Cognitive constraints, planned savings, and downstream economic behaviors

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Abstract: We study how cognitive ability and financial literacy relate to each step of the planning process for retirement, that is, individuals' propensity to plan, planned savings amounts, and actual economic outcomes (savings, portfolio choice, annuity purchase). We find that cognitive ability and financial literacy play different roles: Having high financial literacy is an important and positive factor for all stages of the planning process, while high cognitive ability is especially relevant for planning concrete (and higher) savings amounts. Moreover, the propensity to plan and planned savings amounts help predict three downstream economic behaviors. Our findings suggest that when crafting public policy to develop individuals' retirement readiness, next to improving financial literacy, another target should be to enhance cognitive skills and provide, for example, smart tools supporting the preparation of concrete plans.

JEL classification: D12; D14; D91

Key words: Retirement planning; planned savings; cognitive ability; financial literacy; economic behaviors

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1. Introduction

Worldwide population aging and the shift of pension systems from defined benefit to defined contribution require individuals increasingly to carry more responsibility to prepare financially for retirement (Gomes et al., 2021). Researchers and policymakers worry that individuals might not save enough to accumulate adequate finances for retirement (Munnell et al., 2021) or underinsure against an uncertain life span through buying annuities (e.g., Brown, 2007). Moreover, substantial heterogeneity in wealth accumulation has been documented, which has been related to heterogeneity in classical preference parameters (time preference, risk aversion) (Bernheim et al., 2001), cognitive ability (Banks et al., 2010), financial literacy (Lusardi and Mitchell, 2014), and behavioral traits, such as present bias (Laibson, 1997; O'Donoghue and Rabin, 1999) and exponential growth bias (Stango and Zinman, 2009).

One important behavioral trait found to explain heterogeneity in wealth accumulation is an individual's propensity to plan, that is, the tendency to plan for long-term goals (such as saving for retirement) that may result in downstream goal-setting behaviors (Ameriks et al., 2003; Xiao and O'Neill, 2018). The literature documents that individuals with a greater propensity to plan save more and are thus better prepared for retirement (Ameriks et al., 2003; Khwaja et al., 2007; Lusardi and Mitchell, 2007; Mayer et al., 2011; Binswanger and Carman, 2012; Lee and Kim, 2016). An individual's propensity to plan has been found to be related to socio-economic factors like age, gender, marital status, income, and education (Tomar et al. 2021), financial literacy (van Rooij et al., 2011a; van Rooij et al., 2012), and psychological factors like future time perspective and retirement goal clarity (Hershey and Mowen, 2000; Hershey et al., 2007; Tomar et al., 2021).

What is less clear, however, is what exactly those plans are that planners prepare and through which mechanism those plans are translated into action. Being a planner, that is, having a greater propensity to plan, is measured typically based on Likert-scale agreement questions like "I have spent a great deal of time developing a financial plan" (e.g., Ameriks et al., 2003) and "How much have you thought about retirement?" (e.g., Lusardi and Mitchell, 2007; van Rooij et al., 2011a), or yes/no statements like "Have you or your spouse ever tried to figure out how much you need to save for your retirement?" (e.g., in the U.S. Retirement Confidence Survey and National Financial Capability Study, van Rooij et al., 2012; Fernandes et al., 2014; Anderson et al., 2017). Then, the literature relates those propensity-to-plan measures directly to various economic outcome variables.

In this paper, we use a novel data set that not only elicits individuals' propensity to plan, but also (in part) the actual plan. In particular, we utilize the 2010 to 2018 waves and a 2014 special module in the China Family Panel Studies for a nationally representative urban sample. In addition to eliciting the propensity to plan (yes or no question), the special module asks planners about their savings plans using the question "What is the amount of money you and your spouse need to save for your retirement?", and measures a wide range of individual factors, such as cognitive ability, financial literacy, classical preference parameters, and behavioral traits.

We study the antecedents of individuals' propensity to plan, the planned savings amounts, and whether and how those savings plans translate into economic action by analyzing saving accumulation, portfolio choice, and private annuity purchases. Planning and plan execution create information costs (Reis, 2006) that may constrain individuals with poor financial knowledge and low cognitive abilities to find, access, and process information and to make informed financial decisions with respect to planning, plan execution or both. Both cognitive ability and financial literacy have been found relevant to making sound financial decisions and avoiding mistakes (e.g.,

Agarwal and Mazumder, 2013; Hastings et al., 2013; Gladstone and Barrett, 2022). Cognitive ability is defined as the general brain-based capability to "reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience" (Gottfredson, 1997). Financial literacy refers to financial knowledge and its application to personal finance (Huston, 2010).

In particular, it has been documented that higher financial literacy is related to a greater propensity to plan and higher savings (Lusardi and Mitchell, 2007; van Rooij et al., 2012). Less is known, however, about the role of cognitive ability, and also how both—literacy and cognitive ability— relate to the consecutive steps of the planning process. Earlier literature has suggested that individuals' cognitive ability and financial literacy are often positively related: cognitive ability facilitates financial literacy acquisition (Delavande et al., 2008; Muñoz-Murillo et al., 2020; Paraboni et al., 2021) and declining cognitive ability impairs financial literacy (Triebel et al., 2009; Boyle et al., 2013; Gamble et al., 2015). With respect to financial decisions, both cognitive ability and financial literacy are found to relate similarly to some economic behaviors, such as stock market participation (Christelis et al., 2010; van Rooij et al., 2011b) and annuity valuation (Brown et al., 2017). However, they may also differ in their proximity or involvement level in various decision-making processes. For example, regarding seeking financial advice, studies find that cognitive ability and financial literacy both predict relying more on professional advice (vs. friends and family) but only cognitive ability predicts a greater distrust in financial advisors and, thus, not taking free advice (Kim et al., 2019). Therefore, it is important to generate insights on how cognitive ability and financial literacy both relate to the capability of an individual to make and follow-up upon proper financial plans for retirement. For public policy interventions, it will be interesting to know in which stage of the planning process either one of these factors influences individuals decisions (e.g., for more financial vs. more math education).

Our setting is comparable with many Western economies, like the U.S., in that individual planning and saving are important to secure a healthy financial situation in retirement. Currently, Chinese households' old-age provision relies heavily on the pay-as-you-go social pension. However, rapid population aging threatens the sustainability of the public pension system. Since the 1997 pension reform to foster a multipillar system, the target replacement ratio of the social pension for urban employees has declined (Feng et al., 2011) and is now at only about 45% according to the China Ageing Finance Forum (CAFF50). Meanwhile, the second pillar (occupational pension plans) develops slowly and has a very limited coverage[1]. In order to enhance the individual saving (i.e., the third pillar), the Chinese government recently has implemented a series of public policies, for example, piloting individual tax-deferred commercial endowment insurance and rolling out a voluntary private pension plan. However, contrary to the growing needs to build up personal savings for retirement, many survey results point out that households are not preparing financially enough for retirement[2].

In line with the literature using U.S. or European samples, our results show that being a planner is positively related to higher financial literacy (e.g., as in van Rooij et al., 2011a, 2012; Anderson

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[1] According to the Ministry of Human Resources and Social Security of the People's Republic of China, at the end of 2021, about 27.2 million urban employees participated in occupational pension plans which comprised less than 6.0% of the total urban employees insured by the Urban Employee Basic Pension Scheme.
[2] For example, the China Retirement Readiness Survey 2020, conducted by Tsinghua University and Tencent Holdings Ltd., documents that about 84.0% respondents have not practiced retirement planning. Meanwhile, the China Ageing Finance Survey 2021, conducted by the CAFF50, reveals that about 31.9% respondents' accumulated retirement wealth is below 100 thousand yuan (around 15 thousand U.S. dollars).

et al., 2017). Cognitive ability, however, does not predict being a planner. When looking at the actual plans (of those who plan), we find that higher planned savings are related to both higher cognitive ability and higher financial literacy. Additional evidence on financial literacy also shows that planning for retirement is a multi-faceted process. While higher basic financial literacy (i.e., financial numeracy and understanding of economic concepts for day-to-day financial transactions) predicts higher planned savings, higher advanced literacy (i.e., knowledge of financial investments and portfolio choice) predicts being a planner.

Importantly, we also observe that plans translate into action. In particular, higher planned savings translate into higher savings. In addition, through their indirect effect on the propensity to plan, we observe a direct positive relation to cognitive ability and financial literacy. Moreover, we find that planners, especially those with higher planned savings, invest more into risky assets—that is, stocks or mutual funds—and purchase more private annuities. Doing so is predicted by higher financial literacy as well.

Our results are economically significant: Based on ordinary least squares (OLS) estimates, a one standard deviation increase in cognitive ability and financial literacy results in a 16.4% and 11.1% increase in planned savings, respectively. And planners with higher planned savings (above the median) have over 76% higher savings than non-planners, and their participation in risky asset and annuity markets also increases by 2.4% and 1.8% (about 17.3% and 54.5% of the sample averages).

Our findings are robust to controlling for classical preference parameters (risk aversion and patience), behavioral traits (present bias), and a wide range of demographic variables. Our results are also robust to several concerns related to potential reverse causality. First, we document temporal stability for the test scores for cognitive ability, which makes it unlikely to be affected by previous financial behaviors. Second, by employing IV estimates for financial literacy (instrumented both by parents' financial knowledge and community average financial literacy), we can rule out that higher literacy is caused by previous financial behaviors as well. Third, when analyzing savings behavior, we control for a past survey wave's financial wealth to rule out that the causality runs from savings levels to planned savings. Moreover, using Oster's (2019) approach, we consider selection on unobservables.

Our findings further help to understand why the propensity to plan is positively related to higher savings, and also the heterogeneity therein. In particular, De Bresser and Knoef (2015) find a strong positive correlation between individual expectations on preferred expenditures at retirement and (model) predicted wealth, but also a significant fraction of respondents with expectation mismatches. Our results can explain those findings, as mismatches might be greater among individuals that do not plan (in their survey all respondents needed to provide an estimate).

Overall, our results demonstrate that cognitive ability and financial literacy play different roles when it comes to retirement planning and plan execution. Having financial literacy is an important factor for all stages of a planning process, while cognition seems to be especially relevant for making a concrete plan, that is, at the point where calculation is needed. In particular, higher cognitive ability is related to planning for higher savings—thus, given the concerns about too little savings, higher cognition seems to help to have a more realistic idea about the savings needed. This result is consistent with earlier findings in the annuity literature. For example, Post (2023) shows that people with higher mathematical skills estimate more realistic annuity payouts. In regard to policy implications, our results hint at a new challenge. Next to increasing individuals' financial literacy— which is a challenge of its own (see Fernandes et al., 2014)—investments in cognitive skills (most

likely through school curricula) might be needed to boost retirement readiness. In addition (or as a substitute), easy access to planning tools should be provided.

In addition to our main findings, we also show that present biased individuals save less (e.g., Laibson, 1997; O'Donoghue and Rabin, 1999). However, our analyses uncover the concrete mechanism which gives rise for further policy implications. We find that such individuals actually plan for higher savings (potentially reflecting on their high current spending) but ultimately end up with lower savings. Thus, present biased individuals, seem to suffer from a classical planner-doer conflict (Thaler and Shefrin, 1981) and are aware that they should improve their financial behaviors. Therefore, in order to promote higher savings and, consequently, retirement readiness, (self-)commitment devices (Bénabou and Tirole, 2004) might be useful to overcome a planner-doer conflict.

The structure of this paper is as follows: In Section 2, we introduce the data and sample selection procedure, define variables, and provide descriptive statistics. Our main empirical results, analyzing the relation of financial literacy and cognitive ability with being a planner, planned savings, and outcomes of planning (savings, risky asset, and annuity choices), are presented in Section 3. Section 4 contains robustness checks. In Section 5, we conclude and discuss implications.

2. Data
2.1 The China Family Panel Studies

The China Family Panel Studies (CFPS) are a nationally representative[3], biennial, longitudinal household survey launched in 2010 by the Institute of Social Science Survey of Peking University (Xie and Hu, 2014). It collects a rich variety of detailed individual- and family-level data. In 2014, CFPS conducted a special module for urban households to measure financial literacy, retirement planning, and proxies for classical economic preference parameters (cognitive ability is included in the standard questions of the CFPS). This module was answered by the respondent in the household who is most familiar with household finances. Thus, we can expect that those respondents are the most important determinants of a household's economic decisions.

Among 3,908 respondents who participated in the special module, 3,885 answered the question about whether they or their spouse have calculated the amount of savings needed for retirement. Almost all respondents—except one—who answered yes to the former question gave the exact amount of planned savings (1,235 observations). We exclude observations with planned savings at the 1% tail of both sides to address outliers[4] (65 observations), and also exclude observations with missing values for other (in)dependent variables (100 observations) in the probit regressions of being a planner as well as for control variables (308 observations). One observation was automatically dropped because of perfect prediction. The final sample for our propensity-to-plan analysis includes 3,411 respondents and 1,084 respondents for the analysis of savings plans.

2.2 Variables and descriptive statistics

Our main variables of interest are being a planner and planned savings. The 2014 wave of CFPS asked respondents "Have you or your spouse ever tried to figured out how much you need to save for retirement?" with response options given as "yes", "no", and "do not know". We construct a dummy variable, indicating being a planner, which takes the value of 1 if respondents choose yes, and 0 otherwise[5]. Similar as in U.S. or Dutch samples, we find that a lack of retirement planning is also present in China: only about 32% of respondents indicated that they did plan[6].

The module then further asked planners the specific amount of savings they have calculated to need for retirement, which we use for our variable "planned savings". The mean and median planned savings are about 416 and 200 thousand yuan, which are about 14.4 and 7.5 times the amount of the mean (28,844 yuan) and median (26,635 yuan) annual disposable income of urban residents, respectively, according to the 2014 Statistical Bulletin on National Economic and Social Development. The detailed distribution is displayed in Figure 1a. In regression models, we take the inverse hyperbolic sine[7] of this variable (as well as other wealth variables) to address the variable's skewness (see Figure 1b).

-- Figure 1a, 1b here --

As a common built-in module in all CFPS waves, cognitive ability is measured with 34 questions regarding word recognition and 24 questions regarding mathematical skills (including addition, subtraction, multiplication, division, exponential, logarithm, trigonometric function, sequence, and permutation combination). These questions are sorted according to their complexity and presented to the respondent one by one, with the initial question determined by education level[8]. The tests stop whenever a respondent gave incorrect answers to three consecutive questions. The final score is the serial number of the last question a respondent answered correctly. We use the total score of both word and math questions as our measure of cognition.

A composite measure of financial literacy is elicited based on a series of 12 questions similar to van Rooij et al. (2011b), thus, also allowing to have separate measures for basic and advanced financial literacy (see Appendix Table A1 for details). The basic financial literacy questions measure knowledge in the financial domain and test the understanding of economic concepts necessary for day-to-day financial transactions. They include five questions regarding interest rates of one-year fixed deposit, interest numeracy, interest compounding, inflation, and time value of money. The advanced financial literacy questions test knowledge about financial investments and portfolio choice. They include seven questions regarding diversification, central bank's function, risk properties of different financial products, the definition of stocks, the characteristics of funds, the characteristics of banks' wealth management products, and the function of the stock market. We construct binary variables for correct answers and binary variables for do-not-know answers. Then,

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[5] About 37.4% of respondents in our final sample selected the "do not know" option. We define them as not being a planner because respondents for the special module were required to be most familiar with household finances.

[6] Comparably, the figure for Dutch households is 37.4% in the 2010 wave of the DNB Household Survey (van Rooij et al., 2012) and 31.3% for a sample of older U.S. households in the 2004 wave of the Health and Retirement Study (Lusardi and Mitchell, 2011).

[7] The equation is $\ln(x+\sqrt{x^2+1})$ which is basically the same with natural logarithm transformation while it well accommodates negative and zero values (Chari et al., 2021).

[8] The respondent with the education level being high school and above (middle school, primary school and below) is assigned the 21st (9th, 1st) question of word recognition and the 19th (13rd, 1st) question of mathematical skills.

we perform a factor analysis to obtain the Bartlett score for the first extracted factor, which describes a large share (about 51.2%) of the variation with an eigenvalue being 8.6, using the iterated principal factor method (as in van Rooij et al., 2011b). This first factor has positive loadings on all variables indicating correct answers and negative loadings on all variables indicating do-not-know answers. The second extracted factor loads in distinct directions for the basic and advanced questions.[9] Thus, we also construct two separate measures in the same way for both basic and advanced financial literacy for further analysis (see Section 3.1).

The correlation between cognitive ability and financial literacy for the whole sample is 0.544 (p<0.001), which means that the two measures share a certain amount of similarity in revealing respondents' overall cognitive functioning. Multicollinearity, however, is not likely to be a problem, as the variance inflation factors for cognitive ability (financial literacy) in all regression analyses throughout the paper are around 3 (2). Moreover, there is ample heterogeneity in the sample: the coefficients of variation of cognitive ability are 0.218 and 0.450 for the financial literacy groups above and below the median, respectively.

To study economic behaviors, we include several indicators of individuals' saving and portfolio choice decisions. The former is indicated by household's financial wealth (as in Ameriks et al., 2003)[10], the latter are risky asset and annuity holdings. For risky asset holdings, we construct a binary variable taking the value one if respondents hold stocks or mutual funds (Ge et al., 2021). We also construct two variables for private annuity holdings. One indicates whether respondents are holding an annuity for themselves, and the other indicates whether married respondents or their spouse hold any annuity. In our data, participation rates in all financial assets are low: only 13.9% and hold risky assets and 3.3% of respondents (6.2% of married respondents or their spouse) hold annuities.

In our analysis, we also control for a variety of respondents' demographic and socio-economic characteristics including age, gender, marriage status, education, work, and retirement status[11], self-reported health, types of social or occupational pension coverage, family size, household income, and net wealth. These factors have been found to be related with cognitive ability and financial literacy (Eberhardt et al., 2019; Muñoz-Murillo et al., 2020) as well as economic behaviors. For education, we add three binary variables indicating the highest education level being middle school, high school, college (and above). These dummies of education levels also help to address the confounding effects with respect to the special design of cognition tests, resulting from different initial questions. We also incorporate one variable indicating whether the household is suffering from financial difficulty, which might reflect respondents' financial risk awareness after we control for household net wealth (Lusardi, 2003).

Another set of controls we include are respondents' preferences and behavioral traits, which have been widely documented to influence retirement preparedness. Regarding preferences, we include

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[9] This second factor describes 10.5% of the variation with an eigenvalue of 1.8.

[10] Home equity is one of the most important assets for urban families in China and can be used to finance retirement expenditure, for example, through using a reverse mortgage. Nevertheless, home equity also serves for intergenerational wealth transfers (Hanewald et al., 2020) and it is more likely for parents to give the home equity to their children due to a bequest motive rather than consuming the home value. Furthermore, as robustness checks, we also include a dummy variable indicating home owner, or we include a continuous variable indicating the portion of home value in total gross asset. Our results hardly change.

[11] Retirement planning should also stay relevant when individuals are already retired, for example, updating their plans based on new information (Reis, 2006; Ye et al., 2022). The relationships between cognitive constraints and retirement planning, which we document for the whole sample in Table 2, exist as well in sub-samples separated based on retirement status (see Appendix Table A2).

patience and risk aversion (Ameriks et al., 2003). Regarding traits we include respondents' present bias, as it is closely associated with consumption patterns and found to decrease retirement savings resulting from low self-control (Laibson, 1997; O'Donoghue and Rabin, 1999). Several studies found a (causal) impact of cognitive ability on preferences (Dohmen et al., 2010; Benjamin et al., 2013; Lilleholt, 2019) and higher financial literacy to decrease present bias (Yeh, 2022). Therefore, controlling for these characteristics is important, as it allows us to separate the role of cognitive ability and financial literacy for retirement planning (i.e., potential information constraints) from preferences and traits.

Details about the definitions of main variables and descriptive statistics are given in Table 1.

--Table 1 here--

3. Empirical results
3.1 The role of cognition and financial literacy for being a planner and savings plans

We estimate the determinants of being a planner and planned savings using the following general model:

$$Planning_i = \alpha + \beta Cognition_i + \theta FL_i + \gamma Controls_i + \lambda_p + \varepsilon_i, \qquad (1)$$

where *Planning* represents either being a planner or planned savings for individual *i*, *Cognition* and *FL* represents individual *i*'s test score of cognition and financial literacy, respectively. *Controls* are a vector of control variables aforementioned. We further include province fixed effects, λ_p, to address regional differences in economic development and aging culture. We estimate model (1) using probit for being a planner and OLS for planned savings, and we calculate heteroskedasticity-robust standard errors.

Table 2 presents the estimation results for different sets of control variables (for probit regressions marginal effects are reported). In columns 1 and 4, we control for a variety of demographic and socio-economic characteristics. Consistent with previous literature, column 1 shows that financial literacy is positively and significantly related to the probability of being a planner (van Rooij et al., 2011a; van Rooij et al., 2012). Cognitive ability has no significant relation with being a planner[12]. Both cognitive ability and financial literacy are positively and significantly related to planned savings (column 4).

In columns 2 and 5, we additionally control for individuals' patience, risk aversion, and present bias. Patience is positively associated with a higher probability of being a planner and also higher planned savings suggesting that patient individuals are more willing to substitute current with future consumption. Similar as in van Rooij et al. (2012) analyzing Dutch data on actual savings, risk aversion is negatively and significantly related to planned savings. We can only speculate why we find this result—potentially, "saving" might be associated in the Chinese context with putting money into risky assets. Interestingly, those with higher present bias plan for higher savings which may be a reflection and projection of their higher consumption needs. Including preferences and behavioral traits in the model does not change estimated coefficients of cognitive ability and financial literacy substantially, neither statistically nor economically.

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[12] In Appendix Table A3, we first differentiate between those choosing a certain "no" and those choosing "do not know" when answering the planner question by excluding them from the regressions sequentially, and then show results with the full sample by separately including cognitive ability or financial literacy. We find that cognitive ability is positively related to being a planner when financial literacy is absent. These results further demonstrate that cognitive ability might play some role for being a planner while financial literacy has greater explanatory power.

Overall, the economic magnitude of the effects we find is never negligible. Based on the results with full controls, a one standard deviation increase in financial literacy increases the likelihood of being a planner by 7.4%, which is about 23.3% of the sample average. A one standard deviation increase in the test score of cognition and financial literacy will increase planned savings by 16.4% and 11.1%, respectively.

The above analyses show that cognitive ability and financial literacy play a different role in the different stages of the planning process. We can draw a similar conclusion, when we replace the composite measure of financial literacy with both basic and advanced literacy indexes to better understand the underlying mental process associated. The results are shown in columns 3 and 6. Advanced financial literacy is positively related with the likelihood to be a planner, consistent with previous literature (van Rooij et al., 2011a, 2012). Basic financial literacy relates to higher planned savings. As the very first step in setting up a retirement plan, advanced financial literacy about financial management might enhance retirement– and wealth–management awareness (Anderson et al., 2017) and, thus, higher motivation to plan for retirement. However, for a detailed calculation process greater cognitive ability and basic financial skills might be needed.

--Table 2 here--

3.2 The economic outcomes of retirement planning

We employ the following general model to study the downstream economic behaviors:

$$Economic\ behaviors_i = \alpha + \beta \times Planning_i + \gamma \times Controls^+_i\ (Controls\_al^+_i) + \lambda_p + \varepsilon_i, \quad (2)$$

where *Economic behaviors* represents either savings (financial wealth), risky assets, or private annuity holdings, and *Planning* represents the binary variable of being a planner or planned savings. *Controls* $^+$ (for the regressions of portfolio choice and annuity purchases) are a vector of all control variables as in model (1) plus cognitive ability and financial literacy, while *Controls_al* $^+$ (for the regressions of saving accumulation) excludes the control of net wealth. We also include province fixed effects (λp). We estimate model (2) using probit when the dependent variable is binary and OLS when it is continuous.

3.2.1 Savings

First, we test whether being a planner and planned savings influence saving accumulation. Consistent with previous literature, column 1 in Table 3 shows that being a planner is positively and significantly related to higher savings (by 37.2%). Next, we regress savings on planned savings. The results in column 2 indicate that higher planned savings predict higher actual savings. Economically these results are relevant: a 10% increase in planned savings translates into over 4% higher savings. These results hold, also when including past wave's savings level in the model (see Section 4.2).

Next, we investigate heterogenous effects of being a planner on savings by using respondents' perception of the severity of the social security problem as a moderating variable. The question about planned savings might potentially reflect a preference for self-provision of retirement expenditures rather than relying on the government. Thus, we test whether there is a substitution effect between private and government pensions, as the literature showed that higher expected social pension benefits have a positive effect on current consumption decisions (Zheng et al., 2023). We expect that when individuals perceive a severe social security problem, they would accumulate more

savings themselves to deal with the potential gap from the coverage of social security. The 2014 wave of CFPS asked respondents about their perception of severity of the social security problem in general. Accordingly, we construct a measure for the severity perception of the social security problem with a 0 ("Not serious") to 10 ("Extremely serious") scale. We add this variable and its interaction with being a planner into the regression model of savings. The results in column 3 show that the effect of being a planner on savings is stronger among those who think the social security problem is severer. A one unit increase in the severity perception will increase the marginal effect of being a planner on saving accumulation by 16.9%.

We also see that cognitive ability and financial literacy have direct positive effects on saving accumulation. Moreover, higher patience, less risk aversion, and less present bias are also positively related to savings.

--Table 3 here--

3.2.2 Risky asset holdings

We use risky asset holdings as the dependent variable and show probit regression results in Table 4. Column 2 shows that higher planned savings are related significantly to higher risky asset holdings. In Appendix Table A4, we further split those planners into two groups (that is, Low and High) according to the median (200 thousand yuan) of planned savings. We find that those planners with high planned savings have a 2.4% higher probability of holding risky assets, while the behavior of the low planned savings group does not differ from those without a plan. Overall, the results indicate that planners, especially with higher planned savings, have a higher risk exposure in their financial portfolio, likely with the goal of achieving higher returns and, thus, satisfying retirement income needs.

Moreover, financial literacy and lower risk aversion are positively related to holding risky assets.

--Table 4 here--

3.2.3 Annuity holdings

We use two measures in this section—that is, annuity holdings for the respondent and for married respondents or their spouse.

Columns 1 and 3 of Table 5 show that being a planner increases annuity holdings at the 10% significance level for the second measure. Married individuals or their spouse have a 1.9% higher probability to hold annuities. Planned savings as well increase participation in the annuity market among planners (columns 2 and 4)[13]. Meanwhile, in Appendix Table A4, we see that the above positive effects mainly exist in those who have higher planned savings (above the median) as well. They (or their spouse) have 1.8% (3.3%) higher probability to participate in the annuity market, which is about 54.5% (53.2%) of sample average. The economic magnitude implies that annuity decisions are mainly made under retirement concerns.

Again, we see that higher financial literacy helps to explain higher annuity holdings.

--Table 5 here--

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[13] The results mimic previous findings of Zou et al. (2019).

4. Robustness checks

4.1 Endogeneity of cognitive ability and financial literacy

Our measures of cognitive ability and financial literacy might be endogenously determined in that certain financial behaviors impact cognitive ability and literacy. To deal with such potential concerns, we employ several empirical strategies.

Cognition refers to basic numerical and verbal abilities, which is found to be temporally stable in rank order among individuals after being grown up (Borghans et al., 2008; Almlund et al., 2011), and, thus, is less likely to suffer from endogeneity, as retirement planning usually starts after entering the work force (Christelis et al., 2010). We utilize the unbalanced panel sample from the 2010, 2014, and 2018 waves of CFPS[14] to show evidence of temporal stability of cognitive ability, as the measurement instrument is the same for these waves. First, the serial correlation of the cognition score at four-year intervals reaches a high level of 0.774 (p < 0.001) (Kuhnen and Melzer, 2018). Second, the average cross-sectional standard deviation (11.843) is much larger than the average within-respondent's time-series standard deviation (4.666), which implies that cross-sectional information provides most variation. Finally, we sort the panel respondents in our baseline model (columns 1 to 2 in Table 2) into cognition deciles for the year 2014. Then, we calculate the group averages of cognition for the 2010 and 2018 waves. Appendix Figure A1 shows a monotonically temporal relationship across the sorted groups.

With respect to financial literacy, the literature documents endogenous accumulation. We use two sets of instrumental variables to alleviate this concern. The first set is parents' financial knowledge (van Rooij et al., 2011b) assuming respondents can learn from their parents. The 2014 CFPS asked respondents about their parents' financial knowledge compared to their parents' peers. The answers given were "1 = Way above the average level", "2 = Above the average level", "3 = About average level", "4 = Below the average level", "5 = Way below the average level", and "6 = Do not know". To incorporate the do–not–know answer, we construct a dummy variable for each answer as van Rooij et al. (2011b). The second set is community[15] average financial literacy mimicking the strategy of Haliassos et al. (2020), who find evidence for transmission of financial knowledge from neighbors. We calculate the average financial literacy score of other community respondents (leaving out the respondent)[16]. First stage results show that the higher parents' financial knowledge and the higher community average financial literacy, the higher the respondent's financial literacy, indicating the learning effects and positive externality from close relatives and neighbors (see columns 1 and 3 in Table 6). The Kleibergen Paap F-stats exceed the rule of thumb for strong instruments (F > 10), and the over-identification tests show that we cannot reject the validity of the instruments (see columns 2 and 4). The estimated coefficients for financial literacy are still significantly positive when we instrument financial literacy with the above two sets of instruments. Taken the results above, we conclude that financial literacy is a robust determinant of being a planner and planned savings: Those with higher financial literacy are more likely to plan and plan

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[14] Because of sampling adjustment and missing data, the remaining observations with test score of cognition are 2,919 for the 2010 wave and 1,910 for the 2018 wave compared with the whole sample (3,411) in our baseline model.

[15] Community is the basic level of organizational divisions in China. The mean and median numbers of households are about 2,400 and 1,530 for our sample communities.

[16] Many communities only have one observation in our sample and, thus, excluding the respondent when averaging decreases the observations in IV regressions. However, OLS estimates remain similar when we use this subsample (see columns 1 and 2 in Appendix Table A5). Besides, to reduce the bias when averaging because of too few observations, we exclude those communities with less than 6 observations of financial literacy and rerun IV (probit) regressions. The results still hold according to columns 3 and 4 in Appendix Table A5.

for higher savings.

--Table 6 here--

4.2 Endogeneity of being a planner and planned savings

There might be reverse causality in the regression of savings on being a planner or savings plans, as individuals who have higher financial wealth, may use this as a proxy or anchor for responding the question about savings plans, and they may have more financial resources to plan as well (Lusardi and Mitchell, 2007). To address this, we utilize a change model by adding the lag of financial wealth from the wave 2012 of CFPS as an extra control in model (2). The specification of the change model allows us to estimate the short-term effects of planning for retirement on the changes of saving accumulation between two waves (Berkowitz and Qiu, 2006; Ye and Post, 2020). The results in Appendix Table A6 show that the economic and statistical magnitudes only change a little compared to those in Table 3.

We also employ Oster's (2019) approach to show robustness of our regression results regarding another important bias source, i.e., the omitted variables. This approach evaluates the coefficient stability with inclusion of observable controls, additionally considering the movement of R^2. The idea behind this is that when observables explain a large share of variation in the dependent variable indicated by a higher R^2, the omitted variable bias gets smaller under the assumption that the selection on observables is proportional and, thus, informative about the selection on unobservables. Oster (2019) develop a formal test statistic, i.e., δ^*, to show the degree of the selection on unobservables has to be relative to observables that would explain away the estimated coefficient. The criterion for robustness is that δ^* is above 1. A second validation practice associated with this approach regards the construction of the identified set, with the criterion for robustness being that the identified set excludes zero. We report both δ^*s and the identified sets for significant coefficients of the independent variables of interest in the last two rows of Table 3, 4, and 5[17]. All the δ^* are above one and all the identified sets exclude zero[18].

5. Conclusion

Not planning for retirement finances is a worldwide phenomenon. And, even when individuals have planned for retirement, they still may underestimate the amount of savings needed in retirement and ultimately end up with insufficient finances in retirement. Utilizing a nationally representative urban sample from China, we study the antecedents of the propensity to plan, planned savings amounts, and downstream economic behaviors.

Consistent with financial planning and plan execution being information intensive tasks, we find that cognitive ability and financial literacy play important roles in explaining being a planner and planned saving amounts, as having those skills lowers information constraints. Cognitive ability is hereby especially relevant in the planning stage for concrete monetary amounts, i.e., higher ability predicts greater amounts. Especially, advanced financial literacy relates to a higher probability of calculating concrete savings amounts, which we interpret as the result of enhanced retirement

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[17] When the regression models are non-linear, we calculate statistics based on the results of the analogous OLS regressions (Heimer et al., 2019).

[18] Only in column 3 of Table 5 the controlled estimate is larger than the uncontrolled one, in which case Oster (2019) suggests another standard for a robustness check. As the bounds of the identified set fall within the bounds of the 99.5% confidence interval of the controlled estimate, such an exception is robust as well.

awareness. However, both cognitive ability and basic financial literacy determine the calculated amount with economic importance in magnitude, suggesting a multi-faceted decision-making process of retirement planning.

Moreover, our results demonstrate that being a planner, planned savings, and cognitive abilities impact downstream economic behaviors. Planners in general save more and invest more into annuities. Also, the higher amounts planned are related to higher accumulated savings as well as more investments in risky assets and annuities

Although we observe all those positive effects of planning and cognitive abilities on achieving higher savings, an important question still is whether at least these households (plan to) save enough. To investigate this question, we perform some back-of-the-envelope calculations. Hereby, we focus on the urban employees for which we have adequate information. First, we calculate the remaining life expectancy of a 60-year-old individual according to the procedure specified in Wilmoth et al. (2021), using an age-specific urban life table from 2015 (published in the China Population and Employment Statistics Yearbook 2016). The resulting remaining life expectancy is 25.7 years. The mean (median) planned savings for individual urban employees in our sample are about 347.9 (214.4) thousand yuan after adjusting for marital status (based on column 5 in Table 2). The average annual social pension for retired urban employees in 2014 is 24.6 thousand yuan according to the Annual Report on Social Insurance Development in China (2014) and the average annual salary for urban employees is 56.4 thousand yuan according to the annual China Statistical Yearbook. Thus, given those numbers, the expected replacement rate would increase through the planned savings from 43.9% to 67.6% (58.4% for the median). So economically, the mean plan targets to achieve a substantial increase in retirement finances.

Our findings suggest that in order to improve retirement readiness more focus should be put on stimulating and enabling individuals to calculate concrete amounts of savings needed for retirement. Although there is controversy over the benefit and cost of retirement and financial education in enhancing retirement savings (Gomes et al., 2021), our findings suggest that policy makers should pay more attention to the specific content of such education, for example, designing financial tasks about savings amount calculations or teaching the skills necessary for such calculations. Alternatively (or as a substitute), it might be also beneficial to provide easy access to tools and services that facilitate the calculation of savings needed for retirement.

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Figures and Tables
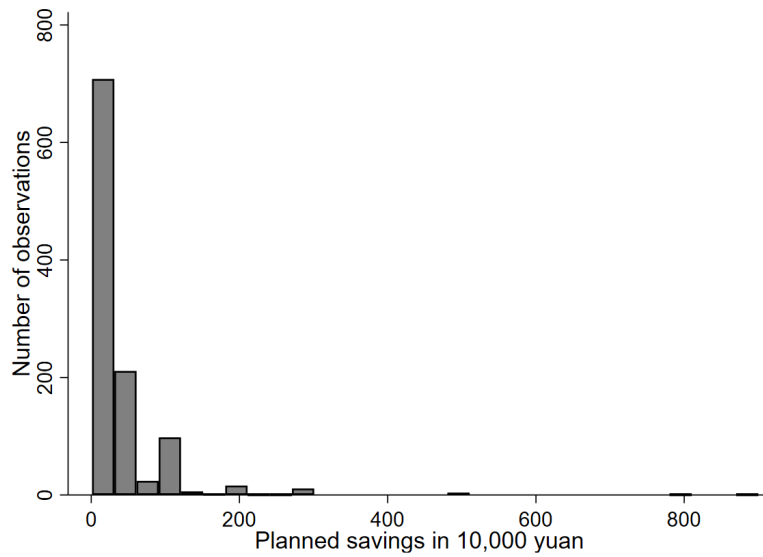
Figure 1a Frequency of planned savings
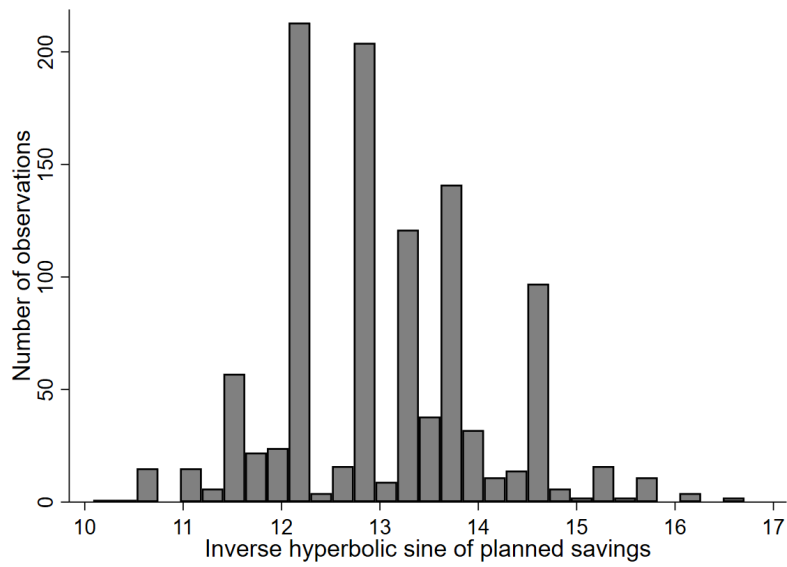
Figure 1b Frequency of inverse hyperbolic sine of planned savings

Table 1 Definitions of main variables

Variable	Definition	Planner analyses			Planned savings analyses		
		Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.
Planner	A binary variable taking the value of one if respondent or his/ her spouse has calculated saving needs for retirement, otherwise (a certain no or do not know) zero	3,411	0.32	0.47			
Planned savings	A continuous variable indicating calculation result of saving needs (in 10,000 yuan) if Planner is equal to one based on the responses to the question: "What is the amount of money you and your spouse need to save for your retirement?"				1,084	41.60	63.73
Financial wealth	Total financial wealth of household (in 10,000 yuan)	3,411	9.07	25.68	1,084	8.94	18.15
Risky asset holdings	A binary variable taking the value of one if household is holding stocks or funds, otherwise zero	3,297	0.14	0.35	979	0.17	0.37
Annuity holdings (Only respondent)	A binary variable taking the value of one if respondent is holding private annuity, otherwise zero	3,089	0.03	0.18	911	0.04	0.21
Annuity holdings (Respondent and spouse)	A binary variable taking the value of one if respondent or his/her spouse is holding private annuity, otherwise zero (if respondent is married)	2,236	0.06	0.24	715	0.08	0.27
Cognition	Total scores of cognition tests including 34 word questions and 24 math questions	3,411	36.74	13.17	1,084	37.19	12.59
Financial literacy	The first component of an iterated principal factor analysis for variables indicating right answers and do-not-know answers of a series of 12 questions eliciting financial literacy, which include 5 basic questions regarding interest rate of one-year fixed deposit, interest numeracy, interest compounding, inflation, and time value of money, and 7 advanced questions regarding diversification, central bank function, risk characteristics of different financial products, the definition of stocks, the characteristics of funds, the characteristics of banks' wealth management products, and stock market's function.	3,411	0.07	0.97	1,084	0.24	0.88
Age	Respondent's age in years	3,411	49.00	14.84	1,084	49.44	14.30
Female	A binary variable taking the value of one if respondent is female, otherwise zero	3,411	0.54	0.50	1,084	0.53	0.50
Marriage	A binary variable taking the value of one if respondent is married, otherwise zero	3,411	0.83	0.37	1,084	0.84	0.37

Middle school	A binary variable taking the value of one if respondent's highest education level is middle school, otherwise zero	3,411	0.30	0.46	1,084	0.32	0.47
High school	A binary variable taking the value of one if respondent's highest education level is high school, otherwise zero	3,411	0.26	0.44	1,084	0.26	0.44
College	A binary variable taking the value of one if respondent's highest education level is college and above (including bachelor's, master's, and doctor's degrees), otherwise zero	3,411	0.22	0.41	1,084	0.21	0.41
Work	A binary variable taking the value of one if respondent is working for pay, otherwise zero	3,411	0.59	0.49	1,084	0.61	0.49
Retirement	A binary variable taking the value of one if respondent is retired, otherwise zero	3,411	0.34	0.47	1,084	0.36	0.48
Health	Self-reported health status, 1 = "Unhealthy", 2 = "Fair", 3 = "Relatively healthy", 4 = "Very healthy", 5 = "Extremely healthy"	3,411	2.93	1.11	1,084	2.97	1.10
Types of social or occupational pension coverage							
#1 Pensions of government and public institutions	A binary variable taking the value of one if respondent is covered by pension of government and public institutions, otherwise zero	3.411	0.21	0.41	1,084	0.23	0.42
#2 Basic pension insurance	A binary variable taking the value of one if respondent is covered by basic pension insurance, otherwise zero	3.411	0.37	0.48	1,084	0.38	0.49
#3 Supplemental pension insurance of the firm	A binary variable taking the value of one if respondent is covered by supplemental pension insurance of the firm, otherwise zero	3.411	0.05	0.21	1,084	0.04	0.21
#4 Old rural pension insurance	A binary variable taking the value of one if respondent is covered by old rural pension insurance, otherwise zero	3.411	0.01	0.12	1,084	0.01	0.10
#5 New rural pension insurance	A binary variable taking the value of one if respondent is covered by new rural pension insurance, otherwise zero	3.411	0.09	0.28	1,084	0.09	0.28
#6 Urban resident	A binary variable taking the value of one if respondent is covered by urban resident pension insurance,	3.411	0.10	0.30	1,084	0.11	0.31

pension insurance	otherwise zero					
#7 No social or occupational pension	A binary variable taking the value of one if respondent is not covered by any type of social or occupational pensions, otherwise zero	3,411	0.24	0.43	1,084	0.22	0.42
Family size	The number of people in the household	3,411	3.18	1.50	1,084	3.15	1.42
Income	Annual income of household (in 10,000 yuan)	3,411	7.86	16.35	1,084	7.79	14.85
Net wealth	Total net wealth of household including total financial wealth and non-financial asset minus total debts (in 10,000 yuan)	3,411	72.01	116.04	1,084	72.66	112.48
Financial difficulty	A binary variable taking the value of one if financial difficulty is the main difficulty the household is facing, otherwise zero	3,411	0.31	0.46	1,084	0.33	0.47
Patience	Time preference based on responses to the statement: "I intend to live in the present more and do not consider the future." 1 = "Totally inapplicable", 2 = "Somewhat inapplicable", 3 = "Generally applicable", 4 = "Somewhat applicable", 5 = "Totally applicable"; reverse coded	3,411	3.19	1.34	1,084	3.30	1.35
Risk aversion	Attitudes toward risky investment based on responses to the question: "If your family invest/In investment, what kind of risk are you willing to take?" 1 = "High risk and high return", 2 = "Moderate risk and steady return", 3 = "Low risk and low return", 4 = "Unwilling to take any investment risk"	3,411	3.03	0.95	1,084	3.01	0.94
Present bias	Average scores based on responses to the two statements: respectively "I will consider affordability when I buy things" and "I spend according on my income in my daily life". 1 = "Totally inapplicable", 2 = "Somewhat inapplicable", 3 = "Generally applicable", 4 = "Somewhat applicable", 5 = "Totally applicable"; reverse coded	3,411	1.86	0.78	1,084	1.86	0.77

This table presents main variables' names and definitions for the CFPS data. Observations for risky asset and private annuity holdings are smaller than those for the whole sample mainly because they are automatically dropped in probit regressions due to perfect predictions.

Table 2 The determinants of being a planner and planned savings: The role of cognitive ability and financial literacy

	(1)	(2)	(3)	(4)	(5)	(6)
	Probit	Probit	Probit	OLS	OLS	OLS
	Planner	Planner	Planner	asinh	asinh	asinh
				(Planned savings)	(Planned savings)	(Planned savings)
Cognition	0.000	0.000	0.000	0.014***	0.013***	0.013***
	(0.001)	(0.001)	(0.001)	(0.004)	(0.004)	(0.004)
Financial literacy	0.079***	0.076***		0.151***	0.126***	
	(0.010)	(0.011)		(0.039)	(0.040)	
Basic			0.017			0.154***
			(0.011)			(0.042)
Advanced			0.065***			-0.014
			(0.011)			(0.040)
Demographic and socio-economic characteristics						
Age	0.005	0.005	0.005	-0.011	-0.008	-0.006
	(0.004)	(0.004)	(0.004)	(0.013)	(0.013)	(0.013)
Age^2	-0.000	-0.000	-0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female	-0.014	-0.012	-0.012	-0.137**	-0.115*	-0.120**
	(0.016)	(0.016)	(0.016)	(0.060)	(0.060)	(0.060)
Marriage	-0.000	0.000	0.003	0.327***	0.336***	0.329***
	(0.023)	(0.023)	(0.023)	(0.085)	(0.084)	(0.083)
Middle school	-0.012	-0.011	-0.010	-0.037	-0.025	-0.026
	(0.026)	(0.026)	(0.026)	(0.094)	(0.093)	(0.093)
High school	-0.057*	-0.055*	-0.056*	-0.003	0.010	0.012
	(0.032)	(0.032)	(0.032)	(0.118)	(0.117)	(0.117)
College	-0.097***	-0.097***	-0.099***	0.137	0.141	0.152
	(0.036)	(0.036)	(0.036)	(0.130)	(0.130)	(0.130)
Work	0.042*	0.041*	0.040*	0.098	0.083	0.086
	(0.022)	(0.022)	(0.022)	(0.079)	(0.079)	(0.079)
Retirement	0.023	0.025	0.026	-0.069	-0.067	-0.075
	(0.028)	(0.028)	(0.028)	(0.104)	(0.104)	(0.104)
Health	0.018**	0.018**	0.018**	-0.064**	-0.056**	-0.056**
	(0.007)	(0.007)	(0.007)	(0.028)	(0.027)	(0.027)
Family size	0.003	0.002	0.002	-0.039*	-0.041*	-0.040*
	(0.006)	(0.006)	(0.006)	(0.023)	(0.023)	(0.023)
asinh (Income)	0.004	0.004	0.004	0.007	0.003	0.001
	(0.005)	(0.005)	(0.005)	(0.023)	(0.022)	(0.022)
asinh (Net wealth)	-0.000	-0.000	-0.000	0.007	0.007	0.006
	(0.002)	(0.002)	(0.002)	(0.007)	(0.007)	(0.007)

	(1)	(2)	(3)	(4)	(5)	(6)
Financial difficulty	0.048***	0.048***	0.045**	0.014	0.020	0.031
	(0.018)	(0.018)	(0.018)	(0.065)	(0.065)	(0.065)
Preferences and behavioral traits						
Patience		0.013**	0.013**		0.038*	0.037*
		(0.006)	(0.006)		(0.022)	(0.021)
Risk aversion		-0.005	-0.004		-0.102***	-0.108***
		(0.009)	(0.009)		(0.034)	(0.034)
Present bias		0.007	0.006		0.069*	0.067*
		(0.010)	(0.010)		(0.037)	(0.037)
Types of social or occupational pension coverage FEs	Yes	Yes	Yes	Yes	Yes	Yes
Province FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,411	3,411	3,411	1,084	1,084	1,084
(Pseudo) R^2	0.078	0.080	0.081	0.279	0.290	0.294

This table presents the (marginal effect) results from probit regressions of being a planner (columns 1, 2, and 3) and OLS regressions of planned savings (columns 4, 5, and 6) on cognitive ability and several indexes of financial literacy with the expansion of the set of control variables. Basic (advanced) financial literacy is the first component of an iterated principal factor analysis for variables indicating correct answers and do-not-know answers of a series of 5 (7) questions regarding basic (advanced) financial literacy. Variables are defined in Table 1. Asinh(X) is the inverse hyperbolic sine of X. Heteroskedasticity-robust standard errors are given in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 3 Being a planner, planned savings, and saving accumulation

	(1)	(2)	(3)
	OLS	OLS	OLS
	asinh (Financial wealth)	asinh (Financial wealth)	asinh (Financial wealth)
Planner	0.372**		-0.706
	(0.185)		(0.488)
asinh (Planned savings)		0.420**	
		(0.167)	
Severity perception of social security			-0.079*
			(0.043)
Planner × Severity perception of social security			0.169**
			(0.071)
Cognition	0.032***	0.020	0.034***
	(0.011)	(0.20)	(0.011)
Financial literacy	1.154***	1.348***	1.163***
	(0.116)	(0.217)	(0.117)
Patience	0.146**	0.177	0.146**
	(0.065)	(0.115)	(0.066)
Risk aversion	-0.466***	-0.293	-0.481***
	(0.110)	(0.198)	(0.110)
Present bias	-0.269**	-0.184	-0.292***
	(0.111)	(0.196)	(0.112)
Other controls - (alternative)	Yes	Yes	Yes
Province FEs	Yes	Yes	Yes
Observations	3,411	1,084	3,387
R^2	0.243	0.275	0.244
δ* for Planner or asinh (Planned savings)	3.438	1.009	N/A
Identified set for Planner or asinh (Planned savings)	[0.273, 0.372]	[0.004, 0.420]	

This table presents the results from OLS regressions of financial wealth accumulation on being a planner (columns 1 and 3) and planned savings (column 2). Severity perception of social security is an ordered variable based on the responses to the question: "In general, how do you think is the severity of the social security problem in China?" (0 to 10 scale where 0 = "Not severe" and 10 = "Very severe"). Other controls - (alternative) include Age, Age^2, Female, Marriage, Middle school, High school, College, Work, Retirement, Health, Types of social or occupational pension coverage, Family size, asinh (Income), and Financial difficulty. Variables are defined in Table 1. Asinh(X) is the inverse hyperbolic sine of X. Heteroskedasticity-robust standard errors are given in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. δ* is calculated based on Oster (2019) assuming R_{max} is equal to 1.3 times of R-squared in regressions with full controls and β is equal to 0. The identified set is calculated assuming R_{max} is equal to 1.3 times of R-squared in regressions with full controls and δ is equal to 1.

Table 4 Being a planner, planned savings, and risky asset holdings

	(1)	(2)
	Probit	Probit
	Risky asset holdings	Risky asset holdings
Planner	0.013	
	(0.011)	
asinh (Planned savings)		0.021*
		(0.011)
Cognition	0.001	-0.002
	(0.001)	(0.001)
Financial literacy	0.084***	0.133***
	(0.009)	(0.020)
Patience	-0.006	-0.003
	(0.004)	(0.008)
Risk aversion	-0.039***	-0.038***
	(0.006)	(0.012)
Present bias	0.001	-0.019
	(0.007)	(0.013)
Other controls -	Yes	Yes
Province FEs	Yes	Yes
Observations	3,297	979
Pseudo R^2	0.292	0.322
δ* for Planner or asinh (Planned savings)	Not sig.	1.222
Identified set for Planner or asinh (Planned savings)		[0.007, 0.033]

This table presents the marginal effect results from probit regressions of risky asset holdings on being a planner (column 1) and planned savings (column 2). Other controls - include Age, Age^2, Female, Marriage, Middle school, High school, College, Work, Retirement, Health, Types of social or occupational pension coverage, Family size, asinh (Income), asinh (Net wealth), and Financial difficulty. Variables are defined in Table 1. Asinh(X) is the inverse hyperbolic sine of X. Heteroskedasticity-robust standard errors are given in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. δ* is calculated based on Oster (2019) assuming R_{max} is equal to 1.3 times of R-squared in the analogous OLS regressions with full controls and β is equal to 0. The identified set is calculated assuming R_{max} is equal to 1.3 times of R-squared in the analogous OLS regressions with full controls and δ is equal to 1.

Table 5 Being a planner, planned savings, and annuity holdings

	(1) Probit Annuity holdings (Only respondent)	(2) Probit Annuity holdings (Only respondent)	(3) Probit Annuity holdings (Respondent and spouse)	(4) Probit Annuity holdings (Respondent and spouse)
Planner	0.007		0.019*	
	(0.007)		(0.010)	
asinh (Planned savings)		0.021***		0.021**
		(0.007)		(0.010)
Cognition	-0.001	-0.001	-0.001	-0.002
	(0.000)	(0.001)	(0.001)	(0.001)
Financial literacy	0.021***	0.032**	0.025***	0.037**
	(0.005)	(0.013)	(0.008)	(0.017)
Patience	-0.001	0.000	0.003	0.009
	(0.002)	(0.005)	(0.004)	(0.008)
Risk aversion	-0.004	-0.007	-0.002	-0.003
	(0.004)	(0.008)	(0.006)	(0.011)
Present bias	-0.001	0.008	0.002	0.013
	(0.004)	(0.008)	(0.007)	(0.012)
Other controls -	Yes	Yes	Yes	Yes
Province FEs	Yes	Yes	Yes	Yes
Observations	3,089	911	2,236	715
Pseudo R^2	0.147	0.272	0.137	0.255
δ* for Planner or asinh (Planned savings)	Not sig.	2.399	315.490	1.647
Identified set for Planner or asinh (Planned savings)		[0.018, 0.023]	[0.019, 0.020]	[0.014, 0.028]

This table presents the marginal effect results from probit regressions of annuity holdings on being a planner (columns 1 and 3) and planned savings (columns 2 and 4). Columns 3 and 4 only include respondents with spouses. Other controls - include Age, Age^2, Female, Marriage, Middle school, High school, College, Work, Retirement, Health, Types of social or occupational pension coverage, Family size, asinh (Income), asinh (Net wealth), and Financial difficulty. Variables are defined in Table 1. Asinh(X) is the inverse hyperbolic sine of X. Heteroskedasticity-robust standard errors are given in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. δ* is calculated based on Oster (2019) assuming R_{max} is equal to 1.3 times of R-squared in the analogous OLS regressions with full controls and β is equal to 0. The identified set is calculated assuming R_{max} is equal to 1.3 times of R-squared in the analogous OLS regressions with full controls and δ is equal to 1.

Table 6 Instrumenting financial literacy with parents' and community average financial literacy

	(1)	(2)	(3)	(4)
	IV probit	IV probit	IV	IV
	1st stage	2nd stage	1st stage	2nd stage
	Financial literacy	Planner	Financial literacy (Planner = 1)	asinh (Planned savings)
Cognition	0.020***	-0.000	0.014***	0.010**
	(0.002)	(0.001)	(0.003)	(0.005)
Financial literacy		0.070*		0.297**
		(0.038)		(0.130)
Parents' financial literacy (the baseline group consists those answering do not know)				
FL: Way below the average level	0.298***		0.220**	
	(0.050)		(0.091)	
FL: Below the average level	0.344***		0.386***	
	(0.042)		(0.080)	
FL: About the average level	0.419***		0.418***	
	(0.043)		(0.078)	
FL: Above the average level	0.539***		0.584***	
	(0.058)		(0.100)	
FL: Way above the average level	0.647***		0.626***	
	(0.116)		(0.139)	
Community average financial literacy	0.266***		0.272***	
	(0.030)		(0.054)	
Other controls	Yes	Yes	Yes	Yes
Province FEs	Yes	Yes	Yes	Yes
Kleibergen-Paap F-stat (weak identification test)		36.575		14.381
p-value of Hansen J (over-identification test)		0.330		0.207
Observations	2,887	2,887	935	935

This table presents the (marginal effect) results of two stages from IV probit regression of being a planner (columns 1 and 2) and IV regression of planned savings (columns 3 and 4) on financial literacy. The first set of instruments are five binary variables of parents' financial literacy indicating respondent's appraisal of their parents' financial literacy compared with their parents' peers ("1 = Way above the average level", "2 = Above the average level", "3 = About average level", "4 = Below the average level", "5 = Way below the average level", and "6 = Do not know"). The second set of instruments is community average financial literacy which averages the financial literacy score of other community respondents (leaving out the respondent). Other controls include Age, Age^2, Female, Marriage, Middle school, High school, College, Work, Retirement, Health, Types of social or occupational pension coverage, Family size, asinh (Income), asinh (Net wealth), Financial difficulty, Patience, Risk aversion, and Present bias. Variables are defined in Table 1. Asinh(X) is the inverse hyperbolic sine of X. Heteroskedasticity-robust standard errors are given in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. The statistics of weak identification test and over-identification test for IV probit regression are estimated using a linear version of the model.
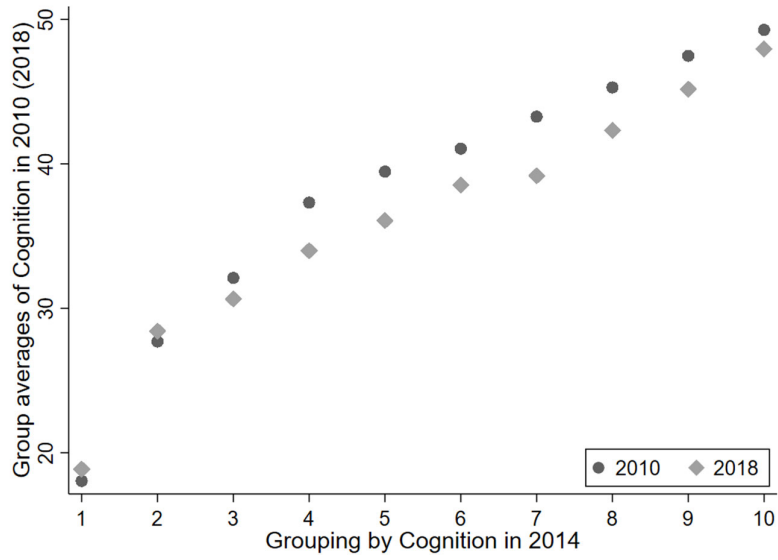
Appendix

Figure A1 Temporal rank-order stability of the test score of cognition

This figure plots the group averages of Cognition for the 2010 and 2018 waves based on ten groups sorted evenly according to the test score at year 2014.

Questions	Correct	Incorrect	Do not know
Basic financial literacy questions			
(1) *Interest rates of one-year fixed deposit*: According to your estimation, what is the current interest rate of one-year fixed deposit in the bank? (Less than 1%/ #1%-5%/ 5%-10%/ More than 10%)	53.9	9.4	36.7
(2) *Interest numeracy*: Suppose you have a one-year fixed deposit of 10,000 yuan and the annual interest rate is 3%. If you do not withdraw within this period, how much money will you get on the due date? (#10300 yuan/ More than 10300 yuan/ Less than 10300 yuan)	44.9	31.9	23.2
(3) *Interest compounding*: After the due date of deposit in the above question, if you continue to save the money as one-year fixed deposit and the annual interest rate is 3%, how much money will you have in this account after one year, including the principal and interests? (10600 yuan/ #More than 10600 yuan/ Less than 10600 yuan)	50.5	24.1	25.4
(4) *Inflation*: If the annual interest rate of your savings account is 3%, and the inflation rate is 5%, how many goods you can buy using your savings in this account after one year? (More than today/ The same as today/ #Less than today)	57.5	18.7	23.8
(5) *Time value of money*: Suppose Zhang San inherits 100,000 yuan today, and Li Si will inherit 100,000 yuan three years later. Who has a higher value of inheritance? (#Zhang San/ Li Si/ The same)	67.4	13.7	18.9
Advanced financial literacy questions			
(6) *Diversification*: In general, investing in a single stock is less risky than investing in a stock fund. (True/ #False)	34.7	23.3	42.0
(7) *Central bank's function*: Which of the following bank is responsible for making and carrying out monetary policies? (Bank of China/ Industrial and Commercial Bank of China/ #People's Bank of China/ China Construction Bank)	30.5	36.9	32.6
(8) *Risk properties of different financial products*: Generally speaking, which of the following investments has the highest risk? (Bank deposits/ Government bonds/ #Stocks/ Funds)	67.1	11.0	21.9
(9) *Definition of stocks*: What does it mean if you purchase stocks of some company? (No matter you hold these stocks for a short term or long term, you lend the money to the company anyway/ #No matter you hold these stocks for a short term or long term, you are the stockholder of the company anyway/ You are the stockholder of a company when you hold its stocks for a long term, while you lend the money to a company when you hold its stocks for a short term/ None of the above is correct)	16.4	41.1	42.5
(10) *Characteristics of funds*: Which of the following statements is correct about funds? (Funds with low process (low NAV per unit) has a better future performance/ #In general, a single fund can invest in several assets, for example, in both stocks and bonds/ In general, funds are able to provide a guaranteed rate of return based on past performance/ None of the above is correct)	12.5	31.5	56.0

(11) *Characteristics of banks' wealth management products*: Which of the following statements is correct about banks' wealth management products? (#Banks' wealth management products, like other risky assets, are also possible to suffer from loss/ Banks' wealth management products is as safe as bank deposits, at least not to lose money/ The expected return of banks' wealth management products is the actual return / None of the above is correct)	29.6	32.7	37.7
(12) *Function of the stock market*: Which of the following statements is correct about the core function of the stock market? (The stock market is helpful in predicting the returns of stocks/ The stock market increases the prices of stocks/ #The stock market helps bring together buyers and sellers of stocks/ None of the above is correct)	28.2	22.0	49.8

Note: Choices are given in parentheses and [#] indicates the correct response. "Do not know" is an alternative choice for all questions.

Table A2 The determinants of being a planner and planned savings: Sub-sample analyses based on retirement status

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Probit	Probit	OLS	OLS	Probit	Probit	OLS	OLS
	Planner	Planner	asinh	asinh	Planner	Planner	asinh	asinh
	Retire=0	Retire=0	(Planned savings)	(Planned savings)	Retire=1	Retire=1	(Planned savings)	(Planned savings)
			Retire=0	Retire=0			Retire=1	Retire=1
Cognition	-0.001	-0.001	0.014**	0.014**	0.000	0.001	0.016***	0.016***
	(0.001)	(0.001)	(0.006)	(0.006)	(0.002)	(0.002)	(0.006)	(0.006)
Financial literacy	0.085***		0.077		0.064***		0.169***	
	(0.014)		(0.054)		(0.017)		(0.060)	
Basic		0.004		0.147***		0.038**		0.143**
		(0.014)		(0.056)		(0.017)		(0.063)
Advanced		0.084***		-0.054		0.031*		0.039
		(0.013)		(0.052)		(0.018)		(0.068)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,244	2,244	698	698	1,167	1,167	386	386
(Pseudo) R^2	0.094	0.098	0.272	0.278	0.090	0.090	0.403	0.404

This table presents the (marginal effect) results from probit regressions of being a planner (columns 1, 2, 5, and 6) and OLS regressions of planned savings (columns 3, 4, 7, and 8) on cognitive ability and several indexes of financial literacy. The first four columns include those who are not yet retired and the last four those who are already retired. Basic (advanced) financial literacy is the first component of an iterated principal factor analysis for variables indicating correct answers and do-not-know answers of a series of 5 (7) questions regarding basic (advanced) financial literacy. Other controls include Age, Age^2, Female, Marriage, Middle school, High school, College, Work, Retirement, Health, Types of social or occupational pension coverage, Family size, asinh (Income), asinh (Net wealth), Financial difficulty, Patience, Risk aversion, and Present bias. Variables are defined in Table 1. Asinh(X) is the inverse hyperbolic sine of X. Heteroskedasticity-robust standard errors are given in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table A3 The determinants of being a planner and planned savings: Sub-sample analyses for do-not-know answers and certain no answers, and the separate role of cognitive ability and financial literacy

	(1) Probit Planner	(2) Probit Planner	(3) Probit Planner	(4) Probit Planner	(5) OLS asinh (Planned savings)	(6) OLS asinh (Planned savings)
Cognition	0.002	-0.002	0.002*		0.016***	
	(0.001)	(0.001)	(0.001)		(0.004)	
Financial literacy	0.067***	0.102***		0.076***		0.154***
	(0.014)	(0.013)		(0.010)		(0.039)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Province FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,135	2,360	3,411	3,411	1,084	1,084
(Pseudo) R^2	0.095	0.125	0.067	0.080	0.283	0.281

This table presents the (marginal effect) results from probit regressions of being a planner (columns 1 to 4) and OLS regressions of planned savings (columns 5 and 6) on cognitive ability and financial literacy. Column 1 excludes respondents who choose "do not know" when answering the planner question while column 2 excludes respondents who choose a certain no. Other controls include Age, Age^2, Female, Marriage, Middle school, High school, College, Work, Retirement, Health, Types of social or occupational pension coverage, Family size, asinh (Income), asinh (Net wealth), Financial difficulty, Patience, Risk aversion, and Present bias. Variables are defined in Table 1. Asinh(X) is the inverse hyperbolic sine of X. Heteroskedasticity-robust standard errors are given in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table A4 The economic consequences of being a planner and planned savings: Group dummies based on being a planner and planned savings

	(1) OLS asinh (Financial wealth)	(2) Probit Risky asset holdings	(3) Probit Annuity holdings (Only respondent)	(3) Probit Annuity holdings (Respondent and spouse)
Low	0.037	-0.003	-0.013	-0.005
	(0.235)	(0.016)	(0.010)	(0.015)
High	0.762***	0.024*	0.018**	0.033***
	(0.238)	(0.014)	(0.007)	(0.012)
Cognition	0.030***	0.001	-0.001	-0.001
	(0.011)	(0.001)	(0.000)	(0.001)
Financial literacy	1.150***	0.084***	0.021***	0.025***
	(0.116)	(0.009)	(0.005)	(0.008)
Patience	0.142**	-0.006	-0.001	0.003
	(0.065)	(0.004)	(0.002)	(0.004)
Risk aversion	-0.455***	-0.039***	-0.003	-0.002
	(0.110)	(0.006)	(0.004)	(0.006)
Present bias	-0.273**	0.000	-0.002	0.001
	(0.111)	(0.007)	(0.004)	(0.007)
Other controls -	No	Yes	Yes	Yes
Other controls - (alternative)	Yes	No	No	No
Province FEs	Yes	Yes	Yes	Yes
Observations	3,411	3,297	3,089	2,236
(Pseudo) R^2	0.244	0.292	0.155	0.142
δ* for High	1.798	1.534	3.687	4.198
Identified set for High	[0.356, 0.762]	[0.014, 0.037]	[0.022, 0.027]	[0.036, 0.043]

This table presents the (marginal effect) results from OLS regression of financial wealth accumulation (column 1), probit regression of risky asset holdings (column 2), probit regressions of annuity holdings (columns 3 and 4) on group dummies based on being a planner and planned savings. Columns 4 only includes respondents with spouses. Low (High) is a binary variable taking the value of one if Planner is equal to 1 and Planned savings is 200 thousand yuan or lower (higher than 200 thousand yuan), otherwise zero, and the baseline group includes those with Planner equal to 0. Other controls - include Age, Age², Female, Marriage, Middle school, High school, College, Work, Retirement, Health, Types of social or occupational pension coverage, Family size, asinh (Income), asinh (Net wealth), and Financial difficulty. Other controls - (alternative) include all variables in Other controls—except asinh (Net wealth). Variables are defined in Table 1. Asinh(X) is the inverse hyperbolic sine of X. Heteroskedasticity-robust standard errors are given in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. δ* is calculated based on Oster (2019) assuming R_{max} is equal to 1.3 times of R-squared in the (analogous OLS) regressions with full controls and β is equal to 0. The identified set is calculated assuming R_{max} is equal to 1.3 times of R-squared in the (analogous OLS) regressions with full controls and δ is equal to 1.

Table A5 Instrumenting financial literacy with parents' and community average financial literacy: Robustness checks

	(1) Probit Planner	(2) OLS asinh (Planned savings)	(3) IV probit 2nd stage Planner	(4) IV 2nd stage asinh (Planned savings)
Cognition	-0.000	0.014***	-0.000	0.011**
	(0.001)	(0.004)	(0.001)	(0.005)
Financial literacy	0.079***	0.090**	0.067*	0.311**
	(0.011)	(0.043)	(0.039)	(0.129)
Other controls	Yes	Yes	Yes	Yes
Province FEs	Yes	Yes	Yes	Yes
Kleibergen-Paap F-stat (weak identification test)			36.723	13.237
p-value of Hansen J (over-identification test)			0.357	0.118
Observations	2,887	935	2,691	873
(Pseudo) R^2	0.085	0.296		

This table presents the (marginal effect) results from probit regression of being a planner (column 1), OLS regression of planned savings (column 2), 2nd stage IV probit regression of being a planner (column 3), and 2nd stage IV regression of planned savings (column 4) on cognitive ability and financial literacy. Columns 1 and 2 include only those having non-missing values of two instrumental variables. Columns 3 and 4 include only those whose communities have at least 6 observations of financial literacy. The first set of instruments are five binary variables of parents' financial literacy indicating respondent's appraisal of their parents' financial literacy compared with their parents' peers ("1 = Way above the average level", "2 = Above the average level", "3 = About average level", "4 = Below the average level", "5 = Way below the average level", and "6 = Do not know"). The second set of instruments is community average financial literacy which averages financial literacy score of other community respondents (leaving out the respondent). Other controls include Age, Age^2, Female, Marriage, Middle school, High school, College, Work, Retirement, Health, Types of social or occupational pension coverage, Family size, asinh (Income), asinh (Net wealth), Financial difficulty, Patience, Risk aversion, and Present bias. Variables are defined in Table 1. Asinh(X) is the inverse hyperbolic sine of X. Heteroskedasticity-robust standard errors are given in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. The statistics of weak identification test and over-identification test for IV probit regression are estimated using a linear version of the model.

Table A6 Being a planner, planned savings, and saving accumulation: A change model

	(1) asinh (Financial wealth)	(2) asinh (Financial wealth)	(3) asinh (Financial wealth)
asinh (Financial wealth 2012)	0.530***	0.624***	0.530***
	(0.039)	(0.070)	(0.039)
Planner	0.339*		-1.015**
	(0.186)		(0.492)
asinh (Planned savings)		0.388**	
		(0.165)	
Severity perception of social security			-0.097**
			(0.043)
Planner × Severity perception of social security			0.212***
			(0.072)
Cognition	0.024**	0.009	0.026**
	(0.011)	(0.020)	(0.011)
Financial literacy	0.984***	1.103***	0.989***
	(0.120)	(0.218)	(0.121)
Patience	0.082	0.178	0.082
	(0.066)	(0.113)	(0.066)
Risk aversion	-0.393***	-0.195	-0.409***
	(0.111)	(0.195)	(0.111)
Present bias	-0.239**	-0.221	-0.265**
	(0.112)	(0.197)	(0.113)
Other controls - (alternative)	Yes	Yes	Yes
Province FEs	Yes	Yes	Yes
Observations	3,130	1,006	3,110
R^2	0.288	0.328	0.288
δ* for Planner or asinh (Planned savings)	2.555	1.020	N/A
Identified set for Planner or asinh (Planned savings)	[0.215, 0.339]	[0.009, 0.388]	

This table presents the results from OLS regressions of the change of financial wealth accumulation on being a planner (columns 1 and 3) and planned savings (column 2). Severity perception of social security is an ordered variable based on the responses to the question: "In general, how do you think is the severity of the social security problem in China?" (0 to 10 scale where 0 = "Not severe" and 10 = "Very severe"). Other controls - (alternative) include Age, Age^2, Female, Marriage, Middle school, High school, College, Work, Retirement, Health, Types of social or occupational pension coverage, Family size, asinh (Income), and Financial difficulty. Variables are defined in Table 1. Asinh(X) is the inverse hyperbolic sine of X. Heteroskedasticity-robust standard errors are given in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. δ* is calculated based on Oster (2019) assuming R_{max} is equal to 1.3 times of R-squared in regressions with full controls and β is equal to 0. The identified set is calculated assuming R_{max} is equal to 1.3 times of R-squared in regressions with full controls and δ is equal to 1.