Financial Market Participation and Cognitive Ability: the Risk Aversion Channel[1]

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Abstract

In this study we investigate the relationship between financial market participation and cognitive abilities through risk aversion. Using two cohorts (2005 and 2009) from the Mexican Family Life Survey, we test if individuals with higher cognitive abilities are less risk averse, and as a consequence, they hold more financial assets. The panel structure of our dataset allows us to identify the relationship between cognitive abilities and financial participation. In a first stage we use the individuals' past cognitive ability score from the Raven's test as an instrument for a measure of current level of risk aversion. In a second stage we relate the adjusted measure of risk aversion with the individual holding of financial assets. Our results provide evidence for the existence of the strong relationship between cognitive abilities and financial market participation through the risk aversion channel, even after controlling by individual's income, age, health status, gender, marital status and work category. To the best of our knowledge, this is the first study in which financial participation, risk aversion and cognitive abilities are modelled jointly, and in which the risk aversion transmission channel connecting cognitive skills and financial market participation is explicitly studied.

Keywords: Financial Market Participation, Risk aversion, Cognitive Ability.

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1 Introduction

Prior literature has identified cognitive ability as a strong predictor of individual's economic and social behaviour. Heckman, Stixrud, and Urzua (2006) present evidence that cognitive ability is a main determinant of individual's labor and educational outcomes. In the finance area, more specifically, a growing number of studies have investigated whether cognitive ability affects individual's financial decisions. In particular, the focus has been on understanding to which extent cognitive ability affects the participation of individuals in financial markets and the exposure to risk they may be willing to face. On this regard, Christelis, Jappelli, and Padula (2010), using a sample of 11 European countries, report that the probability of investing in stocks significantly increase for individuals with high cognitive ability; Grinblatt, Keloharju, and Linnainmaa (2011), using Finnish data, show that stock market participation is monotonically related to IQ even after controlling for economic and demographic characteristics. On the same lines, Bogan and Fertig (2013) find that cognitive limitations reduce the probability of holding risky assets.

This evidence, so far, has documented a statistically significant relation between cognitive ability and individual's holding of financial assets. However, the precise channel through which these two variables are connected is less clear. Christelis, Jappelli, and Padula (2010) mentioned three theoretical channels connecting cognitive ability and financial participation: (i) an information channel: the cost of gathering and processing information is lower for skilled individuals, (ii) a risk aversion channel: cognitive ability may affect the individual's risk aversion, and therefore, his willingness to take risk, and (iii) a perception of risk channel: cognitive ability may affect the individual's perception of risk, making that low cognitive skills individuals may overestimate the information used to take financial

decisions. In this study, we provide empirical evidence connecting cognitive ability and financial participation through the risk aversion channel.

Our study is also motivated by the experimental evidence in Dohmen et al. (2010), which shows that cognitive ability varies systematically with an individual's willingness to take risk and his or her level of impatience. Thus, we connect the empirical literature showing that cognitive ability correlates with risk aversion, and the large literature showing that risk aversion affects financial decisions (Guiso and Sodini, 2012, and references therein). Our main hypothesis is that cognitive ability affects financial participation by influencing risk aversion. To the best of our knowledge, this is the first study that explicitly takes into account the risk aversion channel in this literature, and that identifies a relationship between cognitive ability and financial participation through this channel.

In order to test our main hypothesis, we take advantage of two cohorts (2005 and 2009) of the Mexican Family Life Survey (MxFLS). This longitudinal dataset of Mexican households, contains measures of the three main variables of interest: an individual's cognitive ability test (the Raven Progressive Matrices test; Raven, 1981), an individual's measure of risk aversion build on a lottery-type question, and finally, information about whether the individual holds financial assets. The fact that these three variables are available in a common dataset, for a representative sample of adults, is remarkable as it allows us to overcome several empirical limitations faced by previous works. First, and the most obvious of them, is the fact that most of the prior evidence studies either the relation between cognitive ability and financial participation, cognitive ability and risk aversion, and risk aversion and financial participation. In here, we are able to study them altogether by looking into the relation between cognitive ability and financial participation through the

risk aversion channel. Second, we exploit the longitudinal structure of our dataset to better identify the relationship between cognitive ability and financial participation by using a lagged measure of cognitive ability as an instrument of individual's current level of risk aversion. We later correlate the lagged cognitive ability with individual's financial participation. Third, in the context of this literature, we use a more representative sample of adults. For example, our dataset covers the whole spectrum of ages, whereas most of previous results have been obtained from information of elderly people aged over 50 (e.g., Christelis, Jappelli, and Padula, 2010; Bogan and Fertig, 2013).

Finally our study contributes to the understanding of how different forms of cognition (intelligence) may impact on economic outcomes, in particular, on the holding of financial assets. Recent literature in Psychology and Neurosciences recognizes that intelligence is composed of two related, but definitely distinct, subcategories: fluid and crystallized intelligence. Nisbett et al. (2012) define fluid intelligence as the ability to solve novel problems that depend little on stored knowledge, as well as the ability to learn. Crystallized intelligence, on the other hand, is the individual's store of knowledge about the nature of the world and learned operations such arithmetical ones that can be drawn on solving problems. In short, fluid intelligence accounts for the thinking part of intelligence (abstract reasoning and executive functions) and crystallized intelligence is the knowing part, the accumulation of knowledge from education and experience (McArdle, Smith, and Willis, 2009). In this study, our proxy of cognitive skills is a measure of fluid intelligence, the matrix reasoning Raven test, instead of more common measures present in the literature such as general IQ measure (e.g., Holdnack et al., 2011) or variables such as numeracy or financial literacy that account for crystallized intelligence. Although, it has been shown that variables

measuring mathematical skills are important determinants of individuals financial participation, we test in here whether a different aspect of cognition, the ability of investors to face and solve new problems in the context of finance, plays a role in understanding individual's preferences towards risky assets. McArdle, Smith, and Willis (2009) is the only paper providing evidence on these lines. By using a sample of US data from the Health and Retirement Survey (HRS), the regular dataset and some experimental modules, and the Cognitive Economic survey (CogEcon), they conclude that both aspects of intelligence are important determinants of individual level of wealth, being the effect of fluid intelligence the strongest one. Our evidence adds to those in McArdle, Smith, and Willis (2009), as we identify the transmission channel through which these variables are connected, the risk aversion channel. Besides, our study contains around 10,000 observations, whereas their study uses cognitive measures belonging to an experimental cognitive module containing around 1,000 observations. In this regard, the number of observations is relevant in the sense that limited samples can compromise the power and significance of the estimated results.

Our empirical strategy is based on the estimation of an instrumental variable (IV) probit model in which the binary decision of holding financial assets depends on the current level of risk aversion and several other demographic and social characteristics from the newest round of the MxFLS in 2009 (MxFLS-III). The current level of risk aversion is jointly modelled as a function of the individual's cognitive ability reported in the 2005´s round of the survey (MxFLS-II) that we assume as exogenous. This econometric strategy adds to the current literature by avoiding to some extent endogeneity problems due to the simultaneity between cognitive ability and financial participation. Efforts in this line have been made in

the literature by Grinblatt, Keloharju, and Linnainmaa (2011) that use a sub-sample of siblings in their dataset and the control function approach of Heckman (1979) to address the endogeneity issue. Bogan and Fertig (2013) also estimate Logit and Tobit models with individual fixed effects to deal with a potential endogeneity associated to unobservable time-invariant individual characteristics.

Our results strongly support that cognitive ability effects the individual´s decision of participating in financial markets by holding financial assets. Our first stage estimates show that those individuals with high cognitive skills, as measured by the Raven test, are less risk averse. In the second stage, we find that the predicted risk aversion is strongly negatively correlated with the probability of holding financial assets. In particular, a one unit increase in the risk aversion measure reduces the probability of holding financial assets by 6%. Our results are robust to control for several demographic variables (age, age squared, gender, marital status), social variables (years of education, employment status, self employment, wage, household's financial assets) and (physical and mental) health status. A sub-sample analysis indicates that the inverse relation documented between our measure of risk aversion and individual's financial participation remains if we split the sample between males and females, people aged below and above 45, and in individuals living in rural and urban areas.

In sum, our study contributes to the literature by identifying a channel through which cognitive ability affects financial participation. In particular, we argue that individuals with high cognitive abilities are less risk averse, and as a consequence, they are more prone to hold financial assets.

The remainder of the study is structured as follows. In section 2, we review the relevant literature. A general description of the MxFLS database and the definition of the main variables used in the analysis are given in section 3. In section 4, we introduce the empirical model and discuss our empirical strategy. Our results are presented and discussed in section 5. Finally, we conclude in section 6.

2 Related literature

First, our study is related to the broader literature aimed at identifying the determinants of the participation in financial markets. This literature seeks to explain the "participation puzzle" which states that the participation level in financial markets is low when compared with the predictions of the economic theory. Among the studied determinants of participations it is worth mentioning transaction costs (Mankiw and Zeldes 1991; Heaton and Lucas 2000; Vissing-Jorgensen 2004), the lack of financial knowledge (Hong, Kubik, and Stein, 2004; Guiso and Jappelli, 2008; van Rooij, Lusardi, and Alessie, 2011; van Rooij, Lusardi, and Alessie, 2012; and Benjamin, Brown, and Shapiro, 2013); background risk (Guiso, Jappelli, and Terlizzese, 1996; Guiso and Paiella, 2008; and Paliaa, Qib, and Wuc ,2009), non-standard preferences (Ang, Bekaert, and Liu, 2005; and Cao, Wang, and Zhang, 2005); the lack of trust (Guiso, Sapienza, and Zingales, 2008), among others.

A second, and more specific, literature to which this study is related is the that studying the link between cognitive skills and participation in financial markets. Cole and Shastry (2009), Christelis, Jappelli, and Padula (2010), Grinblatt, Keloharju, and Linnainmaa (2011), Bogan and Fertig (2013), Benjamin, Brown, and Shapiro (2013) are some recent examples of studies in this area. This literature tends to associate high cognitive abilities, of

different kind (math abilities, verbal fluency, recall skills, IQ tests, among others), with a higher probability of participation in financial markets. Also, this strand of the literature shows that individuals equipped with higher cognitive ability hold riskier portfolios: they overweight risky assets, like stocks, and underweight safer assets, like bonds. These studies show that cognitive skills increase the probability of holding financial assets in a range that may varies between 1% and 15%. We add to this literature by studying a channel through which cognitive ability and participation in financial markets are linked.

Cognitive ability not only affects the probability of participation and the composition of portfolio hold by individuals, but also it has a first order effect on the trading behaviour and the performance of the portfolios. Grinblatt, Keloharju, and Linnainmaa (2011) show that a high-IQ investor experiences lower risk, which translates into higher earnings of Sharpe ratios than a low-IQ investor. Grinblatt, Keloharju, and Linnainmaa (2012) document that high-IQ investors are less likely to be affected by the disposition effect, are more likely to provide liquidity into the market and are more engaged in tax-motivated stock sales. In addition, these authors show that high-IQ investor's portfolio outperforms low-IQ investor's portfolio after controlling for market timing and that high-IQ investor's portfolio returns are more informative of future returns than low-IQ investor's portfolio returns. Finally, it is worth mentioning the contribution by Korniotis and Kumar 2010 who document that cognitive ability is positively related to individual's investment skills in a sample of people aged above 50. These investors have benefited from higher levels of experience that improve their investment ability. However, they cannot take advantage of this superior knowledge because of a detrimental effect of cognitive aging. This adverse effect is larger for those less educated, with low income and belonging to minority racial/ethnic groups.

Finally, another strand of the literature that is particularly relevant for this study focuses on how and to which extent cognitive ability directly affects risk aversion. As it will be shown later, the main result of this study is that cognitive ability is negatively associated to the level of individual's risk aversion, and as a consequence, it increases the probability of holding financial assets. This result is consistent with most of the recent literature, both non-experimental and experimental, that tends to support the hypothesis that individuals with low cognitive skills are more reluctant to take risky actions as holding financial assets. Grinblatt, Keloharju, and Linnainmaa (2011) provide an example of the non-experimental literature. Experimental studies supporting this hypothesis are Frederick 2005; Dohmen et al. 2010; Beauchamp, Cesarini, and Johannesson 2011; Benjamin, Brown, and Shapiro 2013. The contribution of Dohmen et al. (2010) is particularly interesting. They report that risk aversion and impatience vary systematically with cognitive ability, measured by an IQ test in a sample of 1,000 German adults. In particular, they report a correlation between cognitive ability and risk aversion of -0.23. This correlation is statistically significant after controlling for personal characteristics, educational attainment, income and liquidity constraints. An advantage of this study is that it uses a representative sample of adults, whereas the previous literature is mostly limited to samples composed of elderly people. The article by Benjamin et al. (2012) also finds a negative correlation between risk aversion and cognitive ability using an experimental sample of Chilean high school graduates. Finally, Andersson et al. (2013) argue that the relation between cognitive ability and risk aversion may be contaminated by noisy decision making of individuals answering the questions trying to measure their levels of risk aversion.

In sum, this study is related to the literature aiming to identify the determinants of participation in financial markets, and to the more specific literature studying how cognitive ability affects individual financial decisions and risk taking behaviour. Any of the aforementioned articles studies the jointly behaviour of cognitive ability, risk aversion and financial market participation.

3 The Mexican Family Life Survey Dataset

To empirically analyse the relation between financial participation, risk aversion and cognitive abilities we employ the MxFLS. Although this survey includes several waves of data collection, we employ those carried out over the last two waves. We focus here on the MxFLS-II conducted in 2005-2006 and on the MxFLS conducted in 2009-2012.[2] We thus rule out the baseline round of the survey in 2002 (MxFLS-I), as the relevant thematic content on risk aversion and cognitive abilities was not initially covered. The survey has a national coverage with a stratified sample design in which Mexican states are the main geographic unit of representativeness. The modules in the MxFLS cover multidisciplinary topics, starting from household composition, income generation, receipt of public and private transfers, child labour and general aspects of intra-household dynamics. More details on the dataset can be found in Rubalcava and Teruel (2004).

The multiple rounds of the MxFLS are intended to generate information for a longitudinal panel of 8,000 households. Households were selected randomly from a previous stage of random geographic selection of localities. The survey was implemented with a projected oversampling of 10 percent to avoid potential lack of representativeness due to non-random

[2] All MxFLS rounds are available at http://www.ennvih-mxfls.org/

attrition. The fieldwork stage involved face-to-face visits by enumerators across the whole country. Surveys with completed modules were only tolerated in the data collection process. From the selected households, approximately 35,000 individuals were characterized in the final survey database.

Financial participation variable

Our empirical approach entails the identification of a binary variable in the MxFLS indicating whether individuals aged 25 to 65 hold any type of formal financial product. In this sense, the survey details additional characteristics of each household member in one module that is presented to every individual over 15 years of age. The information in this module includes one special set of questions that determine the kind of assets the household counts on. It includes physical assets such as own house, cars, motorcycles, appliances, poultry and other livestock.

One specific question of the survey identifies whether the individual holds a financial product. It enquires on the individual and household ownership of saving or checking accounts, any other financial asset, registered securities, pension savings and others. The question groups all these options and does not allow any level of disaggregation. We thus obtain a binary variable from this module of the MxFLS which we employ as dependent variable in our econometric approach.

Due to this limitation in the dataset, our main dependent variable measures participation in financial markets in a broader sense than prior studies in which individuals are asked for their holding of specific asset classes like stocks, mutual funds, bonds, etc. Thus, our results provide insights about the effect of cognitive ability on financial participation but they are

silent about an expected theoretical change in the rebalancing of the holdings of financial assets towards more riskier or safer assets. Clearly, this feature in our dataset restricts to some extent the scope of the analysis in the study; however, we still provide relevant insights to the understanding of the relation between cognitive ability and participation in this broader sense.

Risk aversion measure

The MxFLS includes an experimental module to capture the risk attitudes of individuals over 15 years of age. The module was not included in MxFLS-I. In MxFLS-II a first version of the risk module was embedded in the survey but it was modified for the MxFLS-III. These facts make us unable to follow up the risk aversion of a single individual over the different rounds of the MxFLS and, consequently, we are also unable to create a panel with this explanatory variable. In our identification strategy, we focus on the risk aversion module from the MxFLS-III.

The risk aversion module contains a first section in which a choice game asking to every individual to select one of two bags. Each bag contains a ball paying off different amounts of money. The highest amounts of money are less likely of being obtained by the individual. The game starts with the following instruction:

> *"Imagine you can choose between two bags. Once you have chosen one of the bags, you will put your hand inside the bag and without looking you will pick a ball which will show the amount of money you have won"*

The game consists of seven questions that lead through 12 different routes. Individuals following the longest route will risk everything he or she obtained in previous steps. The

game choices were ordered in 12 different routes categories on an ascending risk aversion pattern. One bag would certainly pay a conservative amount of money and the other would contain two balls, one paying a lower value and another paying the double. Individuals choosing the shortest route would make up to 10,000 Mexican pesos, while individuals choosing the longest route would make up to 25,000 Mexican pesos. Therefore, the longer the route, the less adverse the individual is.

Further steps were necessary to analyse the categories that resulted from the first section of the risk attitude module in the MxFLS-III. Adding up the different choices as they were continuous variables would lead to a misspecified identification strategy, as the estimated coefficients would indicate inexistent slopes from a lower category to a higher one in an ordinal setting. We thus opted for a quantification of the categories by following Van der Kooij and Meulman (1997). The algorithm employed to achieve the quantification of the categories is known in the statistical package of SPSS as optimal scaling by alternating least squares (Meulman and others, 1998). Once the categories are quantified, we then rescale the resulting continuous variable in the range between 0 and 10, being 0 the value of the least risk averse individual and 10 the value for the most risk averse. We refer to this new variable as a risk aversion index.

Cognitive abilities test scores

Following our framework of analysis, we take into consideration the rich data from the MxFLS II and III in order to generate a cognitive ability test scores. The survey is equipped with a module that measures the scores of the Raven's progressive matrix test Raven and Court (1996) commonly known as Raven's test. The standard version of the Raven's test is based on an abstract reasoning setting that, in this case, is based on 12 different matrices

that are given to 13-65 years old individuals. Each matrix displays a graphic pattern with a blank space that must be filled with different pattern options from a multiple choice set of possible answers. For the survey analysis's sake, the answers to the Raven's test were made available with the datasets.

As mentioned above, the Raven test is not a measure of overall intelligence, but fluid intelligence. Fluid intelligence measures an individual's ability to draw inferences about the best solution to a novel problem. It is related to abstract reasoning and executive function. This type of intelligence is different to crystallized intelligence, which is associated to the accumulation of knowledge and skills (McArdle, Smith, and Willis, 2009; Nisbett et al., 2012). Prior literature studying the relation between cognitive ability and participation in financial markets has mostly used either overall measures of intelligence such as IQ or measures of crystallized intelligence such as numeracy and financial literacy variables. The Raven test has not been used as measure of cognitive skills in the context of this literature.[3] Thus, the use of the Raven test as measure of cognitive ability provides new evidence about this more specific type of intelligence affect the holding of financial assets. We standardize these scores to have a mean of zero and a standard deviation of one.

To sum up, the MxFLS counts on three different rounds over the last decade. It is representative to the Mexican population and contains a multi-thematic questionnaire for 35,000 individuals in 8,000 households. However, the risk attitude module, which provides one of the main explanatory variables to our identification strategy, was not included in the first round (MxFLS-I). Similarly, the risk attitude module in the MxFLS-II was not

[3] Vogl (2014) uses the same dataset, and therefore, the same measure of cognitive ability (the Raven test) to explain the height premium, the fact that taller workers are paid higher wages.

repeated exactly in the MxFLS-III. Therefore, we were unable to make use of the full panel features of the MxFLS. Our quantitative approach explains how we specify an econometric model by employing the MxFLS-II and MxFLS-III.

4 The Empirical Model

Our identification strategy entails the estimation of the effects of risk aversion and cognitive abilities on the probability of hold financial assets. An instrumental variable setting is implicit in the theoretical discussion of this relation. The existing literature suggests that the mediating process through which the cognitive ability affects financial participation is dominated by the individual risk aversion. To some extent, a causal inference between the ownership of any financial product and risk aversion could be also determined by an endogenous process. An unobserved omitted variable in our analysis may confound our findings and attribute the wrong causality. In this sense, an appropriate identification strategy may consider the individual cognitive ability to be exogenous to both financial participation and risk aversion.

As it was shown in the previous section, the available data on risk aversion make us unable to construct a three or two rounds panel dataset. Ideally, time-invariant omitted variables could be coped partially by fitting a fixed effects model. Nonetheless, the available data in this case lead us to specify an alternative, and still reliable, estimation model. We take into consideration the implicit instrumental variable setting by establishing the relation between financial participation and risk aversion in the MxFLS-III with an exogenous component of cognitive ability and some other covariates in the MxFLS-II. In other words, for an individual i we allow the past cognitive ability score ($c_{i,t-1}$) and some other individual

characteristics ($x_{i,t-1}$) to interact with our measure of current risk aversion ($r_{i,t}$) in a first stage framework. Consequently, instead of focusing on the interpretation of a reduced from of current financial participation ($f_{i,t}$) and previous cognitive score, we specify a Wald estimator that provides an unbiased expected value of the effect of risk aversion on financial participation. Our main assumption here is that $c_{i,t-1}$ drives $f_{i,t}$ mostly through $r_{i,t}$. Recall that the literature identifies two other theoretical channels connecting financial participation and cognitive ability (the information cost channel and the perception of risk channel), however, we argue later in the empirical part that if any potential effect through these two alternative channels exists, it is negligible.

The fact that we are considering the past cognitive ability, $c_{i,t-1}$, as exogenous to $f_{i,t}$ and $r_{i,t}$ is not theoretically misleading. The existing literature indicates that previous cognitive ability like the one captured by the Raven's test is determinant for future individual economic decision making (Heckman, Stixrud, and Urzua, 2006; Heckman and Masterov ,2007). An alternative exogenous relation could be obtained by taking into consideration previous risk aversion experience and current financial participation. However, the latter would exceed the limits of our theoretical approach. We thus adapt our model to the available data with the specification of a causal inference model between financial participation and risk aversion in which the past cognitive ability plays an instrumental role.

Formally, we can specify the following simultaneous equation system under a cross sectional setting:

$$f_{i,t} = \alpha_0 + \alpha_1 r_{i,t} + \alpha_2 x_{i,t-1} + u_i \quad (1)$$

$$r_{i,t} = \beta_0 + \beta_1 c_{i,t-1} + \beta_2 x_{i,t-1} + v_i \quad (2)$$

Where, for each individual i, $f_{i,t}$ is a binary variable denoting 1 if the individual current holds any form of financial participation, $r_{i,t}$ is the current individual endogenous risk aversion score, $c_{i,t-1}$ is the past exogenous cognitive ability indicator obtained from the Raven's test and $x_{i,t-1}$ is a vector of past individual characteristics; u_i and v_i are considered independent normal distributed stochastic errors. Finally, α_j and β_k are parameters to be estimated by a maximum likelihood instrumental variable Probit model following Newey (1987).

5 Main Results

Descriptive Analysis

We start the presentation of our estimation results by describing the data from the MxFLS. Recall that our cross sectional setting considers financial participation and risk aversion in the MxFLS-III, while the exogenous covariates, including the instrument ($c_{i,t-1}$), were obtained from the MxFLS-II. The identification of individuals in both rounds resulted in a non-random attrition of 14 percent with a cross section dataset with 10,035 observations. We attempt to mitigate the no-random attrition by including the Heckman (1979) inverse of Mill's ratio to which we refer as a lambda variable.[4]

Table 1 below shows the descriptive statistics of the selected variables for the population between 25-65 years of age and for some other heterogeneous groups. We follow Vogl (2014) in working only with a sample of adults aged between 25 and 65.

[4] We estimate the inverse of Mill's ratio by employing household-level characteristics as the main source of individual attrition of the survey is the absence of the whole household in the MxFLS-III. Given the complexity of the instrumental variable estimation, we opted for a two-step estimation of the inverse of the Mill's ratio.

[Table 1 about here]

As it can be seen from the table above, 14.3 percent of the selected population holds any kind of financial product, in particular in urban areas. Considering that we are working with a broader measure of participation, this number appears low when compared with more developed economies; however, it is consistent with participation in other less developed economies (e.g., Christelis, Jappelli, and Padula, 2010). Financial participation in rural areas is the lowest among selected groups. Males participate more than females and they turn out to predominate as households' head. This is consistent with prior data showing that the financial behaviour of men and women differs (Bogan and Fertig, 2013). Differences between age groups of 25-45 and 45-65 do not seem to be important. The risk aversion index in the scale 0-10 reveals that urban individuals are the least risk averse. On average, the risk aversion and its standard deviation score is stable among groups. Gender differences reveal that men are 42 percent of the selected population as the group of 25-45 shows higher education level denoted by years of education.

As for our instrument, Figure 1 below shows the kernel density estimate for the standardized variable containing the Raven's test scores. The distribution of the Raven's test scores, as an indicator of fluid intelligence, apparently is skewed on the right, in spite of the fact that the left tail shows higher density of the Raven's test core than the right tail. The heterogeneous groups shown in Table 1 above indicate that all of them are above the average, with the exception of those individuals in rural areas.

[Figure 1 about here]

The kernel density of risk aversion index is shown by Figure 2 below. It shows the re-scaled variable once the categories were quantified and indicates that the mode is around the point 8 over the 0 - 10 scale. Table 1 above shows that the average of this index for the whole sample is 5.2, with females being more risk averse than males. Consistent with the Raven's test score, the highest risk aversion index is presented in rural areas.

[Figure 2 about here]

We included some other variables that may be related with risk aversion following previous literature. First, we included a binary variable indicating whether the individual is suffering from any chronic illness. These characteristic can lead the individual to adopt a higher risk behaviour in financial terms (Eisenhauer and Ventura, 2003). It shows that an average of 14.8 percent of individuals reported some kind of chronic illness, including diabetes, hypertension, heart disease, cancer and others. Second, we include a binary variable indicating whether the individual has been depressed within the four weeks prior to the survey. Bogan and Fertig (2013) have found that this kind of mental conditions can be related with lower levels of risk aversion. Our data shows that an average of 36 percent of the selected population has experienced some degree of depression in the MxFLS-II. The inclusion of the depression variable in our empirical model is important as this variable may acts as a proxy for individual's risk perception. Thus, by including this variable in the model, we are controlling for the potential effect of cognitive ability on financial participation through the perception of risk channel. Thus, we can say that our main results are not driven by an omission of the alternative transmission channels.

Individual labor market characteristics were also employed in our empirical approach. The data show that males participate more than women in the labor markets and that the most frequent work category is non-agricultural worker. Similarly, it was found that wages in urban areas double those in rural areas. An additional control variable in consideration is the value of financial assets at the household level, for which the age group of 25-45 years of age presents the highest holding values. Finally, the Raven's test score, the instrumental variable, is listed as a normalized variable.

Estimation results

Our instrumental variable probit model involves the simultaneous equation system specified by equations (1) and (2). Equation (2) is the first stage of the maximum likelihood algorithm that solves the system. It relates the individual risk aversion index with the cognitive ability captured by the Raven's test score accounting for some other covariates. The results are presented with an initial specification considering solely the Raven's test score, another accounting for other covariates and the others display the results for the heterogeneous groups taken into account for the data description.

Table 2 below shows the results of the first stage. The first fact to note is that the coefficient of the Raven's test score obtained the expected sign. In other words, past cognitive ability is related with lower current risk aversion attitude. This result is strongly robust to the inclusion of additional covariates, to the extent that the coefficients for the Raven's test score in the first two columns are the same in terms of significance. The coefficients for the groups of analysis are similar. Nonetheless, the age group of 25-45 did not obtain a significant coefficient, which demonstrates that past cognitive abilities is a weak instrument for this age group. As for other covariates, very few of them yielded

significant coefficients. The coefficient for years of education is only significant in for 45-65 years old individuals, indicating a negative relation between current risk aversion and education in the previous round of the survey. In contrast, being employed in the past is related with a higher risk aversion, while most of work categories obtained negative coefficients. An interesting finding is that the value of household financial holdings is related with lower current risk aversion. A similar sign was obtained by urban individuals.

[Table 2 about here]

Now we turn into the results of the model where financial participation is the dependent variable. The maximum likelihood estimation of the probit model starts with the specification of a single model without using the Raven's test as an instrumental variable. We then focus on the instrumental variable probit model with and without additional controls and over the selected groups of analysis. The results also report the marginal effect of the risk aversion index as the main variable of interest. We also included the Wald test of exogeneity of the risk aversion index that, if not significant, indicates whether the instrumental model is correctly specified with the selected sample.

Table 3 below provides the results from the estimation of the instrumental variable probit model by maximum likelihood. It shows the estimated coefficients for all the control variables and the instrumented risk aversion through which cognitive abilities impact financial participation probabilities. Recall that these estimates do not represent the marginal change in the probability of financial participation. However, the lower part of the table provides the marginal effect of the risk aversion index on the probability of participation. From these estimations we first note that the age group 25-45 did not obtain a

satisfactory exogeneity specification test, as the Wald Chi2 resulted not significant at a 5 percent threshold. The latter is consistent with the results from the first stage, to the extent that we cannot accept that past cognitive abilities impact financial participation through the risk aversion index.

It is apparent from these estimation results that a single Probit does not fit the specification, since the risk aversion index obtained a non-significant coefficient and its marginal effect is close to zero as a result of the underlying endogeneity between current financial participation and risk aversion. Contrarily, strong evidence of the significance of this effect resulted from the estimation of the instrumental variable probit model. For all the sample of individuals aged 25-65 it was found that a change of one unit in the risk aversion index generates a decrease in the probability of financial participation in 6.7 percentage points. Interestingly, this coefficient is almost unchanged with the inclusion of additional controls, which confirms the robustness of this finding.

[Table 3 about here]

The results are also consistent and robust across the selected heterogeneous groups. The largest marginal effect is evident in rural areas where, in fact, financial participation is low. Similarly, the probability of financial participation of male individuals is more sensitive to changes in an exogenous change in the risk aversion; while those individuals aged 45-65 tend to participate more in financial terms in the light of marginal changes in the exogenous risk aversion index. If we consider a 95 percent confidence interval of the marginal effect coefficient for all individuals [-0.074, -0.064], these results suggest that our instrumental variable estimation are robust to different specification and heterogeneous groups.

6 Conclusions

In this article, we shed light on the relation between cognitive ability and individual's holding of financial assets, through the risk aversion. In particular, we test the hypothesis that individuals with high cognitive abilities are less risk averse, and as consequence, it is more likely that they participate in financial markets by holding financial assets.

We test our hypothesis by using two cohorts of the Mexican Family Life Survey (MX-FLS). This is a longitudinal dataset with national representation, containing information about individual's holding of financial assets, risk aversion and cognitive ability. The fact that a single dataset contains, simultaneously, information about these three variables is not common, and it constitutes a valuable source of information to overcome several empirical underpinnings present in the prior literature.

Our results strongly support the hypothesis that cognitive ability increases the probability of holding financial assets by affecting individual's level of risk aversion. The identified effects are statistically significant at standard level of confidence. These results are robust to control for demographic, social and health variables. The results also hold for sub-samples of men, women, young (25-45 years) adults, older adults (45-65 years), and rural and urban individuals, respectively.

We contribute to the literature in several respects, to the extent that it extends our knowledge of the transmission channels through which cognitive ability affects financial participation. First, we propose and estimate an empirical model in which the probability of holding financial assets depends on the individual's current level of risk aversion, measured by the matrix reasoning Raven’s test, and several demographic, social and health

determinants; we use the level of cognitive ability observed in the MxFLS-II cohort as instrument for the level of risk aversion in the MxFLS-III. In particular, we estimate an IV Probit model. This empirical framework helped us to identify the aforementioned risk aversion channel connecting cognitive ability and holding of financial assets. To the best of our knowledge this is the first study that provides empirical evidence supporting a model in which this channel is explicitly identified. Most of the previous literature tries to identify a direct connection between cognitive skills and financial market participation, but fail to identify a transmission channel.

Closely related to the previous point, our second contribution is that the use of two cohorts of a longitudinal dataset reduces the problem of endogeneity due to simultaneity. This problem is common in those regressions in which participation in financial markets is directly regressed onto cognitive ability. Grinblatt, Keloharju, and Linnainmaa (2011) and Bogan and Fertig (2013) also try overcome this problem but with alternative empirical approaches than the one we used.

A third contribution to the literature is the use of a measure of fluid intelligence, instead of more common measures in this literature of crystallized intelligence, as our proxy of cognitive ability. As stated by Nisbett et al. (2012) both types of intelligences substantially differ, but most important for the purpose of this study, a measure of crystallized intelligence is free of a potential feedback effect with financial decisions as they cannot be influenced by the accumulation of (financial) knowledge as it will be the case with measures of crystallized intelligence. McArdle, Smith, and Willis (2009) also study the effect of fluid and crystallized intelligence on financial decisions but we add to their work by identifying the channel through which these types of cognition are linked.

Finally, we contribute to the literature by analyzing a more representative sample of adults than in previous studies. Due to data limitations, most of the prior studies in the literature use samples with adults aged above 50. Here, we have a representative sample of adults aged between 25 and 65. Clearly, this enriches the overall analysis and allows drawing more representative conclusions.

Overall, this study shed light on the channel through which cognitive abilities and participation in financial markets are connected. Our analysis supports the view that high cognitive ability individuals are less risk averse, and as a consequence, their probability of holding financial assets is higher.

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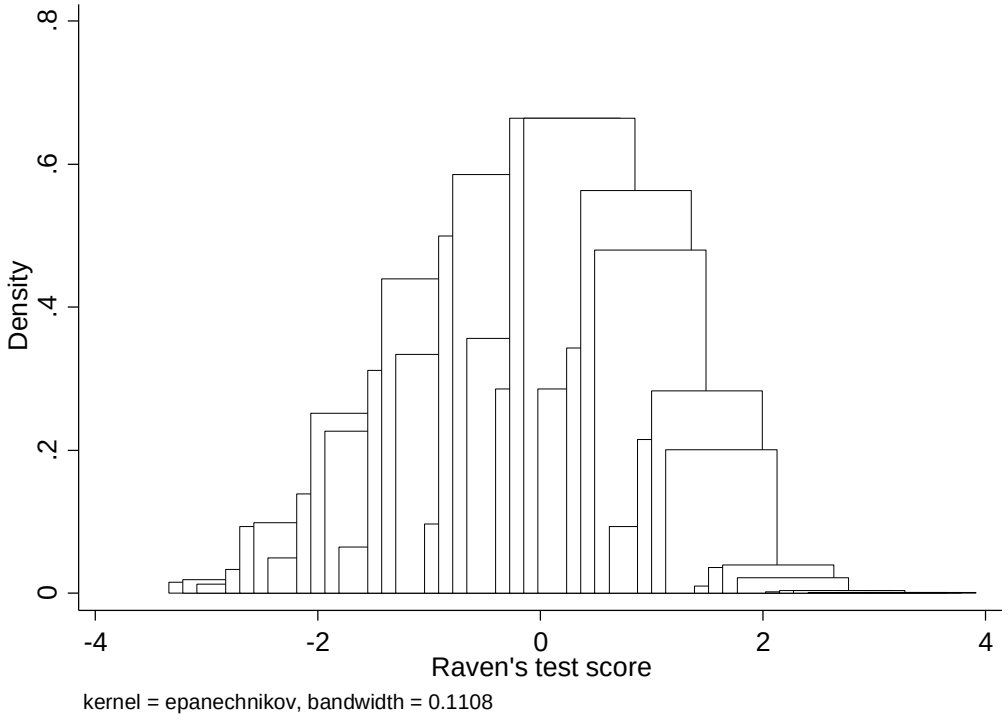
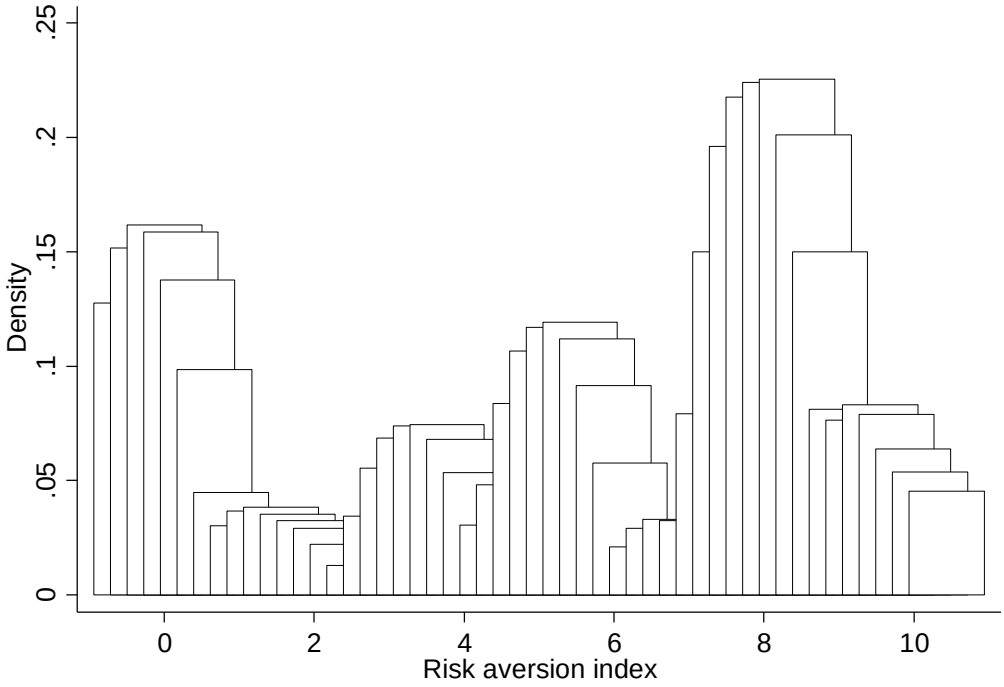
Figure 1. Kernel density estimate for the Raven's test score.



Source: MxFLS-II.

Figure 2. Kernel density estimate for risk aversion.



Source: MxFLS-III.

Table 1. Descriptive statistics of selected endogenous and exogenous variables.

Population aged 25-65	All	Male	Female	25-45	45-65	Urban	Rural
Financial participation = 1 (a)	0.143	0.162	0.128	0.145	0.140	0.175	0.097
	[0.350]	[0.369]	[0.334]	[0.352]	[0.347]	[0.380]	[0.296]
Risk aversion (0-10) (a)	5.221	5.160	5.266	5.159	5.285	4.985	5.559
	[3.474]	[3.534]	[3.430]	[3.445]	[3.503]	[3.532]	[3.362]
Gender	0.421	1.000	0.000	0.404	0.439	0.415	0.430
	[0.494]	[0.000]	[0.000]	[0.491]	[0.496]	[0.493]	[0.495]
Age	44.02	44.37	43.77	34.78	53.43	43.72	44.45
	[10.96]	[11.26]	[10.74]	[5.99]	[5.53]	[10.94]	[10.98]
Years of education	5.610	5.603	5.618	6.499	4.703	6.035	5.002
	[3.887]	[3.936]	[3.851]	[3.869]	[3.692]	[4.053]	[3.552]
Head of the household	0.366	0.692	0.128	0.231	0.503	0.367	0.364
	[0.482]	[0.462]	[0.334]	[0.422]	[0.500]	[0.482]	[0.481]
Spouse	0.363	0.022	0.612	0.307	0.421	0.360	0.368
	[0.481]	[0.146]	[0.487]	[0.461]	[0.494]	[0.480]	[0.482]
Married	0.739	0.768	0.719	0.649	0.831	0.715	0.773
	[0.439]	[0.422]	[0.450]	[0.477]	[0.375]	[0.451]	[0.419]
Chronic illness	0.148	0.142	0.153	0.145	0.152	0.160	0.132
	[0.356]	[0.349]	[0.360]	[0.352]	[0.359]	[0.367]	[0.339]
Depressed	0.364	0.360	0.366	0.363	0.364	0.362	0.365
	[0.481]	[0.480]	[0.482]	[0.481]	[0.481]	[0.481]	[0.482]
Employed	0.509	0.752	0.333	0.480	0.539	0.542	0.462
	[0.500]	[0.432]	[0.471]	[0.500]	[0.499]	[0.498]	[0.499]
Farmer	0.035	0.077	0.004	0.016	0.055	0.010	0.071
	[0.183]	[0.267]	[0.065]	[0.124]	[0.227]	[0.099]	[0.256]
Family worker	0.026	0.028	0.025	0.026	0.026	0.026	0.026
	[0.160]	[0.165]	[0.157]	[0.160]	[0.160]	[0.160]	[0.160]

Non-agricultural worker	0.274	0.386	0.193	0.298	0.249	0.349	0.166
	[0.446]	[0.487]	[0.394]	[0.458]	[0.433]	[0.477]	[0.372]
Rural laborer	0.050	0.107	0.008	0.043	0.056	0.014	0.100
	[0.217]	[0.309]	[0.090]	[0.203]	[0.230]	[0.117]	[0.301]
Boss, employer	0.031	0.039	0.025	0.024	0.038	0.037	0.022
	[0.174]	[0.194]	[0.157]	[0.153]	[0.192]	[0.189]	[0.148]
Self-employed	0.083	0.100	0.070	0.062	0.104	0.095	0.064
	[0.275]	[0.300]	[0.255]	[0.241]	[0.305]	[0.294]	[0.245]
Employee without remuneration	0.009	0.012	0.007	0.010	0.009	0.010	0.009
	[0.096]	[0.110]	[0.085]	[0.098]	[0.095]	[0.098]	[0.094]
Wage ($)	2,291	3,837	1,286	2,229	2,349	2,885	1,449
	[12395]	[8959]	[14098]	[15764]	[7947]	[14971]	[7253]
Value of HH financial assets ($)	24,043	28,219	21,023	43,252	4,487	40,221	986
	[1,412,779]	[1,539,897]	[1,313,265]	[1,988,552]	[41,356]	[1,842,795]	[9,988]
Urban	0.588	0.579	0.594	0.601	0.575	1.000	0.000
	[0.492]	[0.494]	[0.491]	[0.490]	[0.494]	[0.000]	[0.000]
Raven test score (i)	0.000	0.020	0.012	0.010	0.021	0.131	-0.149
	[1.000]	[0.998]	[0.997]	[0.985]	[1.009]	[0.973]	[1.008]
Observations	10,035	4,058	4,960	4,417	4,627	5,300	3,707

Source: MxFLS-II, III.

Note: (1) a: this variable is obtained from the MxFLS III. (2) i: This variable is the instrument. (3) Standard deviations in brackets.

Table 2. First stage estimation of risk aversion index.

Risk aversion (0-10) (a)	All - First stage	All - First stage	Male - First stage	Female - First stage	25-45 - First stage	45-65 - First stage	Urban - First stage	Rural - First stage
Gender		-0.167			-0.158	-0.096	-0.269	-0.129
		(0.105)			(0.133)	(0.232)	(0.189)	(0.172)
Age		0.009	0.033	-0.013	0.229	-0.308	0.018	-0.013
		(0.038)	(0.045)	(0.049)	(0.159)	(0.217)	(0.047)	(0.055)
Age2		0.000	-0.000	0.000	-0.003	0.003	-0.000	0.000
		(0.000)	(0.000)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
Years of education		-0.010	-0.014	-0.005	0.017	-0.045***	-0.005	-0.019
		(0.013)	(0.014)	(0.017)	(0.017)	(0.015)	(0.015)	(0.018)
Head of the household		0.058	0.140	-0.005	0.199	-0.182	0.265	-0.194
		(0.150)	(0.248)	(0.153)	(0.221)	(0.224)	(0.186)	(0.270)
Spouse		-0.135	-0.503	-0.160	-0.093	-0.276	-0.145	-0.142
		(0.173)	(0.405)	(0.174)	(0.249)	(0.275)	(0.249)	(0.221)
Married		-0.086	-0.240	-0.090	-0.085	-0.176	0.033	-0.285**
		(0.098)	(0.188)	(0.161)	(0.181)	(0.211)	(0.191)	(0.145)
Chronic illness		-0.119	-0.293	-0.012	-0.229	-0.063	-0.071	-0.194
		(0.152)	(0.193)	(0.160)	(0.222)	(0.190)	(0.187)	(0.241)
Depressed		0.017	-0.031	0.046	0.051	-0.020	-0.032	0.071
		(0.078)	(0.117)	(0.093)	(0.059)	(0.128)	(0.107)	(0.119)
Employed		1.630**	1.808**	2.380**	1.466	1.619*	0.342	2.371***
		(0.675)	(0.776)	(1.041)	(1.050)	(0.829)	(1.459)	(0.723)
Farmer		-1.346*	-1.115		-1.933*	-1.079	-0.405	-1.928***
		(0.697)	(0.726)		(1.114)	(0.869)	(1.375)	(0.657)
Family worker		-2.193***	-2.122***	-2.912***	-2.198*	-2.020**	-0.959	-2.853***
		(0.703)	(0.740)	(1.023)	(1.177)	(0.835)	(1.532)	(0.757)
Non-agricultural worker		-1.805***	-1.536**	-2.754**	-1.568	-1.895**	-0.549	-2.481***

		(0.690)	(0.750)	(1.075)	(1.065)	(0.861)	(1.472)	(0.731)
Rural laborer		-1.633**	-1.463*	-2.468***	-1.194	-1.836*	0.101	-2.380***
		(0.721)	(0.765)	(0.945)	(0.956)	(0.979)	(1.512)	(0.707)
Boss, employer		-1.561**	-1.393**	-2.338**	-1.546	-1.483*	-0.336	-2.172***
		(0.683)	(0.670)	(1.113)	(1.315)	(0.867)	(1.486)	(0.788)
Self-employed		-1.804***	-1.845**	-2.379**	-1.962*	-1.597*	-0.625	-2.352***
		(0.676)	(0.822)	(1.061)	(1.136)	(0.938)	(1.442)	(0.748)
Employee without remuneration		-1.977**	-1.429	-3.277***	-1.797	-1.963*	0.063	
		(0.800)	(0.960)	(1.118)	(1.209)	(1.057)	(1.606)	
Wage ($)		0.000	-0.000	0.000	0.000	-0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Value of HH financial assets ($)		-0.000***	0.000	-0.000***	-0.000***	0.000**	-0.000***	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Urban	-0.541***	-0.440***	-0.408***	-0.444***	-0.581***	-0.277**		
	(0.126)	(0.124)	(0.140)	(0.139)	(0.156)	(0.140)		
Lambda	-0.104	-0.144	-0.192	-0.069	-0.238	-0.039	-0.021	-0.276
	(0.228)	(0.236)	(0.329)	(0.310)	(0.292)	(0.345)	(0.289)	(0.403)
Raven's test score (i)	-0.107***	-0.098***	-0.094	-0.105**	-0.035	-0.153***	-0.139**	-0.040
	(0.034)	(0.035)	(0.063)	(0.050)	(0.050)	(0.055)	(0.063)	(0.041)
Constant	5.574***	5.461***	4.606***	5.870***	1.609	14.118**	4.655***	6.218***
	(0.183)	(0.801)	(0.990)	(1.006)	(2.718)	(5.825)	(0.944)	(1.267)
Observations	10,035	9,044	4,058	4,960	4,417	4,627	5,300	3,707

Source: MxFLS-II, III.

Note: (1) a: this variable is obtained from the MxFLS III. (2) i: This variable is the instrument. (3) *** p<0.01, ** p<0.05, * p<0.1. (4) Robust standard errors at the state level in parentheses.

Table 3. Maximum likelihood instrumental variable Probit estimation of the financial participation.

Financial participation = 1 (a)	All - Probit	All - IV Probit	All - IV Probit	Male - IV Probit	Female - IV Probit	25-45 - IV Probit	45-65 - IV Probit	Urban - IV Probit	Rural - IV Probit
Risk aversion (0-10) (a)	-0.015	-0.276***	-0.274***	-0.280***	-0.261***	-0.292***	-0.242***	-0.239***	-0.298***
	(0.014)	(0.011)	(0.017)	(0.017)	(0.035)	(0.008)	(0.053)	(0.047)	(0.006)
Gender			0.029			-0.029	0.185	0.080	-0.021
			(0.052)			(0.052)	(0.144)	(0.088)	(0.053)
Age			-0.007	-0.000	-0.012	0.044	0.020	-0.005	-0.009
			(0.013)	(0.014)	(0.020)	(0.056)	(0.103)	(0.016)	(0.017)
Age2			0.000	0.000	0.000	-0.001	-0.000	0.000	0.000
			(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
Years of education			0.000	-0.003	0.004	0.006	-0.004	0.003	-0.004
			(0.004)	(0.006)	(0.006)	(0.005)	(0.008)	(0.005)	(0.006)
Head of the household			-0.070	0.009	-0.196*	0.023	-0.060	-0.128	-0.063
			(0.064)	(0.081)	(0.113)	(0.080)	(0.061)	(0.127)	(0.082)
Spouse			-0.070	-0.140	-0.108*	-0.047	0.063	-0.101	-0.045
			(0.057)	(0.120)	(0.063)	(0.063)	(0.129)	(0.090)	(0.071)
Married			0.166**	0.052	0.221*	0.045	0.234**	0.306**	-0.020
			(0.076)	(0.094)	(0.133)	(0.103)	(0.118)	(0.120)	(0.080)
Chronic illness			-0.024	-0.055	-0.015	-0.042	-0.076	-0.025	-0.046
			(0.057)	(0.064)	(0.072)	(0.080)	(0.094)	(0.077)	(0.082)
Depressed			-0.008	-0.021	-0.001	0.007	-0.012	-0.015	0.011
			(0.031)	(0.039)	(0.037)	(0.023)	(0.053)	(0.039)	(0.041)
Employed			0.623**	0.621**	1.235**	0.528*	0.419	0.107	0.793***
			(0.279)	(0.297)	(0.613)	(0.318)	(0.410)	(0.634)	(0.300)
Farmer			-0.591**	-0.445		-0.675**	-0.390	-0.393	-0.674**
			(0.275)	(0.271)		(0.307)	(0.424)	(0.566)	(0.289)

Family worker			-0.762***	-0.685**	-1.344**	-0.748**	-0.443	-0.184	-0.950***
			(0.290)	(0.270)	(0.610)	(0.355)	(0.443)	(0.670)	(0.323)
Non-agricultural worker			-0.614**	-0.480*	-1.270**	-0.536*	-0.414	-0.047	-0.817***
			(0.294)	(0.286)	(0.624)	(0.325)	(0.460)	(0.660)	(0.298)
Rural laborer			-0.707***	-0.579**	-1.340***	-0.474*	-0.634	-0.303	-0.822***
			(0.265)	(0.282)	(0.511)	(0.282)	(0.409)	(0.587)	(0.307)
Boss, employer			-0.542**	-0.432*	-1.167*	-0.495	-0.407	0.052	-0.758**
			(0.265)	(0.259)	(0.618)	(0.397)	(0.421)	(0.640)	(0.341)
Self-employed			-0.662**	-0.613**	-1.221*	-0.660*	-0.452	-0.137	-0.796**
			(0.288)	(0.300)	(0.631)	(0.338)	(0.459)	(0.651)	(0.315)
Employee without remuneration			-0.787**	-0.669*	-1.389**	-0.602*	-1.088**	0.008	
			(0.325)	(0.391)	(0.650)	(0.360)	(0.541)	(0.647)	
Wage ($)			0.000	0.000	0.000	0.000	0.000	-0.000	0.000*
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Value of HH financial assets ($)			-0.000***	0.000	-0.000***	-0.000***	0.000**	-0.000***	-0.000
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Urban	0.353***	-0.031	-0.009	-0.021	0.025	-0.134	0.116		
	(0.089)	(0.075)	(0.081)	(0.096)	(0.122)	(0.085)	(0.096)		
Lambda		-0.071	-0.118	-0.110	-0.115	-0.115	0.016	-0.152	-0.101
		(0.087)	(0.087)	(0.090)	(0.107)	(0.129)	(0.115)	(0.093)	(0.124)
Constant	-1.216***	1.104***	1.115**	1.052**	1.011	0.682	-0.196	0.592	1.763***
	(0.086)	(0.196)	(0.508)	(0.465)	(0.752)	(0.855)	(3.231)	(0.701)	(0.451)
Observations	10,035	10,035	9,044	4,058	4,960	4,417	4,627	5,300	3,707
Risk aversion (0-10)									
dF/dx	**-0.003**	**-0.067*** **	**-0.068*** **	**-0.071*** **	**-0.066*** **	**-0.073*** **	**-0.060*** **	**-0.062*** **	**-0.077*** **
Std. Err.	**0.003**	**0.003**	**0.005**	**0.005**	**0.009**	**0.004**	**0.013**	**0.010**	**0.004**
Wald Chi2 - Exogeneity		27.23	13.19	5.915	6.269	3.313	4.672	5.402	6.990
P-value		0.000	0.000	0.015	0.012	0.069	0.031	0.020	0.008

Source: MxFLS-II, III.

Note: (1) a: this variable is obtained from the MxFLS III. (2) *** p<0.01, ** p<0.05, * p<0.1. (3) Robust standard errors at the state level in parentheses.