascular disease, Frijling et al. (2004) show that patients with an internal locus of control perceive a lower risk of having a myocardial infarction or stroke. More recently, Jia et al. (2015) show that high self-control, which is related to internal locus of control, results in lower weighting of probability of health and disease risks.<sup>21</sup> For a broader range of domains, Kallmen (2000) measure the perception of risk, both to oneself and to the general public, from smoking, alcohol consumption, various diseases, traffic accidents, different forms of radiation, bad food, nuclear waste, war, violence and aggression. Sjöberg (2000) performs a similar analysis on a set of 15 different hazards ranging from lightning strikes to AIDS. Both studies show that internal locus of control (perception of control) is strongly associated with a lower degree of risk perception. In a vein directly related to economic risk perceptions, Simon et al. (2000) show that in a sample of prospective entrepreneurs internal locus of control is related to lower perception of risk in opening a new business venture.

We complement this evidence by testing the link between locus of control and the perception of risk in financial investments. However, due to data limitations, we can only test this relation indirectly by exploiting the relation between the prices of financial options (one of the components of household’s investments in equity) and the return variance of their underlying assets. For equity in general, an internal locus of control should lower the perceived risk of these assets, encouraging risk-averse households to hold relatively more of them. However, financial options are very particular equity: they become more valuable when the price of their underlying asset is more volatile (Black and Scholes, 1973). This happens because a higher underlying volatility results in a larger probability that the option will be “in the money”. Thus, investors with a stronger internal locus of control (who perceive the underlying assets as less risky) will consider the market price of options as relatively high compared to their own valuation, and will therefore be more

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<sup>20</sup>Specifically, they consider the risk of suffering from drinking problem, contracting AIDS, having a heart attack before the age of 40, attempting suicide, or being diagnosed with cancer.

<sup>21</sup>Although the existing evidence strongly suggests a link between internal locus of control and lower risk perception, it is not unanimous. See Crisp and Barber (1995) and Riechard and Peterson (1998).

likely to sell them and less likely to buy them.<sup>22</sup>

The DHS collects detailed information on the respondents' types of option investments. In particular, it asks whether households have open positions in financial options and whether they bought or sold them (i.e., whether they are in long or short positions). We test our hypothesized mechanism by looking at the behavior of these option investors. If our hypothesized mechanism holds, internal locus of control should be positively related to the likelihood of selling options, and negatively related to the likelihood of buying them. Using the sub-sample of equity investors only, we estimated a multinomial model for being an option seller, an option buyer, or being both a seller and a buyer (the reference category is holding equity, but no option). The estimation results are reported in Table A.3 in the Appendix, and summarized in Figure 2. The table and figure show a significant positive relation between internal locus of control and the likelihood of selling options. For buyers, the relation is not significant in spite of the fact that they are more prevalent than sellers in our data. This evidence provides indirect but uniquely consistent evidence supporting our hypothesized mechanism.

## 6 Robustness checks

### 6.1 Measurement error

Measures of internal locus of control, risk aversion, or time preferences obtained through multiple survey questions are only imperfect proxies for the constructs they attempt to measure, and the measures themselves are likely to suffer from measurement error. Under the classical errors-in-variables assumption, our coefficient estimates will suffer from attenuation bias. Cobb-Clark and Schurer (2013b) show that failing to control for attenuation bias can lead to a serious underestimation of the true effect of locus of control. Although our validated measure of internal locus of control combines the information of 13 different items, which arguably decreases the potential attenuation bias, it is possible that some bias remains. This also holds for the marginal effects of risk aversion and patience.

To identify the true values of the parameters for internal locus of control, risk aversion, and time preferences, we have run instrumental variable (IV) regressions that account for

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<sup>22</sup>The relation between option prices and risk is strictly true for the implied volatility of the underlying asset. However, to the extent that implied volatility is predictive of future volatility—as shown by, for example, Fleming (1998)—the positive relation between perceived risk and option prices should hold.

measurement error. For these IV-regressions, we use as instruments two indices for each personality trait which we compose by dividing the block of underlying survey questions into two sets of items: one with the first half of the personality items and another one with the second half of the items. Subsequently, we construct two time-invariant indices of internal locus of control, similar to our main measure, by first taking the mean of the first (or second) half of the statements for each person by year, reversing the appropriate items so that higher scores correspond to people with a stronger internal locus of control, and then taking the time average of these reversed means for each person. We do the same for risk aversion and time preferences. Assuming that the measurement error in each personality item is classical and the covariance between the measurement errors of the two indices is equal to zero, we are able to identify the true values of the parameter of the personality traits by using index 2 as an instrument for index 1 for each personality trait in the regression of equity ownership on internal locus of control, risk aversion, and time preferences (see Lubotsky and Wittenberg (2006) for a more detailed explanation).

Columns (1) and (2) of Table A.6 show the results OLS estimations of equity ownership on indices 1 and 2 of internal locus of control, risk aversion, and time preferences and confirm that replacing the original personality scales with the two indices give us the same result as in our main analysis. The marginal effects of internal locus of control, risk aversion, and patience do not significantly differ when we use the index that includes only the first half of the items of the block of underlying survey questions measuring the corresponding personality traits or the second half of the items. Column (3) presents the IV-results in which we instrument the three first personality indices with the three second indices. From the first stage F-statistics it is clear that the instruments are strong instruments. The Cragg-Donald F-statistics of all three variables are well beyond the critical value, although the comparatively low value of the F-statistic of intern locus of control suggest that it measures with more error. The second stage subsequently shows that all coefficients are larger, but internal locus of control rises the most of all three. The coefficient more than doubles in size, indicating that internal locus of control in the previous estimations is indeed considerably underestimated. A one standard deviation increase in internal locus of control increases the likelihood to hold equity 7.0 percentage points after dealing with the attenuation bias. Column(4) finally shows the results of a three stage least squares instrumental variables regression which links each instrument exclusively to the corresponding personality trait, opposed to a normal two stage least squares regression in which the whole set of instruments is used to simultaneously instrument internal locus of control, risk aversion, as well as time preferences. This three stage

least squares estimation should therefore be more efficient. The point estimates from this exercise are almost identical to those in Column (3).

## **6.2 Alternative definitions of internal locus of control**

We further check the robustness of our findings with respect to alternative measures of locus of control. The evidence so far in the literature is that locus of control forms during childhood and stabilizes during adolescence (Sherman, 1984; Cobb-Clark and Schurer, 2013a). We therefore have run a regression in which we restrict the sample to household heads aged 30 or more so that we are sure that internal locus of control has stabilized for the people in our estimation sample. Column (1) of Table A.4 in the Appendix shows that our main finding hold when we apply this sample restriction. In additional analyzes, we use the first measure of locus of control observed in the data and treat it as time constant (Column (2)), we use a time varying measure of locus of control (Column (3)), and use the lead value of equity holding which we then regress on previous year's values of locus of control and other covariates (Column (4)). The latter evidence is consistent with Granger causality between internal locus of control and investments in equity. We find that our main finding is robust to the alterations of the definitions of internal locus of control.

## **6.3 Alternative definitions of equity investments**

As a last robustness check we investigate the extent to which our findings hold for various components of our equity measure. As discussed earlier, equity includes mutual funds and mutual fund accounts, stocks and shares, open put or call option positions, and substantial stock holdings (excluding private equity holdings in their own company). Table A.5 in the Appendix shows that the relation we find between locus of control and equity holding is exclusively driven by the fact that household heads with a high internal locus of control are more likely to hold stock (Column (1)), as we find no significant relations with the other components of equity. This is consistent with stocks being the riskier asset class here, and with locus of control having the most sizeable effect in this asset class where risk is predominant. Note that risk aversion is negatively related with all components of equity, but especially stocks, and that patience mostly positively relates to mutual funds that have a longer payout time.

## 7 Conclusions

Recent studies in finance show that household investors' decisions are related to factors that are not fully captured by classical portfolio theory. In this paper we show that a household head's internal economic locus of control is an important determinant of investment in equity, over and beyond economic preferences (risk and time preferences) and socioeconomic characteristics. We find that internal economic locus of control is related to both the decision to participate in equity and the portfolio share of equity, and we show that this relation is economically significant. Through various specification checks, we rule out the possibility that the relation between internal economic locus of control and investment in equity is driven by other variables prominent in the economics and finance literature, such as financial literacy. We also show that this relation is not driven by the fact that locus of control would proxy other traits or attitudes such as overconfidence, optimism, trust, or the Big Five personality traits. Robustness checks rule out that the relation we find between locus of control and equity participation is driven by measurement error, but they do show that locus of control is particularly related to stocks participation, rather than mutual funds and bonds. Based on previous literature and our own findings, we suggest that a possible explanation is that those who have an internal economic locus of control have a lower perception of risk when investing in equity.

Our results are important in and by themselves since they not only link locus of control, an important personality trait, to household's investment behavior, but they also help us understand this effect under the traditional risk–return paradigm in investment. Our results also have important implications for current market policy. First, they imply that a part of risk perceptions is inflexible and will not respond to interventions aimed to increase investor's information or improve the ease with which they make investments. This effectively points out to a glass ceiling in the effects of financial literacy and other programs intended to increase stock market participation and use. Second, they imply that a low internal locus of control could be a suitable candidate for explaining the non-participation of financially-savvy households in risky asset markets. Third, personality–driven bias in investment decisions may also be present in highly sophisticated and knowledgeable investors, such as fund managers and board members, which could steer the investment strategies of their funds toward a more equity-based strategy. Locus of control could therefore be an important metric to select fund managers, given their pivotal role in handling other people's wealth.

At this stage we cannot say whether the investment bias related to internal locus

of control is ultimately beneficial or harmful for household investors. More research is needed to determine whether the effects of internal locus of control and other personality traits on investment decisions are to be treated as real investment mistakes (i.e., whether they are welfare-decreasing), and whether having an internal economic locus of control leads to higher returns on investments. Moreover, since our findings suggest that those who have an internal economic locus of control have a lower perception of risk, further research could focus on issues of portfolio diversification and portfolio management.

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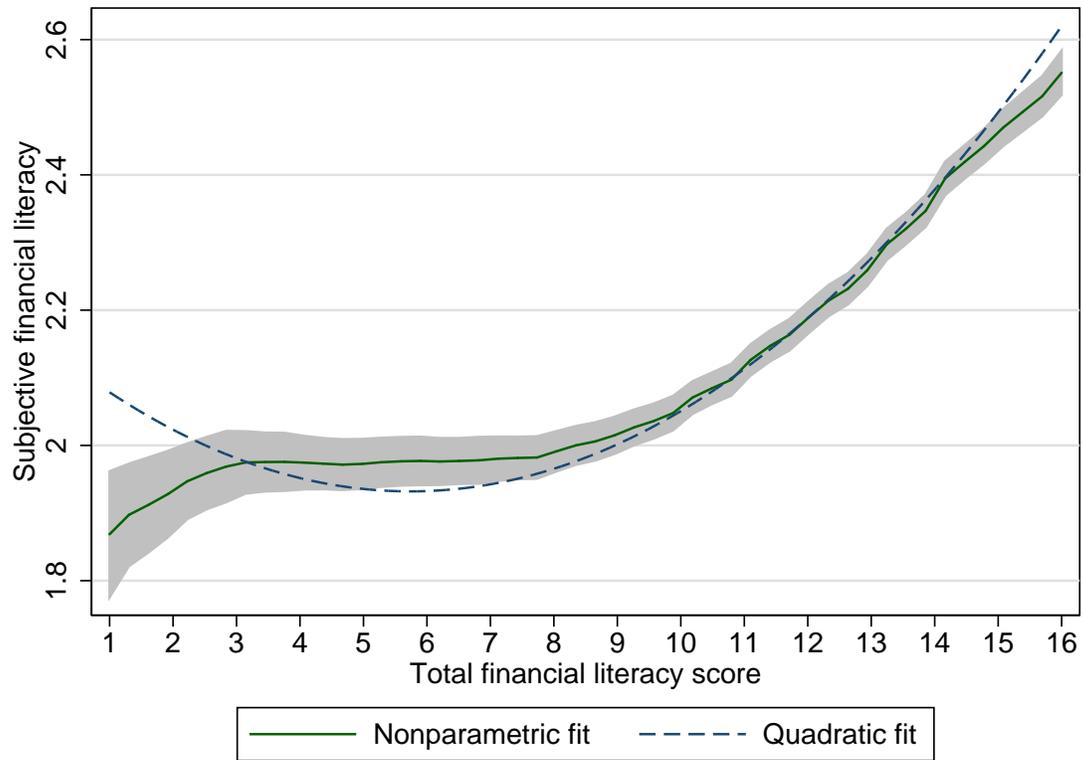
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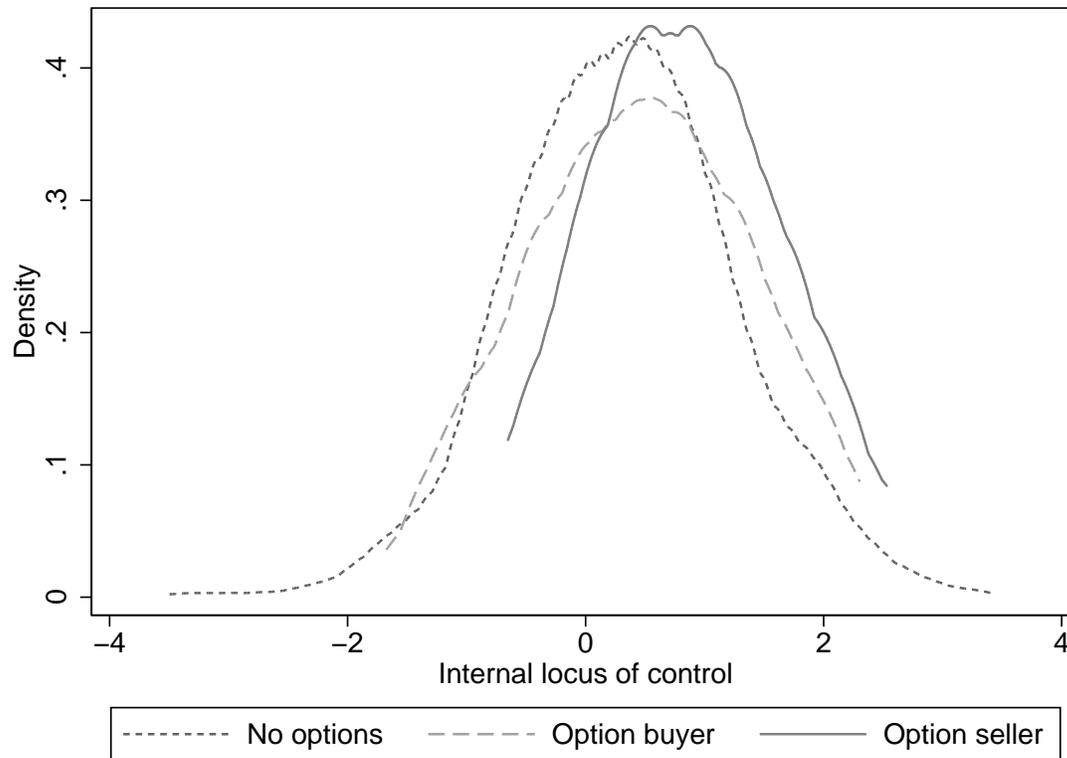
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**Figure 1:** Relation between subjective and objective financial literacy, to construct overconfidence



**Figure 2:** Distributions of internal locus of control for option non-investors, option buyers, and option sellers



**Table 1:** The relation between equity ownership and internal economic locus of control

Dependent variable: Equity ownership	(1)	(2)	(3)	(4)
Internal locus of control	0.073*** (0.009)	0.062*** (0.009)	0.049*** (0.008)	0.024*** (0.008)
Risk aversion			-0.157*** (0.008)	-0.144*** (0.007)
Patience			0.045*** (0.008)	0.031*** (0.007)
Socio-demographic characteristics:	No	Yes	Yes	Yes
Income and wealth:	No	No	No	Yes
$R^2$	0.04	0.10	0.21	0.30

Linear probability models (OLS) with an estimation sample of 16,184 household-year observations for 2,947 households observed in the 1994-2015 period. The dependent variable is a dummy that takes the value of one if the respondent household owns any equity. Socio-demographic characteristics include a quadratic term for age and dummies for gender, education, marital status, household composition, household size, and household head occupation. Income and wealth include six dummies for net household income and three dummies for household wealth quartile. All regressions include a full set of year and region interaction dummies as additional controls. Standard errors clustered at the household level in parenthesis. \*\*\* denotes significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

**Table 2:** The effect of locus of control on the share of wealth invested in different assets

Dependent variable: Share of wealth invested in Assets	Equity (1)	Bonds (2)	Cash (3)	Other assets (4)
Internal locus of control	0.013*** (0.004)	0.001 (0.001)	-0.016*** (0.004)	0.001 (0.001)
Risk aversion	-0.062*** (0.004)	-0.003** (0.001)	0.067*** (0.004)	-0.002 (0.001)
Patience	0.006* (0.004)	0.001 (0.001)	-0.010** (0.004)	0.002** (0.001)
Socio-demographic characteristics:	Yes	Yes	Yes	Yes
Income and wealth:	Yes	Yes	Yes	Yes

Average marginal effects of fractional response regressions with an estimation sample of 16,184 household-year observations for 2,947 households observed in the 1994-2015 period. The dependent variables are the share of financial wealth invested in each asset class. Socio-demographic characteristics include a quadratic term for age and dummies for gender, education, marital status, household composition, household size, and household head occupation. Income and wealth include six dummies for net household income and three dummies for household wealth quartile. All regressions include a full set of year and region interaction dummies as additional controls. Standard errors clustered at the household level in parenthesis. \*\*\* denotes significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

**Table 3:** Controlling for financial literacy

Dependent variable: Equity ownership	(1)	(2)	(3)	(4)	(5)	(6)
Internal locus of control	0.073*** (0.013)	0.035** (0.013)	0.034** (0.013)	0.038*** (0.013)	0.036*** (0.014)	0.019 (0.013)
Subjective financial literacy	0.091*** (0.016)	0.053*** (0.015)	0.051*** (0.015)	0.054*** (0.015)	0.016 (0.013)	0.006 (0.012)
Total financial literacy score		0.036*** (0.003)				
Basic financial literacy score			0.017 (0.011)	0.013 (0.011)	0.023** (0.010)	0.020** (0.010)
Advanced financial literacy score			0.041*** (0.004)	0.035*** (0.004)	0.026*** (0.004)	0.019*** (0.004)
Socio-demographic characteristics:	No	No	No	Yes	Yes	Yes
Risk aversion and patience:	No	No	No	No	Yes	Yes
Income and wealth:	No	No	No	No	No	Yes
$R^2$	0.06	0.14	0.14	0.16	0.26	0.33

Linear probability models (OLS) with a subsample of 7,617 household-year observations for 1,187 households observed in the 2004-2015 period. The dependent variable is a dummy that takes the value of one if the respondent household owns any equity. Subjective literacy, total literacy, basic literacy, and advanced literacy are measured in 4-point, 17-point, 6-point, and 11-point scales, respectively. Socio-demographic characteristics include a quadratic term for age and dummies for gender, education, marital status, household composition, household size, and household head occupation. Risk aversion and patience include both time-constant indices. Income and wealth include six dummies for net household income and three dummies for household wealth quartile. All regressions include a full set of year and region interaction dummies as additional controls. Standard errors clustered at the household level in parenthesis. \*\*\* denotes significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

**Table 4:** Controlling for overconfidence

Dependent variable: Equity ownership	(1)	(2)	(3)	(4)	(5)
Internal locus of control		0.080*** (0.012)	0.067*** (0.012)	0.055*** (0.012)	0.030*** (0.011)
Overconfidence	0.042*** (0.012)	0.027** (0.012)	0.029*** (0.011)	0.002 (0.010)	-0.001 (0.009)
Socio-demographic characteristics:	No	No	Yes	Yes	Yes
Risk aversion and patience:	No	No	No	Yes	Yes
Income and wealth:	No	No	No	No	Yes
$R^2$	0.02	0.05	0.10	0.22	0.31

Linear probability models (OLS) with a subsample of 10,850 household-year observations for 1,244 households observed in the 1994-2015 period. The dependent variable is a dummy that takes the value of one if the respondent household owns any equity. Overconfidence is measured as the individual time-average of the residual of the following regression:  $Subjective\ Literacy = -0.076 * Objective\ Literacy + 0.006 * Objective\ Literacy^2 + \varepsilon$ , ran with 8,620 household-year observations for 1,328 households in the 2004-2015 period. Socio-demographic characteristics include a quadratic term for age and dummies for gender, education, marital status, household composition, household size, and household head occupation. Income and wealth include six dummies for net household income and three dummies for household wealth quartile. All regressions include a full set of year and region interaction dummies as additional controls. Standard errors clustered at the household level in parenthesis. \*\*\* denotes significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

**Table 5:** Controlling for optimism, trust, and personality

Dependent variable: Equity ownership	(1)	(2)	(3)	(4)	(5)
Panel A					
Internal locus of control		0.086*** (0.013)	0.070*** (0.013)	0.052*** (0.013)	0.024** (0.011)
Optimism	0.011* (0.006)	0.002 (0.006)	0.004 (0.006)	0.008 (0.005)	0.005 (0.005)
$R^2$	0.02	0.05	0.10	0.22	0.31
Panel B					
Internal locus of control		0.083*** (0.013)	0.071*** (0.013)	0.055*** (0.013)	0.026** (0.011)
Trust	0.102*** (0.028)	0.094*** (0.027)	0.070*** (0.027)	0.047** (0.024)	0.032 (0.021)
$R^2$	0.03	0.06	0.11	0.22	0.31
Panel C					
Internal locus of control		0.081*** (0.009)	0.075*** (0.009)	0.056*** (0.009)	0.028*** (0.008)
Openness	0.034*** (0.010)	0.017 (0.010)	0.005 (0.011)	-0.003 (0.009)	0.003 (0.008)
Conscientiousness	-0.013 (0.010)	-0.025*** (0.010)	-0.024** (0.010)	-0.016* (0.009)	-0.016** (0.008)
Extraversion	-0.012 (0.010)	-0.013 (0.010)	-0.008 (0.010)	-0.029*** (0.008)	-0.023*** (0.007)
Agreeableness	-0.030*** (0.011)	-0.032*** (0.010)	-0.010 (0.010)	0.011 (0.010)	0.018** (0.008)
Neuroticism	-0.027*** (0.009)	-0.014 (0.009)	0.012 (0.009)	-0.007 (0.009)	-0.003 (0.008)
$R^2$	0.03	0.06	0.11	0.22	0.31
Socio-demographic characteristics:	No	No	Yes	Yes	Yes
Risk aversion and patience:	No	No	No	Yes	Yes
Income and wealth:	No	No	No	No	Yes

Linear probability models (OLS). Panels A, B and C have, respectively, subsamples of 9,288 household-year observations (1,032 households), 9,096 household-year observations (1,011 households), and 15,724 household-year observations (2,743 households). The dependent variable is a dummy that takes the value of one if the respondent household owns any equity. Optimism is measured via the 24-point scale LOT-R. Trust is measured via a dummy for trusting others as asked in the World Value Survey. The Big Five are measured in standardized indices constructed using the 50-item scales in Goldberg (1992). Socio-demographic characteristics include a quadratic term for age and dummies for gender, education, marital status, household composition, household size, and household head occupation. Risk aversion and patience include both time-constant indices. Income and wealth include six dummies for net household income and three dummies for household wealth quartile. All regressions include a full set of year and region interaction dummies as additional controls. Standard errors clustered at the household level in parenthesis. \*\*\* denotes significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

# Appendix

## Internal (economic) locus of control items:

*Please indicate for the following statements to which extent you agree or disagree. 1 means 'totally disagree' and 7 means 'totally agree':*

1. Saving and careful investing is a key factor in becoming rich
2. Whether or not I get to become wealthy depends mostly on my ability
3. In the long run, people who take very good care of their finances stay wealthy
4. If I become poor, it's usually my own fault
5. I am usually able to protect my personal interests
6. When I get what I want, it's usually because I worked hard for it
7. My life is determined by my own actions
8. There is little one can do to prevent poverty (reverse coded)
9. Becoming rich has nothing to do with luck
10. Regarding money, there isn't much you can do for yourself when you are poor (reverse coded)
11. It's not always wise for me to save because many things turn out to be a matter of good or bad fortune (reverse coded)
12. It is chiefly a matter of fate whether I become rich or poor (reverse coded)
13. Only those who inherit or win money can possibly become rich (reverse coded)

**Financial risk aversion items:**

*The following statements concern saving and taking risks. Please indicate on a scale from 1 to 7 to what extent you agree with the following statements, where 1 indicates ‘totally disagree’ and 7 indicates ‘totally agree’:*

1. I think it is more important to have safe investments and guaranteed returns, than to take a risk to have a chance to get the highest possible returns
2. I would never consider investments in shares because I find this too risky
3. If I think an investment will be profitable, I am prepared to borrow money to make this investment
4. I want to be certain that my investments are safe
5. I get more and more convinced that I should take greater financial risks to improve my financial position
6. I am prepared to take the risk to lose money, when there is also a chance to gain money

**Patience items:**

*Now follow some statements about the future. Please indicate on a scale from 1 to 7 to what extent you agree with the following statements, where 1 indicates 'totally disagree' and 7 indicates 'totally agree':*

1. I think about how things can change in the future, and try to influence those things in my everyday life
2. I often work on things that will only pay off in a couple of years
3. I am only concerned about the present, because I trust that things will work themselves out in the future
4. With everything I do, I am only concerned about the immediate consequences (say a period of a couple of days or weeks)
5. Whether something is convenient for me or not, to a large extent determines the decisions that I take or the actions that I undertake
6. I am ready to sacrifice my well-being in the present to achieve certain results in the future
7. I think it is important to take warnings about negative consequences of my acts seriously, even if these negative consequences would only occur in the distant future
8. I think it is more important to work on things that have important consequences in the future, than to work on things that have immediate but less important consequences
9. In general, I ignore warnings about future problems because I think these problems will be solved before they get critical
10. I think there is no need to sacrifice things now for problems that lie in the future, because it will always be possible to solve these future problems later
11. I only respond to urgent problems, trusting that problems that come up later can be solved in a later stage
12. I get clear results in my daily work, this is more important to me than getting vague results

**Table A.1:** Summary statistics of all the key variables in the DHS

	Obs.	Mean	Percentile				
			Min	10 <sup>th</sup>	50 <sup>th</sup>	90 <sup>th</sup>	Max
Internal locus of control (unstandardized)	11,122	4.56	1.92	3.87	4.56	5.27	6.77
Owns equity	11,122	0.29					
Owns stocks	11,122	0.14					
Owns mutual funds	11,122	0.22					
Owns bonds	11,122	0.03					
Owns other assets	11,122	0.02					
Age	11,122	47.30	25	32	48	61	80
Female	11,122	0.40					
High school educated	11,122	0.31					
University educated	11,122	0.45					
People in household	11,122	2.41	1	1	2	4	8
<i>Household type:</i>							
Living alone	11,122	0.30					
Living with partner, no kids	11,122	0.30					
Living with partner and kids	11,122	0.34					
Living with kids	11,122	0.04					
Other	11,122	0.02					
<i>Occupation:</i>							
Employed	11,122	0.77					
Own business	11,122	0.06					
Self-employed	11,122	0.03					
Unemployed	11,122	0.01					
Works own household	11,122	0.09					
Retired	11,122	0.03					
Volunteer	11,122	0.01					
Other	11,122	0.03					
<i>Household net income:</i>							
Less than €10,000	11,122	0.04					
Between €10,000 and €14,000	11,122	0.09					
Between €14,000 and €22,000	11,122	0.28					
Between €22,000 and €40,000	11,122	0.40					

(Continued on next page)

**Table A.1** – continued from previous page

	Obs.	Mean	<i>Percentile</i>				
			Min	10 <sup>th</sup>	50 <sup>th</sup>	90 <sup>th</sup>	Max
Between €40,000 and €75,000	11,122	0.14					
€75,000 or more	11,122	0.02					
Household financial wealth (thousands of €)	11,122	33.10	0	1.05	11.9	78.1	3,181
Share of wealth in equity	11,122	0.12	0	0	0	0.51	1
Share of wealth in stocks	11,122	0.04	0	0	0	0.05	1
Share of wealth in mutual funds	11,122	0.08	0	0	0	0.34	1
Share of wealth in bonds	11,122	0.01	0	0	0	0	0.99
Share of wealth in other assets	11,122	0.01	0	0	0	0	1
Risk aversion (unstandardized)	11,122	5.16	1.5	4	5.2	6.28	7
Patience (unstandardized)	11,122	4.22	2	3.44	4.2	5.01	6.58
Subjective financial literacy	8,118	2.23	1	1	2	3	4
Total financial literacy score	7,502	10.80	0	5	12	15	16
Basic financial literacy score	7,502	4.17	0	3	4	5	5
Advanced financial literacy score	7,502	6.67	0	2	7	10	11
Optimism	6,261	10.70	3	8	11	14	15
Trust	6,110	0.43					
Openness	10,756	0	-4.25	-1.22	-0.03	1.37	3.12
Conscientiousness	11,122	0	-3.85	-1.34	0.04	1.32	2.69
Extraversion	10,756	0	-3.06	-1.29	-0.04	1.28	3.06
Agreeableness	10,756	0	-4.97	-1.21	0.04	1.33	2.33
Neuroticism	10,756	0	-2.26	-1.33	-0.03	1.31	3.48
Experience: Years investing in equity	11,122	1.81	0	0	0	6	22

**Table A.2:** Internal locus of control and investor experience

Dependent variable: Time-varying measure of internal locus of control	(1)	(2)	(3)	(4)
Experience: Years investing in equity	0.029*** (0.006)	0.015** (0.006)	-0.000 (0.004)	0.004 (0.008)
First measure of internal locus of control			0.776*** (0.018)	
Socio-demographic characteristics:	No	Yes	Yes	Yes
Risk aversion and patience:	No	Yes	Yes	Yes
Income and wealth:	No	Yes	Yes	Yes
Household fixed effects:	No	No	No	Yes
$R^2$	0.02	0.14	0.56	-

OLS regressions with a subsample of 7,263 household-year observations for 2,609 households observed in 2005, 2006, 2007, 2009, 2011, 2013, and 2015. The dependent variable is a time-varying measure of internal locus of control, constructed as the within-year average of the 13 items reported in the DHS. Experience is the cumulative number of years a household has held equity in the past. The first measure of locus of control is time-constant. Socio-demographic characteristics include a quadratic term for age and dummies for gender, education, marital status, household composition, household size, and household head occupation. Income and wealth include six dummies for net household income and three dummies for household wealth quartile. All regressions include a full set of year and region interaction dummies as additional controls. Standard errors clustered at the household level in parenthesis. \*\*\* denotes significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

**Table A.3:** Locus of control and investing in financial options

Outcome =	Option Buyer (1)	Option Seller (2)	Buyer & Seller (3)
Internal locus of control	1.017 (0.247)	1.951** (0.615)	1.758 (0.616)
Risk aversion	0.482*** (0.114)	0.382*** (0.124)	0.483** (0.162)
Patience	1.043 (0.305)	0.920 (0.162)	0.614 (0.336)
Base outcome:	Has equity but not options		
Socio-demographic characteristics:	Yes		
Risk aversion and patience:	Yes		
Income and wealth:	Yes		

Multinomial logit with an estimation sample of 3,198 household-year observations for 849 households observed in the 1994-2015 period. Odds ratios reported. The dependent variable categorizes households based on whether they sold financial options, they bought them, they did both, or they did neither in a given DHS wave. Socio-demographic characteristics include a quadratic term for age and dummies for gender, education, marital status, household composition, household size, and household head occupation. Income and wealth include six dummies for net household income and three dummies for household wealth quartile. The model includes a full set of year and region interaction dummies as additional controls. Standard errors clustered at the household level in parenthesis. \*\*\* denotes significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

**Table A.4:** Main results with different constructions of locus of control

Dependent variable: Equity ownership	<i>Time-invariant</i>		<i>Time-varying</i>		
	>30 years old (1)	First measure (2)	Std. mean (3)	Factor analyses (4)	Lagged mean (5)
Internal locus of control	0.021** (0.009)	0.019** (0.010)	0.033*** (0.010)	0.033*** (0.011)	0.031** (0.012)
Risk aversion	-0.148*** (0.009)	-0.126*** (0.011)	-0.130*** (0.010)	-0.153*** (0.011)	-0.113*** (0.011)
Patience	0.023*** (0.008)	0.017* (0.009)	0.025*** (0.009)	0.024** (0.010)	0.016 (0.012)
Socio-demographic characteristics:	Yes	Yes	Yes	Yes	Yes
Income and wealth:	Yes	Yes	Yes	Yes	Yes
Observations	10,375	11,122	3,518	3,510	2,415
Households	2,172	2,362	1,729	1,729	1,143
$R^2$	0.30	0.25	0.27	0.27	0.24

Linear probability models (OLS). The dependent variable is a dummy that takes the value of one if the respondent household owns any equity. >30 years old: Main measure, but sample restricted to household heads older than 30. First measure: Standardized mean of items when they were first measured in the DHS. Std. mean: Using the time-varying mean of items as indices. Factor analyses: Weighted time-varying indices, with linear weights derived from a factor analyses of each item set. Lagged mean: One-year lags of simple mean indices as predictors. Socio-demographic characteristics include a quadratic term for age and dummies for gender, education, marital status, household composition, household size, and household head occupation. Income and wealth include six dummies for net household income and three dummies for household wealth quartile. All regressions include a full set of year and region interaction dummies as additional controls. Standard errors clustered at the household level in parenthesis. \*\*\* denotes significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

**Table A.5:** The effect of locus of control in the ownership of different types of financial assets

Dependent variable: Ownership of different assets types	Stocks (1)	Mutual funds (2)	Bonds (3)	Other assets (4)
Internal locus of control	0.023*** (0.006)	0.009 (0.007)	0.006 (0.004)	0.003 (0.002)
Risk aversion	-0.107*** (0.007)	-0.103*** (0.008)	-0.020*** (0.004)	-0.007*** (0.002)
Patience	0.011* (0.006)	0.028*** (0.006)	0.007* (0.004)	0.005** (0.002)
Socio-demographic characteristics:	Yes	Yes	Yes	Yes
Income and wealth:	Yes	Yes	Yes	Yes
$R^2$	0.22	0.22	0.06	0.03

Linear probability models (OLS) with an estimation sample of 16,184 household-year observations for 2,947 households observed in the 1994-2015 period. The dependent variable is a dummy that takes the value of one if the respondent household owns any of the assets marked above. Socio-demographic characteristics include a quadratic term for age and dummies for gender, education, marital status, household composition, household size, and household head occupation. Income and wealth include six dummies for net household income and three dummies for household wealth quartile. All regressions include a full set of year and region interaction dummies as additional controls. Standard errors clustered at the household level in parenthesis. \*\*\* denotes significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.

**Table A.6:** The effect of locus of control on equity ownership, corrected for measurement error

Dependent variable: Equity ownership	OLS Index 1 (1)	OLS Index 2 (2)	2SLS (3)	3SLS (4)
Internal locus of control	0.027*** (0.007)	0.030*** (0.008)	0.070** (0.029)	0.073*** (0.012)
Risk aversion	-0.138*** (0.007)	-0.125*** (0.008)	-0.151*** (0.011)	-0.161*** (0.005)
Patience	0.031*** (0.007)	0.026*** (0.007)	0.041*** (0.012)	0.040*** (0.005)
First stage statistics:			(F-statistic)	(t-statistic)
Internal locus of control:	-	-	42.81	39.55
Risk aversion:	-	-	841.66	138.85
Patience:	-	-	420.80	105.18
Socio-demographic characteristics:	Yes	Yes	Yes	Yes
Income and wealth:	Yes	Yes	Yes	Yes

Columns (1) and (2): Linear probability models (OLS) with two sets of indices for locus of control, risk aversion, and patience constructed with different partitions of the sets of items for each construct. Column (3): Two Stage Least Squares Instrumental Variable regression, instrumenting the first indices with the second indices. Column (4): Three Stage Least Squares regression, where the exclusion restriction for each one of the first indices is the second index. Estimation subsample of 15,810 household-year observations for 2,769 households observed in the 1994-2015 period. The dependent variable is a dummy that takes the value of one if the respondent household owns any equity. Socio-demographic characteristics include a quadratic term for age and dummies for gender, education, marital status, household composition, household size, and household head occupation. Income and wealth include six dummies for net household income and three dummies for household wealth quartile. All regressions include a full set of year and region interaction dummies as additional controls. Standard errors clustered at the household level in parenthesis. \*\*\* denotes significance at the 1% level, \*\* at the 5% level, and \* at the 10% level.