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Abstract

Using representative household panel data, we show that the investment behavior of households is related to the economic locus of control of household heads. A household's internal locus of control in economic issues is positively related to its decision to hold risky assets as well as its share of risky investments. We find evidence that these relations are due to a lower perception of the risk of investing in risky assets: Those who have an internal economic locus of control perceive less variance in risky assets, which makes these assets more attractive. The relation between investment in risky assets and locus of control cannot be explained by risk and time preferences or by personality traits such as optimism and the Big Five traits. Furthermore, the relation is independent of household socioeconomic background in terms of wealth or knowledge—it holds for sophisticated and unsophisticated households alike.

JEL classification: G11; D14; D19

Keywords: Household finance; Internal locus of control; Personality trait; Risk perception

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1 Introduction

The rising participation of households 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 have guided our understanding in this matter underline risk and time preferences as the 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., 2005; Guiso et al., 2008; Van Rooij et al., 2011). However, only a few personality traits, such as overconfidence and optimism, have been identified as drivers of investment behavior so far. This is particularly surprising, considering the rapid growth of the behavioral finance literature since De Bondt (1998). Data constraints are one of the major reasons for this research gap; economic preferences, personality traits, and investment decisions are seldom jointly observed in one dataset. Another reason is that, apart from overconfidence and optimism, personality traits are hard to incorporate into expected utility models. However, the fact that they are harder to model does not mean that they do not matter; the literature on non-cognitive traits suggests that many of these personality aspects are likely to be important for several economic outcomes (e.g., Heckman et al., 2006; Borghans et al., 2008; Almlund et al., 2011).

This paper focuses on a person's internal economic locus of control, one of the personality traits that has received the most attention in studies on household investment decisions in various fields. An internal 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 efforts, as opposed to the result of luck, change, fate, or the intervention and influence of others (Rotter, 1966; Furnham, 1986). There is evidence that internal locus of control is important in a range of economic situations, such as the labor market (e.g., Bowles et al., 2001a,b; Coleman and DeLeire, 2003; Heineck and Anger, 2010) and the credit market (Tokunaga, 1993), as well as entrepreneurship (Evans and Leighton, 1989), which suggests it can be an important predictor of individual investment decisions. Our hypotheses are that, in addition to risk and time preferences, having an internal economic locus of control positively relates to the decision to participate in risky assets, as well as the share of risky investments in a household's total portfolio. We propose that these results are driven by the relation between internal locus of control and the subjective perception of risk in risky assets.

An important body of the personality and clinical psychology literature supports this mechanism. Slovic (1992) and Riechard and Peterson (1998) argue that the perceived risk is lower when people believe they have control over the risky situation. Kallmen (2000) provides a direct test of this hypothesis by showing that internal locus of control is associated with a lower perception of risk regarding behaviors such as smoking, drinking alcohol, and traffic accidents. Crisp and Barber (1995) survey several papers showing the relation between internal locus of control and objective knowledge of the risk involved in various health-related choices. They also show that a person's internal locus of control is related to different assessments of the risk involved in various sexual activities. Our paper focuses on a person's *economic* locus of control, that is, the extent to which a person believes that his or her economic outcomes are determined by personal effort.[1] If a person's internal economic locus of control is indeed related to the perceived risk of risky asset investments, as suggested by the literature mentioned above, then internal economic locus of control will be positively related to the decision to participate in risky assets and to the risky share of investments.

We use representative household data to test the hypotheses outlined above. Our main results show that a one standard deviation increase in internal locus of control increases the probability of participating in risky assets by 4.8 percentage points and increases the risky share of investments by 1.7 percentage points. These magnitudes are economically important, since they correspond to around 15% of their unconditional means. Using a selection of households that invest in options, we provide evidence consistent with our proposed mechanism that internal locus of control affects risky asset investments through differences in risk perception.

Our robustness analyses deal with several possible issues in our estimation. We first show that our main results are not due to internal locus of control acting as a proxy for unobserved optimism or other personality traits as measured by the Big Five. Second, we show evidence suggesting that other drivers of the relation between internal locus of control and risky asset investment (e.g., optimism and other personality traits) are unlikely to play an important role. Third, we show that our main findings also hold for more sophisticated households (i.e., well educated, financially literate, and wealthy), whereas other financial behavioral biases are usually particularly important for less skilled

[1] In economics there is no model that links locus of control to the perception of risk, but Heckman et al. (2006) show that a measure of non-cognitive skills, of which one main component is a person's internal locus of control, is related to several risky activities and their outcomes, such as smoking and drug use.

households (e.g., Agnew and Szykman, 2005; Calvet et al., 2009). Finally, we investigate the role of measurement error in our estimation and conclude that our main results are not due to a correlated measurement error artifact.

Our findings complement the literature on behavioral and psychological drivers of individual financial investment (e.g., Barber and Odean, 2001; De Bondt, 1998; Barber and Odean, 2001; Puri and Robinson, 2007). This literature's primary focus is on optimism and overconfidence and how they affect individual investment decisions. However, this literature has largely ignored 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.[2] Our study also shifts away from the predominant focus on the portfolio allocation of assets for households that already invest in risky assets, since it focuses on the decision to participate in risky assets and the overall share of household wealth allocated to them (the intensive and extensive margins). Our results have more common ground with other studies on the behavioral drivers of risky asset participation (e.g., Van Rooij et al., 2011) and we show that internal locus of control adds to our understanding of this participation decision, on top of other proposed explanations in this literature.[3] Specifically, we show that the lack of internal locus of control provides a feasible explanation for the non-participation in risky assets of wealthier, better-educated, and more financially literate households, which is a part of the equity participation puzzle that is often difficult to explain (e.g., Mehra and Prescott, 1985; Mankiw and Zeldes, 1991; Heaton and Lucas, 2001).

The remainder of the paper is structured as follows. Section 2 describes our data. Section 3 presents the main relation between internal locus of control and investment in risky assets and explores the variance perception mechanism. Section 4 presents several robustness checks of our main results. Section 5 concludes.

2 Data

For this study we use information from the 2005, 2006, 2007, and 2009 waves of the Dutch Central Bank Household Survey (DHS), an annual panel survey of Dutch households

[2]Two exceptions are the studies of McInish (1982) and Durand et al. (2008), who view personality traits in a financial investment context. However, both studies are silent on the extensive and intensive margins of risky assets investment. More importantly, their samples are highly selective.

[3]See, for example, Hong et al. (2005); Guiso et al. (2008); Christelis et al. (2009), and Kaustia and Torstila (2011) for other studies that explain household participation in risky assets.

designed to be representative of the Dutch population over the age of 16.[4] To analyze investment decisions at the household level, we only use the information provided by persons responsible for a household's finances since they report the household's joint asset holdings. Our estimation sample includes only households for which we have data on financial assets, measures of economic locus of control, and other socioeconomic variables used as control variables. We observe 1,373 households, for a total of 3,365 household–year observations.[5]

We define participating in risky assets as holding a positive amount of money 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 equity, bonds, savings, and current account balances, savings certificates, insurance policies, growth funds, own private equity, and other savings. We use risky asset holdings and total financial wealth to construct the two main dependent variables for our analyses: a dummy variable for investors in risky assets and the risky share of investments, which is just the value of risky assets held as a proportion of total financial wealth.[6]

The DHS includes a block of 13 statements measuring internal economic locus of control. As mentioned above, economic locus of control captures 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, change, fate, or the intervention and influence of others.[7] The 13 statements measure the survey respondents' agreement with the importance of their own actions to their wealth in various situations and all are measured in a seven-point Likert scale. These statements are a subset of items from Furnham (1986).[8] We

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

[5]About 2,000 household heads report household asset holdings in the sample period, but some 500 of lacked household income or other labor market-related information and 150 did not answer the internal locus of control or economic preference questions. However, there are no pronounced differences between our estimation sample and the overall sample in terms of other observable characteristics.

[6]Our results are robust to definitions of risky assets 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 risky assets in excess of €1,000 or €10,000.

[7]It is believed that locus of control forms during childhood and stabilizes during adolescence (Sherman, 1984).

[8]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.

measure internal locus of control using the mean of these 13 statements, giving higher scores 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 that their economic outcomes are determined by factors outside their control).[9] To facilitate the interpretation of our results, we standardize this index by subtracting its sample mean and dividing it by its standard deviation.[10]

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 behavior and to risk preferences elicited using lottery choices (e.g., Barsky et al., 1997). The survey questionnaire also includes 12 questions measuring patience and the extent to which individuals consider the future consequences of their current decisions from Strathman et al. (1994).[11] Using previous waves of the DHS, Borghans and Golsteyn (2006) show that these 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 constructed the internal locus of control index.[12]

We control for an extensive set of individual and household characteristics that may

[9]Even though both locus of control and economic locus of control were originally devised as multi-dimensional personality traits, nowadays 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).

[10]The unstandardized internal locus of control index is bell shaped and spread across the entire possible range of scores, with a mean of 4.6 and a variance of 0.48. Our results are robust to different constructions of the index. For example, we obtain similar results by using the first principal component from an analysis of all economic locus of control items.

[11]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). Some of the items included in the patience measure are similar to internal locus of control items, which could cause a spuriously high correlation between the two measures. Our main analysis uses the index constructed with all items, but our results all hold if we use only those items that most clearly measure patience to construct the index.

[12]See Appendix A for a full listing of the items used to construct the internal locus of control, risk aversion, and patience indices.

be correlated with internal locus of control and that have been shown to be important for household investment decisions. Our analyses include individual characteristics of the household head such as a quadratic term for age, marital status, gender, high school and university education, self-reported financial literacy, and employment status. We also include household characteristics such as a home ownership dummy, the number of people living in the household, and total household income, household wealth, and household debt (in logs). All regressions include year and region dummies and a set of dummies marking the number of times we observe each household to account for differences in households that remain longer in the panel. Table 1 shows summary statistics for our estimation sample.[13]

[INSERT TABLE 1 ABOUT HERE]

3 Results

3.1 Equity participation and the risky share of assets

Figures 1 and 2 show non-parametrically how the probability to participate in risky assets and the risky share of investments, respectively, increase with a higher internal locus of control. Both figures show positive relations between the risky investment variables and internal locus of control and suggest that these relations are approximately linear. Table 2 shows that the positive relation between internal locus of control and investment in risky assets observed in Figures 1 and 2 still holds after controlling for various individual and household characteristics. The table reports the marginal effects from a probit model on the probability of investing in risky assets and the marginal effects from a Tobit model on the risky share of investments.[14]

[INSERT FIGURES 1 AND 2 ABOUT HERE]

[13] Our sample statistics are similar to those of the overall sample in the DHS. Accounting for differences between asset classifications, our estimation sample is similar to the DHS 2005 wave used by Guiso et al. (2008). None of our main results change if we use population weights for the analyses.

[14] The probit and Tobit models use pooled cross-sectional data. We use these models because they best suit our data. We obtain very similar results using random effect-limited dependent variable models, with the disadvantage that their results are sensitive to the numerical methods underlying the estimation. Models with household fixed effects are unsuitable for our research question since we want to identify the effect of internal locus of control, which seems to be time invariant in our sample, consistent with the findings of Sherman (1984). Mundlak (1978)'s or Chamberlain (1980)'s treatment of the random effects suffers from the same problem. The downside of not using panel models is that we cannot control for unobserved household heterogeneity, but Table B.1 shows that this is not likely to change our main results.

Columns 1 and 2 of Table 2 illustrate the size and significance, respectively, of the relation between internal locus of control and the decision to participate in risky assets. Columns 3 and 4 do the same for the risky share of investments. Estimation results show that a one standard deviation increase in internal locus of control corresponds to a 4.8 percentage point increase in the probability to invest in risky assets and a 1.7 percentage point increase in the risky share of investments. These marginal effects are relatively large; they correspond to around 15% of the unconditional means of the investment variables. In fact, the risky asset participation impact we found for internal locus of control is similar to the effect of a one standard deviation increase in trust (Guiso et al., 2008), twice as large as the impact of a one standard deviation in numeracy (Christelis et al., 2009) and half as large as the impact of a one standard deviation in financial literacy (Van Rooij et al., 2011).

Columns 2 and 4 show that including risk aversion, patience, and financial literacy in the models has little effect on the marginal effects of internal locus of control.[15] Risk aversion has a large and negative effect on both the decision to participate in risky assets and the risky share of investments, which is consistent with most portfolio models and with the majority of empirical studies on stock market participation. Patience has large positive effects in both equations. Financial literacy also has strong positive effects in both equations, consistent with Van Rooij et al. (2011).

Most of the control variables in our regressions affect the investment variable in the expected manner. There are large gender differences in investment, with female-headed households being less likely to invest at both the intensive and extensive margins in risky assets. These gender effects could be due to a number of reasons, ranging from lower future earnings for women—which are not captured by either wealth or current income—to gender personality differences unrelated to internal locus of control. There are also large positive wealth and education relations with investment and a negative relation with self-employment. The latter is usually attributed to the higher risk exposure of self-employed households. Most of these effects are also found in other studies.[16]

[15]The special attention paid to risk and time preferences is based on the many theoretical models that motivate their role in individual portfolio choice (e.g., Samuelson, 1969; Svensson, 1989) and the empirical correlation 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 McInish (1982). Financial literacy is also of particular importance, since it is an important driver of risky asset participation and the risky share of investments (Van Rooij et al., 2011); moreover, it proxies for investor sophistication, which can potentially change the determinants of investment decisions (e.g., Agnew and Szykman, 2005).

[16]We performed an extensive control analysis of the model specification. In particular, we used more disaggregated measures of education, included wealth and debt as distribution deciles, modified our in-

[INSERT TABLE 2 ABOUT HERE]

3.2 Variance perception

Our hypothesis on the mechanism underlying our main findings is that households with an internal locus of control believe that the variance of risky asset returns is lower than the one perceived for those with an external locus of control (cf. Kallmen, 2000), inducing higher participation rates and shares of risky investments. We test this hypothesis indirectly by exploiting the relation between the prices of financial options (one of the components of our risky asset category) and the return variance of their underlying assets. Under the assumption that internal locus of control is indeed negatively related to perceived risk in risky assets, a stronger internal locus of control lowers this perceived risk and thus encourages risk-averse households to hold more such assets. However, in the case of financial options, lower risk means lower prices (Black and Scholes, 1973). In that case, prospective investors with a stronger internal locus of control will perceive the market prices of options as relatively high compared to their own valuation and will thus be *less* likely to buy and more likely to (short-)sell them.[17]

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 hypothesis is correct, internal locus of control should be negatively related to the likelihood of buying options and positively related to the likelihood of selling them. Table 3 shows exactly this pattern: In a multinomial logit model, internal locus of control has a significant and positive marginal effect on the likelihood of selling options, while the effect on the chance of buying options is insignificant. The negative marginal effect on neither buying nor selling options is a reflection of the main relation between internal locus of

come measure, and checked for possible non-linearities in all our variables, including internal locus of control. Our main results are robust to these specification checks, in both size and statistical significance. We also paid special attention to disaggregated wealth measures. In additional regressions we separated wealth into financial wealth, durable assets wealth (the estimated value of vehicles such as cars, motorcycles, boats, and caravans), and housing wealth. Both durable asset wealth and housing wealth have a large and significant effect on the probability of holding equity, but once we include financial wealth they become insignificant.

[17] 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—shown by, for example, Fleming (1998)—the positive relation between perceived risk and option prices should hold.

control and risky asset investment.[18]

[INSERT TABLE 3 ABOUT HERE]

4 Robustness Analyses

4.1 Optimism, price expectations, and the Big Five

So far we have interpreted our results based on the assumption that our measure of internal locus of control clearly captures this underlying personality trait. However, some personality studies show a positive correlation between internal locus of control and optimism (e.g., Guarnera and Williams, 1987; Hoorens and Buunk, 1993). Therefore, it is important to check that the effect of internal locus of control is not simply capturing unobserved differences in optimism.

The DHS provides us with a way to control for optimism. The proxy variable we use for this purpose is the standardized answer to the question *"What is the chance of having a sunny day tomorrow, according to you?"*, which is originally coded in percentage points.[19] The first column of Table 4 shows that our optimism proxy is positively related to the decision to participate in risky assets, as expected. However, the marginal effect of internal locus of control remains virtually unchanged, which suggests that internal locus of control is not simply acting as a proxy for optimism.

Another important driver of investment in risky assets is subjective return expectations, which can be related to optimism but are ultimately different. Even though internal locus of control does not proxy for optimism, it could still proxy for inflated return expectations of risky assets. To address this issue, we use the answers to the following

[18] Our sample of option traders is small (only 42 households have open option positions), which makes the significant coefficient of internal locus of control more remarkable.

[19] We have four different proxy variables for optimism: the question on the chances of a sunny day tomorrow, a measure of happiness (e.g., Dember and Brooks, 1989; Wallis et al., 2005; Neff et al., 2007), and two questions on life expectancy that we can turn into proxies for optimism similarly to Puri and Robinson (2007). While none of these variables acts as a direct measure of optimism, the correlation between all of them is positive and the correlations between them and other explanatory variables are mostly the same and coincide with our intuitions about optimistic behavior. All proxies are strongly correlated with each other and most are positively correlated with Big Five Extraversion and negatively with Big Five Neuroticism, consistent with Williams (1992) and Brunnermeier and Parker (2005). We choose the sunny day proxy because it has both the strongest correlation with internal locus of control and with participation in risky assets. The internal locus of control coefficient does not change if we use proxies other than the answers to the sunny day question. Combining the information of all proxies does not yield different results.

question, which was asked in the 2005 and 2006 waves of the DHS: *"In the next two years, how do you expect worldwide share prices to develop? Will the share prices rise or drop or stay about equal?"*. Following Guiso et al. (2008), we include a dummy variable indicating respondents who believe the stock market will rise to control for positive return expectations. The second column of Table 4 shows that the price expectations dummy is a strong predictor of the decision to participate in risky assets. However, the marginal effect of internal locus of control remains unaltered, suggesting that price expectations are not driving the effect of internal locus of control either.

Finally, we consider whether internal locus of control is acting as a proxy for other personality traits.[20] To rule out this possibility, we use a 50-item measure of the Big Five personality traits, included in the 2005 and 2009 waves of the DHS. The Big Five (Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism) are a comprehensive, data-driven inventory of traits considered to capture most personality differences (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). We measured each trait of the Big Five through 10 items and constructed a standardized index for each trait similarly to the way we did for internal locus of control. The last column of Table 4 shows that the marginal effect of internal locus of control is not affected by including the Big Five in the analysis. None of the Big Five is statistically significant beyond the 10% level or are not robust to alternative model specifications.

[INSERT TABLE 4 ABOUT HERE]

4.2 Other mechanisms

Even though our evidence suggests that the relation of internal locus of control and investment in risky assets works via the perception of risk, other mechanisms may be at play. A first possible alternative is that internal locus of control has an effect on risky asset investment via human capital. Coleman and DeLeire (2003) and Fouarge et al. (2013) show that internal locus of control relates to human capital investment. More human capital lowers information costs for investing in risky assets and can therefore increase investments in these assets. In our data there is a strong correlation between internal locus of control and human capital indicators—the level of education as well as financial

[20] The evidence presented by Durand et al. (2008) suggests this.

literacy—that supports this hypothesis. However, human capital cannot completely explain the internal locus of control effect: Column 2 in Table 2 already shows that internal locus of control retains a strong positive coefficient even after controlling for the level of education and financial literacy.

A second alternative hypothesis is that internal locus of control affects risky asset investment because it drives households to gather more and better information before making investment decisions. This mechanism requires two conditions: that internal locus of control relates to the choice of financial advice and that financial advice choice leads to (greater) investment in risky assets. The first condition is supported in the context of car purchasing by Srinivasan and Tikoo (1992), who show that a stronger internal locus of control relates to searching for more information before making a purchase decision. They attribute this result to lower perceived search costs and larger perceived benefits for those with a stronger internal locus of control. The second condition is supported by Shum and Faig (2006), who show that financial advice is predictive of stock market participation. The DHS asks the respondents to define the most important advisor they seek when making financial decisions, and we test this second alternative mechanism and its two conditions by first relating internal locus of control to the households' choices of financial advisor and then relating this choice to investment in risky assets. However, neither link is supported in our data: We find no relation between internal locus of control and advisor choice nor any between advisor choice and investment in risky assets. In view of the results presented in this section, we conclude that our hypothesis on the perceived risk of risky assets is the most consistent with the data.

4.3 Heterogeneous effects

One particularity of the distribution of internal locus of control across our sample is that we find households with a strong internal locus of control that vary greatly in their background characteristics: older and younger, females and males, wealthy and poor, high and low income, and married and single, among others (see Figure B.1). We exploit this variation to document the heterogeneity in the relation between internal locus of control and investment behavior. Previous research in behavioral finance has found evidence of such heterogeneity. In particular it shows that other psychological biases disappear as investors become more sophisticated. Agnew and Szykman (2005) show that non-participation, investment in company stock, and $1/n$ heuristics decrease as salaries increase. Calvet et al. (2009) find that financial wealth, family size, and education decrease the prevalence of

underdiversification, risk-taking inertia, and the disposition to hold losing stocks and sell winning stocks.

Remarkably, as shown in Figure B.2, we find little heterogeneity in the relation between internal locus of control and investment in risky asset. This suggests that internal locus of control affects investment decisions in a fundamentally different way than other psychological biases that disappear for more sophisticated investors.

4.4 Measurement error

Our measure of internal locus of control combines the information in 13 different items and we implicitly assume, as is usual with this type of aggregation, that each item measures internal locus of control with some noise. Therefore combining the items decreases the potential attenuation bias caused by measurement error. However, it is possible that some bias remains. This holds for the marginal effects of internal locus of control, as well as the effects of risk aversion and patience. To measure the remaining error, we calculate the Cronbach alpha for each of our three indices.[21]

The first column of Table 5 shows the ordinary least squares coefficients of internal locus of control, risk aversion, and patience on the probability of participating in risky assets, each corrected for measurement error bias. The table shows the corrected marginal effect of internal locus of control and thus the extent to which their economic size was underestimated before. The estimated increase in the likelihood of investing in risky assets is now estimated at six percentage points, or around 20% of the mean unconditional investment probability. In addition, the first column of Table 5 allows us to assess the relative importance of internal locus of control versus risk aversion and patience based on the size of their coefficients. By comparing the coefficients, we see that even though risk aversion seems to be the most important factor, internal locus of control plays an important role in explaining investment in risky assets, with a coefficient that is 27% as large.[22]

[21] See Mueller and Plug (2006) for an analogous approach to correct the effects of personality on earnings. Since the bias of the coefficients due to measurement error in the error-in-variable model is not explicitly calculated for a probit or logit model, we have to rely on linear probability models at this stage. We also use instrumental variable methods and the Lubotsky and Wittenberg (2006) multiple-proxy index to correct for attenuation bias and find similar results.

[22] This is not usually possible, since studies on equity participation do not have enough information to estimate the measurement error in each of their variables (see e.g., Guiso et al., 2008). In our measurement error-corrected model, the relative size of the coefficient can be directly compared, assuming that the measurement error correction eliminates the attenuation bias or at least makes the bias of the coefficients comparable.

Although multi-item indices help us correct for attenuation bias, one of their drawbacks is they can introduce an identification problem. Specifically, if the error term in any of the 13 internal locus of control items is correlated with other regressors, our coefficients could be biased or, in the worst case scenario, spuriously driven by this correlation. Both risk aversion and patience could cause such a problem, since they are both constructed using multi-item measures. To check whether correlated measurement error is driving our results, we re-estimate the risky asset participation model including only one-item measures of internal locus of control, risk aversion, and patience. By using these one-item measures, we decrease the risk of the measurement error term in internal locus of control being correlated with risk aversion or patience.[23] The second column of Table 5 shows that our main results hold if we use the one-item measures instead of the indices. The coefficients are smaller than in Table 2, which is consistent with a stronger attenuation bias in the one-item measures versus the indices.

[INSERT TABLE 5 ABOUT HERE]

5 Conclusions

Recent studies in finance show that household investment 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 risky assets, on top of 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 risky assets and the risky share of investments and we show that this relation is substantial. We further provide evidence supporting the hypothesis that this relation is driven by the fact that those who have an internal economic locus of control perceive lower risk when investing in risky assets.

Through various robustness analyses, we rule out the possibility that the relation between internal economic locus of control and investment in risky assets is driven by

[23]This comes at the cost of a stronger attenuation bias, though. We chose the items based on how unambiguously they seem to measure each trait *a priori* and all three items load highly on the first principal component of their respective traits. The items chosen were the following: "It is chiefly a matter of fate whether I become rich or poor" for internal locus of control, "I get more and more convinced that I should take greater financial risks to improve my financial position" for risk aversion, and "With everything I do, I am only concerned about the immediate consequences (say, a period of a couple of days or weeks)" for patience. All questions were included with their original seven-point Likert scale measures and all the item scores were reversed. The item means are 4.88, 5.27, and 4.28 and their standard deviations are 1.45, 1.65, and 4.24, respectively.

other variables prominent in the household finance literature. We also show that this relation does not disappear as households become more sophisticated and that it is not driven by measurement error artifacts.

Another important finding in our study is that the relation between internal economic locus of control and investment in risky assets does not seem to be unique to any particular socioeconomic group; it is of equal importance for wealthy and poor, educated and uneducated, and financially literate and illiterate households. This finding has several important implications. First, it means that internal locus of control could be a suitable candidate for explaining the non-participation of households in risky asset markets and the fact that even sophisticated households fail to participate when they optimally should. Second, it suggests that the personality-driven bias in investment decisions may also hold for highly sophisticated and knowledgeable investors, such as fund managers and board members. Thus, even managers and board members with a stronger internal economic locus of control could be steering the investment of their funds toward a more equity-based strategy, compared to those with an external economic locus of control.

At this stage we do not know whether the investment bias related to internal locus of control is ultimately beneficial or harmful for households. 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 investment mistakes and whether having an internal economic locus of control leads to higher returns on investments.

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Figure 1: *Local polynomial regression of risky asset ownership on internal locus of control*

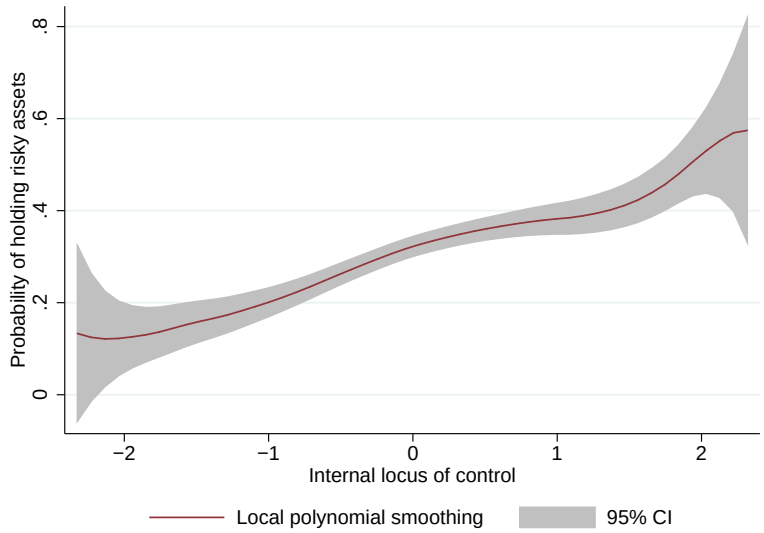


Figure 2: *Local polynomial regression of the share of risky assets on internal locus of control*

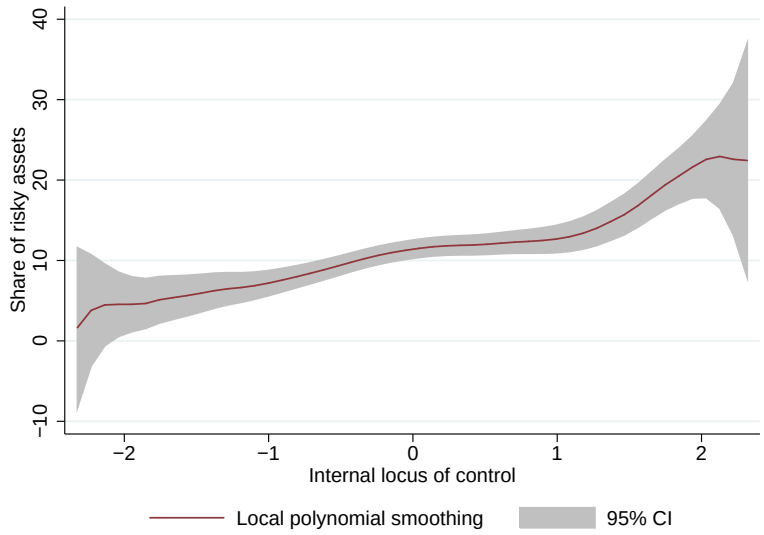


Table 1: *Summary statistics for the subsample of the DNB Household Survey used in this study*

This table shows the summary statistics of the variables used in our study. The data come from the DNB Household Survey, a representative panel of the Dutch population collected by CentERdata. We use information from the 2005, 2006, 2007, and 2009 waves. The summary statistics of monetary amounts are reported in thousands of Euro, even though the variables are included in logs in the regressions. Internal locus of control, risk aversion, and patience are unstandardized in this table but we standardize them for the regression analyzes.

	Mean	Median	Std. Dev.	Min	Max
Internal locus of control	4.626	4.667	0.696	1.5	7
Household owns risky assets	0.31	0	0.463	0	1
Household owns stocks directly*	0.482	0	0.5	0	1
Household total wealth (1,000 Euro)	77.781	33.331	168.189	0.01	2770
Household total debt (1,000 Euro)	5.953	0	32.141	0	900
Household total risky assets (1,000 Euro)	11.817	0	50.344	0	900
Household direct stockholdings (1,000 Euro)	4.29	0	30.346	0	694
Risky asset holdings over financial wealth*	10.972	0	23.144	0	100
Stocks over risky assets	32.852	0	42.113	0	100
Age	53.689	54	14.691	23	94
Female	0.404	0	0.491	0	1
Married	0.654	1	0.476	0	1
Number of people in household	2.311	2	1.244	1	7
Gross household income (1,000 Euro)	39.309	36.348	25.89	0	575
Lives in own house	0.542	1	0.498	0	1
High school degree	0.271	0	0.445	0	1
University degree	0.141	0	0.348	0	1
Retired	0.295	0	0.456	0	1
Self-employed	0.032	0	0.176	0	1
Unemployed	0.024	0	0.153	0	1
Risk aversion**	5.276	5.333	1.023	1.333	7
Patience**	4.18	4.167	0.749	1.25	6.9
Financial literacy	2.188	2	0.679	1	4
Expects stock prices to rise***	0.544	1	0.497	0	1
Optimism (chance of sunny day tomorrow)	50.315	50	27.37	0	100

* This information is calculated for households that hold own risky assets (n = 1,043)

** This information is only available for a subsample of households (n = 3,092)

*** This information is only available for a subsample of households in the 2005 and 2006 waves (n = 1,163)

Table 2: *The relation between internal locus of control, risky asset ownership, and the share of risky assets over financial wealth*

*Columns (1) and (2) show probit marginal effects at the mean on a dummy variable for households that own risky assets. Columns (3) and (4) report Tobit marginal effects at the mean on the ratio of risky asset holdings over financial wealth (from 0 to 100). All regressions include a full set of year and region dummies and selection dummies as additional control variables. Standard errors clustered at the household level are included in parenthesis. We report McFadden's Pseudo R^2 measure. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.*

	Risky asset ownership		*Risky asset share*	
	(1)	*(2)*	*(3)*	*(4)*
Internal locus of control	0.048***	0.042***	1.681***	1.194***
	(0.012)	(0.013)	(0.435)	(0.408)
Risk aversion		−0.157***		−5.142***
		(0.014)		(0.435)
Patience		0.045***		1.120***
		(0.012)		(0.380)
Financial literacy		0.072***		1.181**
		(0.017)		(0.527)
Age	−0.000	0.001	−0.137	−0.127
	(0.006)	(0.007)	(0.241)	(0.216)
Age Squared (/100)	0.000	0.001	0.186	0.228
	(0.006)	(0.006)	(0.226)	(0.201)
Female	−0.113***	−0.014	−4.086***	−0.303
	(0.027)	(0.030)	(0.988)	(0.949)
Married	−0.048	−0.028	−2.307**	−1.636
	(0.032)	(0.033)	(1.167)	(1.060)
Number of people in household	0.012	0.004	0.432	0.189
	(0.013)	(0.013)	(0.426)	(0.396)
Log. of household income	−0.005	−0.010	−0.168	−0.353
	(0.006)	(0.007)	(0.217)	(0.240)
Log. of household wealth	0.154***	0.160***	4.596***	4.171***
	(0.012)	(0.012)	(0.349)	(0.333)
Log. of household debt	−0.003	−0.006*	0.009	−0.055
	(0.003)	(0.003)	(0.111)	(0.103)
Lives in own house	0.031	0.000	1.817	1.183
	(0.033)	(0.034)	(1.236)	(1.143)
High school degree	0.051*	0.042	1.901*	1.536
	(0.029)	(0.030)	(1.062)	(0.990)
University degree	0.084**	0.054	3.270**	1.849
	(0.039)	(0.040)	(1.328)	(1.212)
Retired	0.009	0.018	0.249	0.730
	(0.039)	(0.039)	(1.340)	(1.185)
Self-employed	−0.139**	−0.227***	−4.888**	−6.402***
	(0.059)	(0.063)	(2.030)	(1.948)
Unemployed	−0.041	−0.060	−0.203	−0.093
	(0.078)	(0.080)	(2.954)	(2.764)
Observations	3,365	3,092	3,365	3,092
Pseudo R^2	0.19	0.29	0.05	0.07

Table 3: *The relation between internal locus of control and buying and selling options*

*All columns show marginal effects on option investment choices from a multinomial logit model. The dependent variable takes three values, depending on whether the household is an option seller (Column 1), an option buyer (Column 2), or neither (Column 3). We control for age, gender, marital status, household size, high school and university education dummies, logs of wealth, debt and income, and dummies for house owners, unemployed, and self–employed. Standard errors clustered at the household level are included in parenthesis. We report McFadden's Pseudo R^2 measure. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.*

	Seller *(1)*	*Buyer* *(2)*	*Neither* *(3)*
Internal locus of control	0.003∗	0.003	−0.006∗∗
	(0.002)	(0.002)	(0.003)
Observations		3,323	
Pseudo R^2		0.21	

Table 4: *The relation between internal locus of control and risky asset ownership controlling for optimism, return expectations, and the Big Five*

*All columns shows probit marginal effects at the mean on a dummy variable for households that own risky assets. Column (1) includes a standardized optimism proxy based on the reported probability of a sunny day tomorrow. Column (2) includes a proxy for price expectations as a dummy for expecting worldwide stock prices to rise over the next two years (only available in 2005 and 2006). Column (3) includes the Big Five personality traits (only available in 2005 and 2009). We control for age, gender, marital status, household size, high school and university education dummies, logs of wealth, debt and income, and dummies for house owners, unemployed, and self–employed, year, and region dummies. Standard errors clustered at the household level are included in parenthesis. We report McFadden's Pseudo R^2 measure. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.*

	Optimism (1)	*Price exp. (2)*	*Big Five (3)*
Internal locus of control	0.047∗∗∗	0.041∗∗	0.041∗∗∗
	(0.012)	(0.019)	(0.014)
Optimism	0.017∗		
	(0.009)		
Expects stock prices to rise		0.158∗∗∗	
		(0.035)	
Openness			0.029∗
			(0.015)
Conscientiousness			−0.018
			(0.015)
Extraversion			0.019
			(0.014)
Agreeableness			−0.006
			(0.015)
Neuroticism			0.027∗
			(0.015)
Observations	3,365	1,163	1,612
(Pseudo) R^2	0.20	0.19	0.19

†The three regressions are estimated using different subsamples and therefore changes in the coefficient of internal locus of control have to be interpreted based on different baseline estimates. The baseline estimates are the ones of Table 2 for Column (1), and 0.049 and 0.037 for Columns (2) and (3), respectively.

Table 5: *Error–in–variable and One–item models of internal locus of control, risk aversion, and patience on risky asset ownership*

*Column (1) shows error–in–variable coefficients of a linear probability models where the dependent variable is a dummy for households that own risky assets. The correction for classical measurement error follows Greene (p.84, 2003) and uses the Cronbach's alpha of internal locus of control (0.72), risk aversion (0.68) and patience (0.74) as an indicator of their respective reliability. Column (2) shows probit marginal effects at the mean of one–item measures of internal economic locus of control, risk aversion, and patience on a dummy variable for households that own risky assets. We control for age, gender, marital status, household size, high school and university education dummies, logs of wealth, debt and income, and dummies for house owners, unemployed, and self–employed, year, and region dummies. Standard errors clustered at the household level are included in parenthesis. We report the R^2 for the OLS regression and McFadden's Pseudo R^2 measure for the probit regression. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.*

	Error–in–variable *(1)*	*One–item measures* *(2)*
Internal locus of control	0.060***	0.018**
	(0.011)	(0.007)
Risk aversion	−0.218***	−0.037***
	(0.012)	(0.007)
Patience	0.052***	0.023***
	(0.010)	(0.006)
Observations	3,363	3,365
(Pseudo) R^2	0.34	0.21

Appendix A

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
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
11. It's not always wise for me to save because many things turn out to be a matter of good or bad fortune
12. It is chiefly a matter of fate whether I become rich or poor
13. Only those who inherit or win money can possible become rich

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

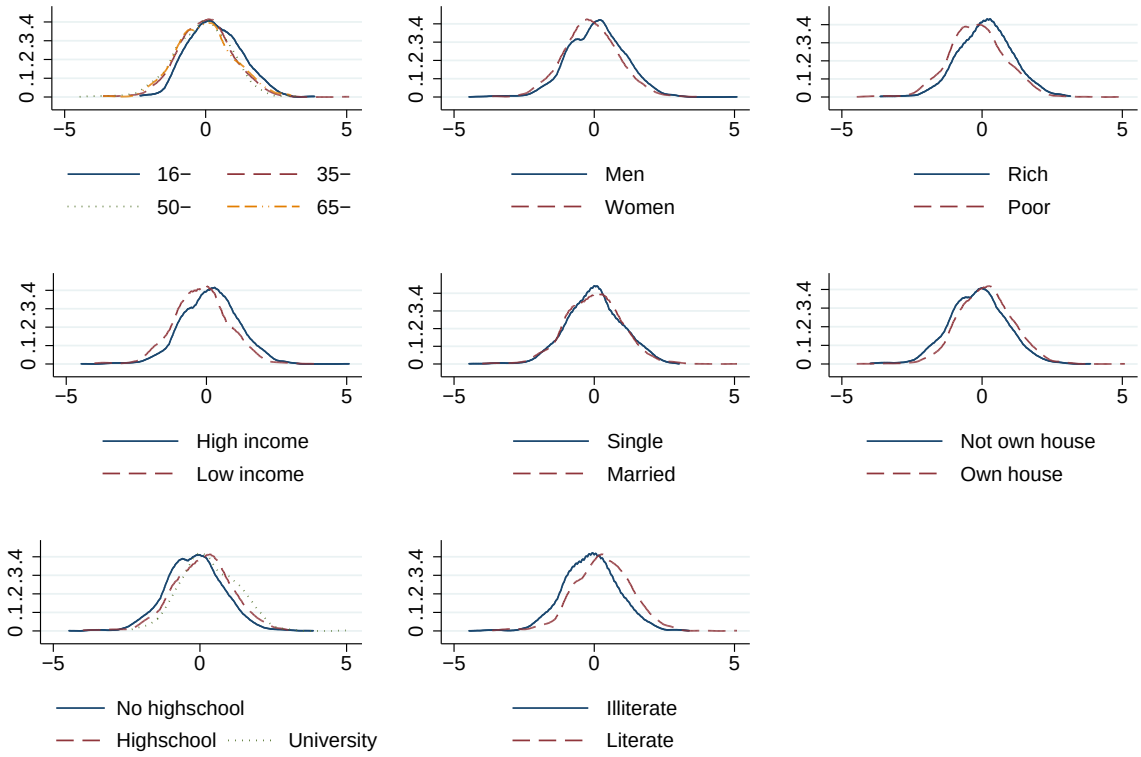
Patience items:

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

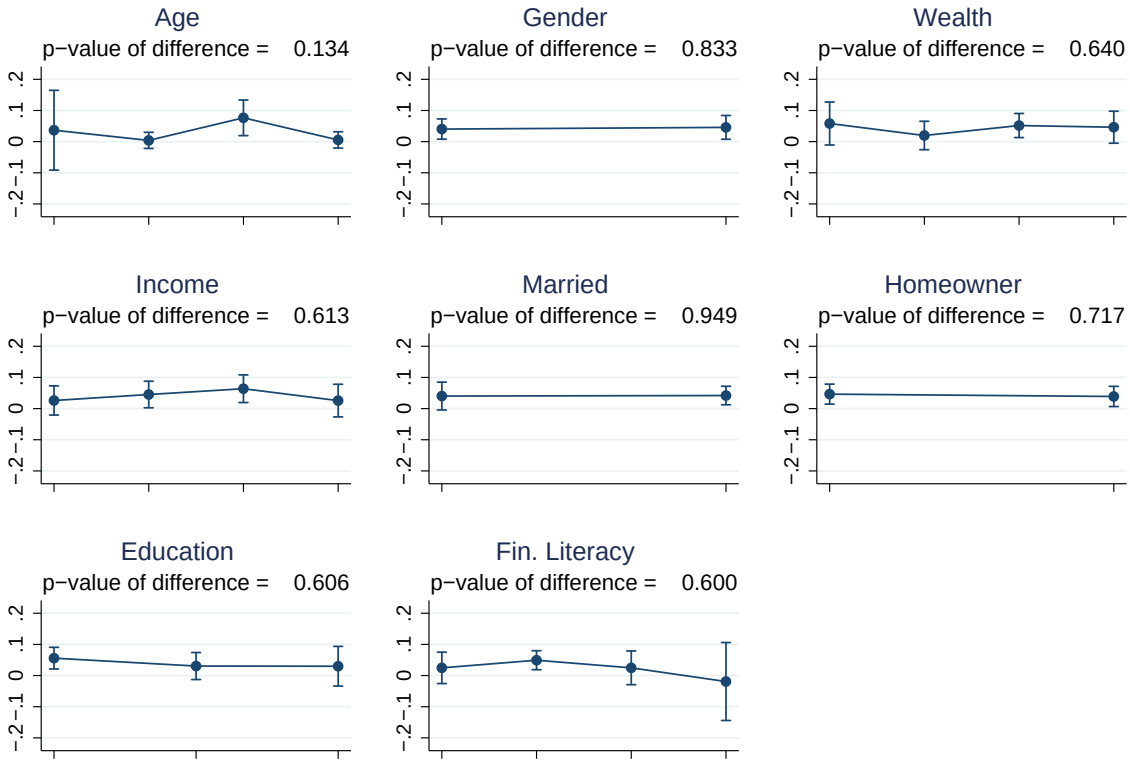
Appendix B

Figure B.1: *Distribution of internal locus of control across our sample*



x axis: Internal locus of control; y axis: Density

Figure B.2: *Marginal effects of internal locus of control on investment in risky assets across our sample*



x axis: Internal locus of control; y axis: Marginal effects on investment in risky assets

Table B.1: *The relation between internal locus of control, risky asset ownership, and the share of risky assets over financial wealth using random effect panel models*

*Columns (1) and (2) show marginal effects at the mean for random effect logit regressions (assuming that the unobserved individual heterogeneity is zero) on a dummy variables for households that own risky assets. Columns (3) and (4) show marginal effects at the mean (assuming that the unobserved individual heterogeneity is zero) for random effect Tobit regressions on the ratio of risky asset holdings over financial wealth (from 0 to 100). All the marginal effect calculations assume the unobserved individual heterogeneity to be zero. All regressions include a full set of year and region dummies and selection dummies as additional control variables. Standard errors clustered at the household level are included in parenthesis. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.*

	Risky asset ownership		*Risky asset share*	
	(1)	*(2)*	*(3)*	*(4)*
Internal locus of control	0.0378***	0.0321***	1.304***	1.126***
	(0.0107)	(0.0104)	(0.354)	(0.357)
Risk aversion		−0.109***		−4.094***
		(0.0103)		(0.367)
Patience		0.0313***		0.565*
		(0.0102)		(0.338)
Financial literacy		0.0403***		0.501
		(0.0147)		(0.511)
Age	0.00244	−0.000552	0.00282	−0.162
	(0.00657)	(0.00594)	(0.203)	(0.194)
Age Squared (/100)	−0.00124	0.00231	0.0703	0.248
	(0.00615)	(0.00554)	(0.191)	(0.181)
Female	−0.144***	−0.0493*	−4.272***	−1.308
	(0.0290)	(0.0268)	(0.875)	(0.879)
Married	−0.0357	−0.0115	−2.549**	−2.334**
	(0.0328)	(0.0304)	(0.993)	(0.978)
Number of people in household	0.0170	0.00613	0.695*	0.387
	(0.0130)	(0.0122)	(0.399)	(0.400)
Log. of household income	−0.00154	−0.00314	−0.249	−0.398**
	(0.00590)	(0.00596)	(0.183)	(0.202)
Log. of household wealth	0.155***	0.145***	4.279***	4.315***
	(0.00999)	(0.00977)	(0.326)	(0.331)
Log. of household debt	−0.00337	−0.00443*	−0.00829	−0.0453
	(0.00260)	(0.00245)	(0.0851)	(0.0853)
Lives in own house	0.0272	0.00900	0.972	1.336
	(0.0294)	(0.0282)	(0.958)	(0.983)
High school degree	0.0666**	0.0472*	2.037**	1.600*
	(0.0304)	(0.0273)	(0.962)	(0.919)
University degree	0.127***	0.0759**	4.172***	2.839**
	(0.0391)	(0.0357)	(1.211)	(1.156)
Retired	−0.0111	−0.00502	−0.118	0.246
	(0.0357)	(0.0330)	(1.077)	(1.079)
Self-employed	−0.140**	−0.193***	−5.654***	−6.442***
	(0.0627)	(0.0624)	(2.047)	(1.927)
Unemployed	−0.0412	−0.0275	0.0554	−0.165
	(0.0629)	(0.0610)	(2.026)	(2.088)
Observations	3,365	3,092	3,365	3,092

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