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Locus of Control and Investment in Risky Assets

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ABSTRACT

Locus of Control and Investment in Risky Assets*

We show that 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. This relation holds when we control for economic preferences and possible confounders such as financial literacy, overconfidence, optimism, trust, and other personality traits. We argue that this relation is driven by a link between internal economic 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.

JEL Classification: G11, D14, D19

Keywords: household portfolios, personality traits, risk and time preferences, risk perception

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1 Introduction

Individual participation in the stock market is now common. Around half of U.S. households and a third of U.K. households invest in the stock market and, in the Netherlands, about a quarter of all households owned stock or mutual funds in 2005 (Van Rooij et al., 2011). The widespread participation of household investors in the stock market demands 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 social preferences and financial literacy also play an important role in portfolio choice (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). In addition, other studies have shown the immense importance of other aspects of personality (and, generally of non-cognitive skills) for various economic outcomes (e.g., Heckman et al., 2006; Borghans et al., 2008; Almlund et al., 2011). In particular, internal locus of control—that is, the extent to which a person believes that the outcomes in one’s life are due to one’s own personal efforts, as opposed to the result of luck, change, fate, or the intervention and influence of others (Rotter, 1966)—has been found to be important in a wide range of economic situations. Internal locus of control impacts labor market outcomes (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 been ignored.

This paper shows how a person’s internal *economic* locus of control affects investment

decisions in equity. Internal economic locus of control captures the perception that economic outcomes, such as the creation of wealth, are due to personal efforts (Furnham, 1986).¹ 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 to the share of risky investments in a household’s total portfolio. Our results show that a one standard deviation increase in one’s internal economic 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 8% and 10% of their respective unconditional means.

We address several potential identification concerns in our estimation. First, we show that our main results are robust to the inclusion of risk and time preferences. Second, we show that the positive relation between internal economic locus of control and equity investment is not driven by a household’s subjective or objective financial literacy. Third, we show that internal economic locus of control does not act as a proxy for other personality traits, such as overconfidence, optimism, trust, and the Big Five. We further show that our results remain robust to the use of alternative definitions of internal economic locus of control and that its effects are mainly on stock investment and not other diversified equity types.

We argue that the mechanism behind the positive relation between an internal economic locus of control and equity investment is risk perception. We show that the positive relation between having an internal economic locus of control and investing in equity is

¹Internal locus of control captures the extent to which individuals believe they are in control of their own future. The concept is silent, however, about which actions one must undertake to achieve this control. In our setting, this means that internal economic locus of control cannot predict whether an “in-control investor” would be more active or passive in the stock market. This is one of the key differences between the effects of internal economic locus of control and overconfidence in an investor model.

driven by the negative influence of an internal economic 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. We document this mechanism by using a selection of households that invest in financial options. Financial options are a particular type of equity that *increases* in value as the variance of their underlying assets increases. Therefore, perceiving less risk in equity should make financial options seem overvalued and thus make them more attractive to sell but not to buy. Consistent with our hypothesized mechanism, we show that a stronger internal economic locus of control generally increases equity participation and also increases the likelihood of *selling* (not buying) financial options.

Our findings contribute to the literature on the behavioral and psychological drivers of individual financial investment, such as the works of De Bondt (1998), Barber and Odean (2001), Puri and Robinson (2007), and Grinblatt and Keloharju (2009). This literature is primarily focused on the impact of overconfidence and optimism on individual investment decisions but largely ignores other personality traits, such as an internal economic locus of control, that can add to the understanding of individual investment from a different perspective.² We further contribute to our understanding of personality-driven investment behavior, not only by assessing the impact of internal economic 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

²Two 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 analyses but do not investigate further.

between internal economic 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 internal economic 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 to alternative definitions of internal economic locus of control and explores its impact on different types of assets. Section 7 concludes the paper.

2 The Dutch National Bank Household Survey

2.1 Measuring equity and financial wealth

For this study we use information from the 1994-2015 waves 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 16.³ 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 only use the information provided by household heads responsible for the household finances. These respondents are also in charge of reporting the household's asset holdings in the survey. Finally, we only keep households that report a positive amount of financial wealth and some cash holdings. Our estimation sample includes only households for which we have data on financial assets, measures of internal 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.⁴

We define participating in equity as holding a positive amount of (at least one of)

³For a detailed description of the DHS, see Kapteyn and Teppa (2011) or visit the CentERdata website at www.centerdata.nl.

⁴In robustness checks, the number of cases varies with the available information used in these analyses.

the following financial products: stocks and shares (excluding private equity holdings in one’s own company), mutual funds, and financial options. To calculate a household’s total financial wealth, we add the total value of the household’s equity holdings to the value of its 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 analyses 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).⁵

2.2 Measuring internal economic locus of control

Each year between 2005 and 2007 and every two years afterward, the DHS included a block of 13 statements measuring internal economic locus of control that are a subset of the items from the validated scale of Furnham (1986).⁶ As mentioned above, a person’s economic locus of control measures the extent to which the 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 (on a seven-point Likert scale) with the importance of their own actions for their financial wealth creation in various situations. The full list of statements is reported in the Appendix.

We construct a time-invariant measure of internal economic locus of control in the following way: We first reverse appropriate items so that higher scores on all 13 statements correspond to people with a stronger internal economic locus of control (i.e., those who

⁵All our monetary variables are measured in nominal euros and we use a conversion rate of 2.20371 guilders per euro for amounts measured before 2003.

⁶This scale was 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 behavior 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 Furnham’s scale is positively correlated with internal locus of control measured by Rotter’s scale.

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). Second, we take the mean of the 13 statements for each person by year. Finally, we take the time average of these means for each person.⁷ We make the assumption that internal economic locus of control is stable over time for the people in our sample, based on evidence that shows that locus of control forms during childhood and stabilizes during adolescence (Sherman, 1984) and is invariant to even strong changes in personal circumstances (Cobb-Clark and Schurer, 2013). We do, however, relax this assumption in Section 6. The unstandardized internal economic locus of control distribution is bell shaped and spreads across the entire 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 by the standard deviation, although our results are robust to different constructions of this index.⁸

2.3 Measuring risk and time preferences

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, thereby 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 behavior and to risk preferences elicited using lottery choices (e.g., Barsky et al., 1997). The DHS questionnaire includes 12 questions measuring patience and the

⁷Even 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., McNish, 1982; Coleman and DeLeire, 2003; Cebi, 2007; Cobb-Clark and Schurer, 2013).

⁸Constructing internal economic locus of control indices through more sophisticated methods, such as the first component of a confirmatory principal component analysis or a factor analysis, yields nearly identical results.

extent to which individuals consider the future consequences of their current decisions from Strathman et al. (1994).⁹ 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 patience or, equivalently, a lower intertemporal discount rate) similarly to the way we construct the internal economic locus of control index. A complete list of all the items used in both the risk and patience indices is available in the Appendix.

We control for an extensive set of individual and household sociodemographic characteristics that have been shown to be important for household investment decisions and which could be correlated with an internal economic locus of control. Our analyses include individual characteristics of the household head, such as a quadratic term for age, gender, 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 affect all households in the same region and at the same time (e.g., aggregate market return variations or regional differences in propensity to invest in equity). Table A.1 in the Appendix shows summary statistics for all the main variables in our analyses for our main estimation sample. Further, in Section 4, we explore in detail the role of potentially key confounding variables such as financial literacy, overconfidence, optimism, trust, and other personality traits.

⁹We 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). See the Appendix for a full list of the items used to construct the internal economic locus of control, financial risk aversion, and patience indices.

3 Impact of internal economic locus of control on risky asset investment decisions

Table 1 reports the ordinary least squares (OLS) coefficients of linear probability models relating the probability of investing in equity under various specifications: raw correlation (Column (1)), after controlling for sociodemographic 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) in Table 1) suggests that a one standard deviation increase in internal economic locus of control results in a 7.3 percentage point higher probability of investing in equity. Controlling for sociodemographic characteristics (Column (2)) reduces the marginal effects by about one percentage point.¹⁰ More important is whether an internal economic locus of control is related to 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 economic locus of control, which is shown for time preferences by Plunkett and Buehner (2007) and suggested for risk aversion by McInish (1982). Column (3) shows that controlling for economic preferences results in a further decrease of the marginal effect of economic locus of control by 1.3 percentage points compared to Column (2), but it still remains highly significant at the 1% level. We further find that the likelihood of holding equity decreases with risk aversion and increases with patience. This finding is consistent with most portfolio models and with the majority of empirical studies on stock market participation.

¹⁰With 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 finding can fully be explained by differences in risk preferences between men and women.

Since holding equity strongly depends on household income and wealth and savings are related to an internal economic locus of control (Cobb-Clark et al., 2013), in Column (4) of Table 1, we additionally control for household income and household wealth. These variables are essential for explaining equity participation and have become standard in the household portfolio literature (e.g., Hong et al., 2004; Guiso et al., 2008). Adding these controls could, however, introduce endogeneity in our model, since equity holdings could themselves co-determine other sources of household wealth, which are also likely to be influenced by peoples' internal economic 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 a further reduction of the marginal effect of economic locus of control. Nevertheless, the relation still remains highly statistically significant: A one standard deviation increase in internal economic locus of control is associated with a 2.4 percentage point higher likelihood of investing in equity. This marginal effect is relatively large, since it corresponds to about one-third of the unconditional effect reported in Column (1) and to 8.3% of the share of households in our data who hold equity. The impact of a one standard deviation increase in internal economic locus of control on risky asset participation is similar to the impact of a one standard deviation in numeracy, as reported by Christelis et al. (2010).

The availability of information on the portfolio share of equity as a proportion of a household's total financial wealth allows us to look not only at the impact of internal economic locus of control on equity investments at the extensive margins, but also at the intensive margin. We rerun the analysis reported in Table 1, replacing the probability of investing in equity with the portfolio share of equity as the dependent variable. Because 70% of all households hold no equity, we estimate a fractional regression to account for the participation hurdle at zero. Table 2 shows the results of this exercise. We find that internal economic locus of control is positively related to the share of wealth invested in

equity and negatively correlated to cash holdings. A one standard deviation increase in internal economic locus of control is associated with a 1.3 percentage point increase in the portfolio share of equity, which is about 11% of the average share of equity for households in our data.¹¹

4 Potential confounders

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

4.1 Financial literacy

Financial literacy plays an important role in portfolio choices, since financial knowledge increases the likelihood of investing in the stock market (Van Rooij et al., 2011). Literacy is also likely to be related to economic locus of control, chiefly because the acquisition of more financial literacy can be a form of human capital accumulation, which has been shown to be driven by one's locus of control (Coleman and DeLeire, 2003). However, it could also be that people with an internal economic locus of control invest more in their financial literacy, which then leads them to invest in equity. In either case, it is important to control for financial literacy as a confounder and as a potential channel that could drive the relation between economic locus of control and investment in equity.

¹¹The general conclusions on potential confounders on equity participation, which we present in Section 4, also hold for portfolio shares. We thus decide to focus on equity participation for the remainder of the paper.

Our data include both a self-assessment and an objective assessment of financial literacy; an internal economic 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 four-point scale, from 1 “not knowledgeable” to 4 “very knowledgeable”. This question is asked in the DHS from 2004 onward. 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 by the total numbers of correct answers to all questions, the basic questions, and the advanced questions, respectively.¹²

Table 3 shows the results of analyses in which we add controls for financial literacy. Column (1) shows that controlling for subjective literacy does not change our main results. We still find that internal economic locus of control is positively and significantly related to the likelihood of investing in equity. The same holds if we control for the overall financial literacy score, as shown in Column (2), although including the overall financial literacy score does reduce the size of the marginal effect to 0.035. Both columns show that subjective literacy and the overall financial literacy score are significantly positively related to investing in equity; individuals who report being more knowledgeable are more likely to invest in equity. Column (3) presents the results of an estimation in which we distinguish between basic and advanced literacy and shows that the marginal effect of our internal economic locus of control measure remains highly significant. In addition, advanced literacy is significantly positively related to the likelihood of investing in equity, but this relation does not hold for basic financial literacy. Adding controls for socioe-

¹²The complete set of questions for objective financial literacy can be found in the study of Van Rooij et al. (2011, pp. 452–454). These questions are only asked in 2004–2005, reducing the number of observations we can use for this sub-analysis. To maximize power, we take the time-constant average of these questions for each respondent across the 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.

economic characteristics of the household head (Column (4)) and economic preferences (Column (5)) hardly affects the magnitude of the marginal effect of economic locus of control and does not affect its significance. In the last column of Table 3, the marginal effect of economic locus of control decreases 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 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 financial literacy, which indicates that the latter is not a confounder for our main results. We thus conclude that financial literacy, either as a confounder or a mechanism, cannot fully account for our main results.

4.2 Overconfidence

A second important potential confounder is overconfidence. Overconfidence holds an important place in the behavioral finance literature, with the seminal papers of both Barber and Odean (2001) and Malmendier and Tate (2005) showing that overconfidence is significantly related to investment decisions. Although fundamentally different concepts, internal economic locus of control could be related to overconfidence, making overconfidence a potential confounding factor in our analyses.

To test overconfidence as a potential confounder, we construct a measure of overconfidence in two stages. First, we regress subjective financial literacy on objective financial literacy. Second, we take the time-constant average of the residual of this regression for each respondent as our measure of overconfidence. The rationale of this measure is that the residuals capture variation in subjective financial literacy over and above measured objective literacy, much in the spirit of the optimism measured by Puri and Robinson

(2007). 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 construct a sufficiently varying measure of overconfidence. We next use this measure of overconfidence as an additional regressor in our analyses.¹³

Column (1) of Table 4 documents the relation between our overconfidence measure and investments in equity and shows that, as expected, overconfidence is significantly positively associated with a stronger likelihood of investing in equity. Controlling for overconfidence does not alter our main conclusion, as can be seen from Columns (2) through (5). Overconfidence does not explain away the relation we find between internal economic locus of control and the likelihood of investing in equity. In Columns (4) and (5), we show that overconfidence is actually explained away by the inclusion of risk and time preferences, while the effect of internal economic locus of control remains similar to that reported in Column (4) of Table 1. We thus conclude that overconfidence is not driving our main results.

A potential concern with our analysis above is that our measure of overconfidence is simply too noisy, which differentiates it from economic locus of control. We have two reasons to believe this is not the case. First, Columns (1) through (3) of Table 4 show a robust and precisely estimated positive effect of overconfidence on investment in equity, even after including economic locus of control in our regressions. This result could not occur with an inherently noisy measure. Second, the leading models of overconfidence in behavioral finance make punctual predictions about the way overconfidence should affect investment in equity and internal economic locus of control simply does not adhere

¹³Subjective 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 could, in principle, yield a time-varying measure of overconfidence. Taking the time-varying mean of the residuals is efficient in terms of power. However, analyses with time-varying overconfidence yield similar results.

to those predictions. Specifically, Gervais and Odean (2001) show that overconfidence should decrease with investor experience. If economic locus of control is simply a proxy for overconfidence, it should also decrease with experience. To check whether this is the case, we regress investor experience investing in equity, measured as the cumulative number of years that an investor has held equity, on a time-varying measure of internal economic locus of control, measured as the individual-specific yearly mean of the 13 items. Table 5 reports several specifications of this regression. Columns (1) and (2) show that internal economic locus of control actually *increases* with additional years of experience as an investor. This finding alone suggests that economic locus of control is not likely to be a proxy for overconfidence. Furthermore, when we control for each person’s first measure of internal economic locus of control (Column (3)) or when we add individual fixed effects (Column (4)), we find no relation between years of experience as an equity investor and economic locus of control. This result strongly suggests that internal economic locus of control is constant over time but, more importantly, that it does not decrease with experience the way overconfidence would. We are therefore reassured that our main effects are not driven by overconfidence.

4.3 Optimism, trust, and the Big Five personality traits

There are at least three other possible confounders we explicitly consider for the relation between internal economic locus of control and investment in equity: optimism, trust, and the Big Five personality traits. All three have been shown to be (somewhat) related to investment in equity (Agnew and Szykman, 2005; Puri and Robinson, 2007; Guiso et al., 2008) and several personality studies show a positive correlation between internal economic locus of control and these variables (e.g., Guarnera and Williams, 1987; Hoorens and Buunk, 1993; Albanese et al., 2013). Therefore, it is important to check that the relation between internal economic locus of control and investment in equity does not

simply capture unobserved differences in optimism, trust, and other personality traits.

To control for optimism, we use the index constructed from the Life Orientation Test, revisited (LOT-R) of Scheier et al. (1994). This is a validated standard measure of optimism also used by Guiso et al. (2008) in household portfolio analyses of the DHS.¹⁴ Column (1) of Panel A in Table 6 shows that the relation between optimism and the likelihood of investing in equity is only weakly significant in our data. Columns (2) to (5) show that the inclusion of optimism does not affect the marginal effect of internal economic locus of control. This result suggests that internal economic locus of control does not simply act as a proxy for optimism.

Guiso et al. (2008) argue that there is a positive relation between trust and investment in equity. This relation would imply that failing to control for trust could result in an overestimation of the marginal effect of economic locus of control if 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 that “most people can be trusted”, as opposed to answering “you can never be too careful when dealing with others”.¹⁵ Column (1) of Panel B in Table 6 shows that trust is positively related to the likelihood of investing in equity. However, controlling for trust in the analyses does not affect the marginal effect of internal economic locus of control (Columns (2)–(5)).

We finally consider whether internal economic locus of control acts as a proxy for other personality traits (Panel C in Table 6). To rule out this possibility, we use a 50-item

¹⁴The items and measurement methodology for the LOT-R can be found in the work of 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.

¹⁵We again expand these measures to be time constant throughout the DHS panel to maximize power.

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 personality traits (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 analogously to the way we aggregate the internal economic locus of control items.¹⁶ Column (1) of Panel C in Table 6 shows that some of the personality traits are indeed correlated with investment in equity. Columns (2) to (5), however, indicate that the marginal effect of internal economic locus of control is not affected by inclusion of the Big Five in the analysis.

In sum, in all the models reported in Column (5) of Table 6, the marginal effect of internal economic locus of control is similar to that reported in Column (4) of Table 1. This result suggests that internal economic locus of control does not capture other aspects of personality or trust.¹⁷

¹⁶The complete 50-item Big Five questionnaire is included in the 2005, 2009, 2013, and 2014 waves of the DHS. Under the classical assumption that these personality traits are stable over time—supported by Cobb-Clark and Schurer (2012), among others—we use their overall mean as a time-constant measure for them.

¹⁷One potential confounder we cannot address is the possible correlation between internal economic 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 do not include a measure of self-esteem, yet the items measuring economic locus of control differ sufficiently from the classical measures of self-esteem (Rosenberg scale) to alleviate some of the concerns for omitted variable bias. Furthermore, self-esteem cannot explain the behavioral mechanism described in Section 5.

5 Economic locus of control and the subjective perception of risk

In this section, we argue that a likely mechanism underlying our main findings is that household heads with an internal economic locus of control have a lower perception of the variance of the returns to risky asset investments compared to those with an external economic locus of control. This induces the former 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 to their benefit. The ex ante outcome variance, which captures fundamental uncertainty, should then be perceived as less pronounced for people with an internal economic locus of control.

Evidence from several studies supports this hypothesized mechanism, starting with the extensive work of Paul Slovic on risk perception and its drivers (in particular, (see Slovic, 1992)). Following this study, there was a surge of research on the relation between locus of control and risk perception, predominantly in the domain of health. Regarding 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.¹⁸ 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 a lower weighting of the probability of health and disease risks. For a broader range of domains, Kallmen (2000) measures the perception of risk, both to

¹⁸Specifically, they consider the risk of suffering from a drinking problem, contracting AIDS, having a heart attack before the age of 40, attempting suicide, or being diagnosed with cancer.

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 contracting AIDS. Both studies show that an internal locus 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 a lower perception of risk in launching a new business venture.¹⁹

We complement this evidence by testing the link between internal economic locus of control and the perception of risk in financial investments. 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 a household’s investments in equity) and the return variance of their underlying assets. For equity, generally, an internal economic locus of control should lower the perceived risk of these assets, encouraging risk-averse households to hold relatively more of them. Financial options, however, are a particular type of equity: They become *more* valuable when the price of their underlying asset is more volatile, since higher underlying volatility results in a larger probability that the option will be “in the money” (see Black and Scholes, 1973). Thus, we would expect that investors with a stronger internal economic locus of control (those who perceive the underlying assets of options as less risky) will consider the market price of options as relatively high compared to their own valuation and will therefore be more likely to sell them and less likely to buy options.²⁰

The DHS collects detailed information on the respondents’ types of option investments.

¹⁹Although the evidence strongly suggests a link between internal locus of control and lower risk perception, it is not unanimous. For more details, see Crisp and Barber (1995) and Riechard and Peterson (1998).

²⁰The 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.

In particular, it asks whether households have open positions in financial options and whether they bought or sold them. Using the subsample of equity investors only, we estimate a multinomial model for being an option seller, an option buyer, or both a seller and a buyer (the reference category is holding equity but no options). The estimation results are reported in Table A.2 in the Appendix and summarized in Figure 2. The table and figure show a significant positive relation between internal economic locus of control and the likelihood of *selling* options. For buyers, the relation is not significant, in spite of the fact that buyers are more prevalent than sellers in our data. Together with the evidence linking locus of control to risk perception, our test provides indirect but compelling evidence supporting our hypothesized mechanism.

6 Robustness checks

6.1 Stability of internal economic locus of control

Throughout this paper, we have maintained the assumption that internal economic locus of control as well as risk aversion and patience are stable within individuals. The evidence in the literature supports these assumptions (Sherman, 1984; Salamanca, 2010; Cobb-Clark and Schurer, 2013; Salamanca, 2016). However, in this section, we consider a few models where we relax this assumption.

We first estimate a model in which we restrict the sample to household heads aged 30 or more. For the people in this estimation sample, it is more likely that internal economic locus of control and economic preferences have stabilized. Column (1) of Table A.3 in the Appendix shows that our main finding holds when we apply this sample restriction. In additional analyses, we use the first measure of internal economic locus of control observed in the data and treat it as time constant (Column (2)), we use a time-varying measure of internal economic locus of control (Column (3)), and we use lagged time-varying measures

of all the regressors (Column (4)). These analyses are all aimed at establishing Granger-causal evidence of the effect of internal economic locus of control on investment in equity. We find that our main finding is robust to the alterations of the definitions of internal economic locus of control.

6.2 Equity types and other assets

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 stocks, mutual funds, and options, of which the former two are by far the leading components. Table A.4 in the Appendix shows that the relation we find between internal economic locus of control and equity holding is exclusively driven by the fact that household heads with a high internal economic locus of control are more likely to hold stock (Column (1)). This finding is consistent with stocks being the riskier asset class, where internal economic locus of control can have the most sizeable effect by decreasing their perceived risk. In Columns (3) and (4), we also explore whether internal economic locus of control is related to bonds and other asset holdings, but we find no such evidence.²¹

7 Conclusion

A growing body of literature in finance and economics shows that household investors' decisions are related to factors that are not fully captured by classical portfolio theory. 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

²¹Note that risk aversion is negatively related to all components of equity, especially stocks, and that patience is mostly positively related to mutual funds that have a longer payout period. These results are all consistent with the general treatment of these asset classes by portfolio theory.

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 that are prominent in the literature. We also show that this relation is not driven by the fact that economic locus of control is a proxy for other traits or attitudes, such as overconfidence, optimism, trust, or the Big Five personality traits. Robustness checks show that our main results hold even after relaxing the assumption that internal economic locus of control is stable over time. We also show that internal economic locus of control is particularly related to participation in stocks, 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 empirically link locus of control, an important personality trait, to a household's investment behavior. More importantly, they increase our understanding of the role of personality and non-cognitive traits in investment behavior and help us understand this effect under the traditional risk–return paradigm in investment. We hope that our way of thinking about the link between personality and risk perception serves to guide formal understanding of the role of other non-cognitive traits in economic decision making.

Our results also have two important implications for current market policy. First, they imply that a part of risk perceptions is inflexible and will not respond to interventions aimed at increasing investor information or improving the ease with which they make investments. This result effectively points to a glass ceiling in the effects of financial literacy and other programs intended to increase stock market participation and use. This implies that a low internal economic locus of control could be a suitable candidate for explaining the non-participation of financially savvy households in risky asset markets.

Second, our results open up the possibility of shifting stock market participation through interventions that shift or enhance the effect of non-cognitive traits (e.g., Anderson, 2012; Heller et al., 2016). These treatments are being intensively explored in other areas of economics and the possibility that they could (intentionally or unintentionally) increase investment in risky assets is exciting.

At this stage, we cannot say whether the investment bias related to internal economic locus of control is ultimately beneficial or harmful for household investors. More research is needed to determine whether the effects of internal economic 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 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, future research could focus on issues of portfolio diversification and portfolio management, which could further our understanding of the role of personality in shaping investor behavior.

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Figure 1: Relation between subjective and objective financial literacy, for constructing overconfidence

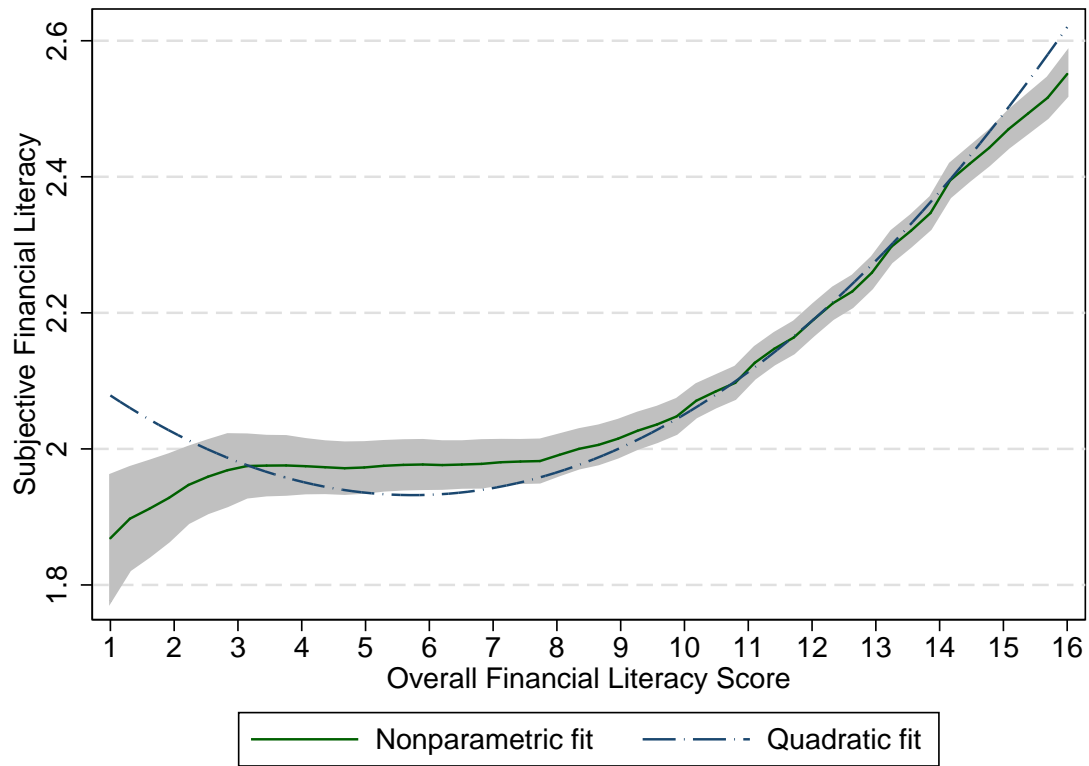


Figure 2: Distributions of internal economic locus of control for option non-investors, option buyers, and option sellers

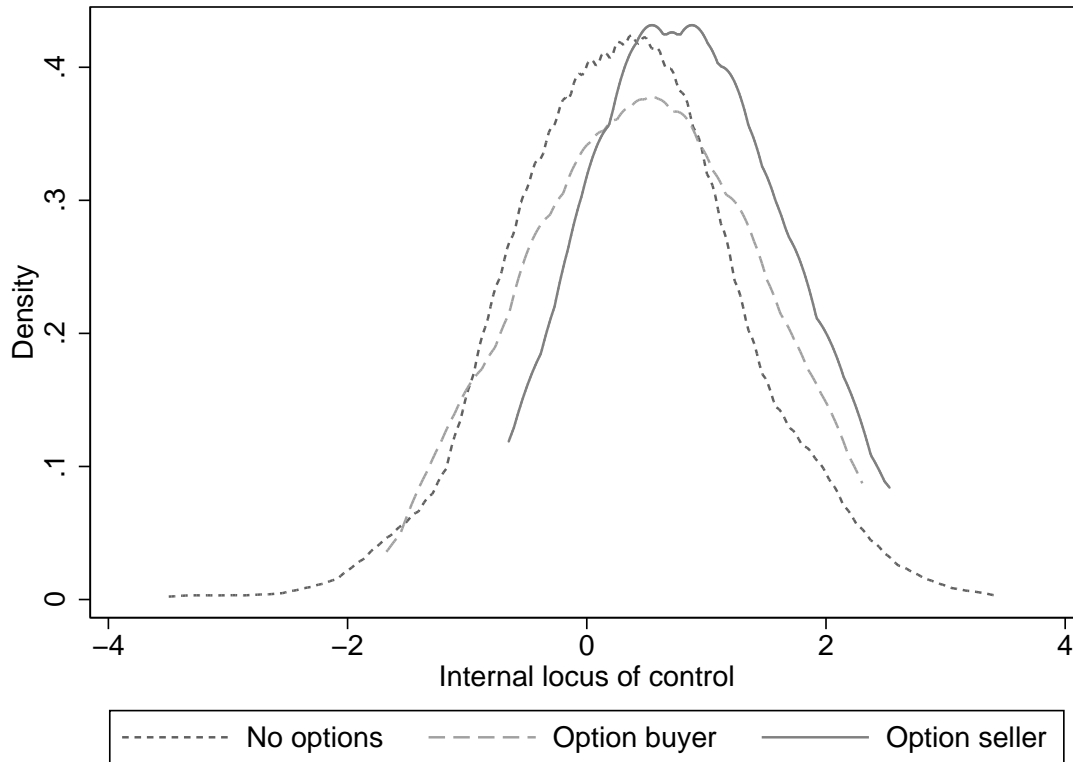


Table 1: The relation between equity ownership and internal economic locus of control

Dependent variable: Equity ownership	(1)	(2)	(3)	(4)
Internal economic 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
Observations	16,184	16,184	16,184	16,184
Households	2,947	2,947	2,947	2,947

Linear probability model (OLS) coefficients. 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 relation between internal economic locus of control on the share of wealth invested in different assets

Dependent variable: Share of wealth invested in:	Equity (1)	Bonds (2)	Cash (3)	Other assets (4)
Internal economic 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
Observations	16,184	16,184	16,184	16,184
Households	2,947	2,947	2,947	2,947

Average marginal effects of fractional response regressions. 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: The relation between equity ownership and internal economic locus of control, controlling for financial literacy

Dependent variable: Equity ownership	(1)	(2)	(3)	(4)	(5)	(6)
Internal economic 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
Observations	7,617	7,617	7,617	7,617	7,617	7,617
Households	1,187	1,187	1,187	1,187	1,187	1,187

Linear probability model (OLS) coefficients. 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: The relation between equity ownership and internal economic locus of control, controlling for overconfidence

Dependent variable: Equity ownership	(1)	(2)	(3)	(4)	(5)
Internal economic 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
Observations	10,850	10,850	10,850	10,850	10,850
Households	1,244	1,244	1,244	1,244	1,244

Linear probability model (OLS) coefficients. 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: Internal economic locus of control and investor experience

Dependent variable: Time-varying measure of internal economic 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	-
Observations	7,263	7,263	7,263	7,263
Households	2,609	2,609	2,609	2,609

OLS regression coefficients. 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 6: The relation between equity ownership and internal economic locus of control, controlling for optimism, trust, and personality

Dependent variable: Equity ownership	(1)	(2)	(3)	(4)	(5)
Panel A					
Internal economic 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
Observations	9,288	9,288	9,288	9,288	9,288
Households	1,032	1,032	1,032	1,032	1,032
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
Observations	9,096	9,096	9,096	9,096	9,096
Households	1,011	1,011	1,011	1,011	1,011
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
Observations	15,724	15,724	15,724	15,724	15,724
Households	2,743	2,743	2,743	2,743	2,743
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 coefficients (OLS). 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, where 1 means you completely disagree and 7 means you completely agree:

1. Saving and careful investing are 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's 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 completely disagree and 7 indicates completely 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. (reverse coded)
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. (reverse coded)
6. I am prepared to take the risk of losing money, when there is also a chance to gain money. (reverse coded)

Patience items

The following statements are about the future. Please indicate on a scale from 1 to 7 to what extent you agree with the following statements, where 1 indicates completely disagree and 7 indicates completely 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. (reverse coded)
4. With everything I do, I am only concerned about the immediate consequences (say, a period of a couple of days or weeks). (reverse coded)
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. (reverse coded)
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 the negative consequences of my actions 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. (reverse coded)
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. (reverse coded)
11. I only respond to urgent problems, trusting that problems that come up later can be solved in a later stage. (reverse coded)
12. I get clear results in my daily work and this is more important to me than getting vague results. (reverse coded)

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

	Obs.	Mean	Percentile				
			Min	10 th	50 th	90 th	Max
Internal economic locus of control (unstandardized)	11,122	4.56	1.92	3.87	4.56	5.27	6.77
Owens equity	11,122	0.29					
Owens stocks	11,122	0.14					
Owens mutual funds	11,122	0.22					
Owens bonds	11,122	0.03					
Owens 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					
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

(Continued on next page)

Table A.1 – continued from previous page

	Obs.	Mean	<i>Percentile</i>				
			Min	10 th	50 th	90 th	Max
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 economic locus of control and investing in financial options

Investor Outcome:	Option Buyer (1)	Option Seller (2)	Buyer & Seller (3)
Internal economic 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		
Observations	3,198		
Households	849		

Multinomial logit odds ratios. 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.3: Main results with different constructions of internal economic 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 economic 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
R^2	0.30	0.25	0.27	0.27	0.24
Observations	10,375	11,122	3,518	3,510	2,415
Households	2,172	2,362	1,729	1,729	1,143

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.4: The relation between internal economic locus of control in the ownership of different types of financial assets

Dependent variable: Ownership of:	Stocks (1)	Mutual funds (2)	Bonds (3)	Other assets (4)
Internal economic 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
Observations	16,184	16,184	16,184	16,184
Households	2,947	2,947	2,947	2,947

Linear probability model (OLS) coefficients. 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.