Financial Illiteracy and Pension Contributions:
A Field Experiment on Compound Interest in China

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Abstract

This paper uses a field experiment to study the relationship between financial literacy and retirement savings in China. When the Chinese government launched a highly subsidized pension system in rural areas in 2009, 73% of households chose to save at a level that is lower than that implied by a benchmark life-cycle model. We test to what extent the low contribution level is due to a fundamental misunderstanding of the nature of compound interest. In a field experiment with more than 1000 Chinese households, we randomly assigned some households to a financial education treatment, emphasizing the concept of compound interest. This treatment increased the pension contribution by roughly 40%. The increase accounts for 51% of the gap between contribution levels in the Control group and those implied by the benchmark model. To pinpoint mechanisms, we elicited financial literacy after the intervention, and added a third group in which we explain the pension benefit in general. We find that the neglect of compound interest is correlated with low contributions to the pension plans in the control group, and that financial education about compound interest does help households partially correct their erroneous understanding of compound interest. Moreover, explaining compound interest increases their ability to translate benefits into their own situation. Welfare analysis suggests that financial education increases total welfare, although the fact that the treatment effects are heterogeneous implies that some households end up saving more than the level implied by the benchmark model.

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1. Introduction

The inadequacy of retirement savings in the U.S. is a common, if not uncontroversial, theme in the literature. Two bodies of literature have developed to explain this phenomenon. One, focusing on the lack of information and financial sophistication, stresses the importance of financial literacy and financial education. The other literature attributes under-saving to self-control problems and procrastination.

This paper follows the first literature and uses a field experiment to study the relationship between financial illiteracy and retirement savings in China. We focus on one specific aspect of financial illiteracy, namely, the neglect of compound interest, and study whether financial education can improve people's understanding and change their behavior.

In China, although the savings rate is relatively high (Chamon and Prasad 2010), survey evidence suggests that rural households save little for their retirement due to the traditional reliance on children. Yet, a dramatic fertility decline during the past few decades and increased longevity together are causing the population to age rapidly. Aging increases the burden on grown children to support their parents and challenges the tradition of saving little for retirement and relying on the children (Wang and Xia 1994; Wang 2000; Song 2001).

Population aging and the lack of retirement savings together cause social problems in rural areas, such as increasing tensions between the old and the young, and even spur rising suicides among old farmers (Zhang and Tang 2008). Therefore, the standard of living of the rural elderly has become an important concern for both researchers and policy makers.

In 2009 the Chinese government introduced the New Rural Social Pension Insurance

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2 Diamond and Hausman (1984), Venti and Wise (1996), and Lusardi (1999) find that many households arrive at retirement with very little wealth. There is also opposite evidence: Scholz et al. (2006) find that most households in the Health and Retirement Study have accumulated more wealth than their optimal targets.

3 This literature on financial literacy includes, but is not limited to, Lusardi (1999), Lusardi and Mitchell (2007b). The literature on procrastination includes Laibson et al. (1998), O’Donoghue and Rabin (1999), Diamond and Kőszegi (2003), Choi et al. (2001), Madrian and Shea (2001).

4 In a national survey of elderly, 10% of the rural elderly reported that they saved for their retirement and only 2% thought they saved enough (Guo and Chen 2009). In the China Health and Retirement Longitudinal Study, 4% of rural elderly reported that they relied on personal savings for old-age support, and 86% relied on their children (Zhao et al. 2009).

5 By 2010, six working persons were supporting one retired person in China, but by 2050 fewer than two will support each retired person. I define “working persons” as those aged 15 to 60 and “retired person” as those aged 60 or over.
Program (NRSPIP), which is voluntary and highly subsidized. Rural households can choose from a menu of five annual contribution levels: 100 RMB, 200 RMB, 300 RMB, 400 RMB, or 500 RMB, ranging from 2% to 8% of annual per capita net income in 2010. The matching contributions from the government are: 30 RMB, 30 RMB, 40 RMB, 45 RMB, and 50 RMB, respectively. The individual pension accounts consist of the individual contributions, the matching contributions, and the earned interest. Pensioners start to receive their pension at age 60, and the annual payout includes a share from individual pension accounts plus a 960 RMB subsidy. Given the high subsidies, the pension seems likely to be an attractive product prima facie.

Indeed, 93% of rural households in the study areas participated in the pension plans, but 88.5% of households contribute at the lowest level, 100 RMB. This is consistent with the survey evidence that rural households save little for their retirement (Guo and Chen 2009; Zhao et al. 2009). We show that a benchmark life-cycle model based on Gourinchas and Parker (2002) implies that 73% of households should save more in the pension plan than what we observe in practice, and they should increase their annual contribution by 80% on average. The question, then, is why rural households do not save more for their retirement.

There are several possible explanations for the low level of retirement savings. Rural households might not trust that the government will deliver their pension in future. It is also possible that they save for retirement using other instruments, or plan to rely on their children. Although we cannot rule out these explanations, we will show some evidence in Section 8 that these are unlikely to be the main explanations for under-saving in our research setting.

In this paper, we explore another possible explanation: financial illiteracy. Research from the U.S. and other countries suggests that financial illiteracy is widespread and is correlated with poor decision making, even when the consequences are as significant as they are for retirement savings (Bernheim 1998; Lusardi and Mitchell 2007a, 2007b). The evidence on financial education is mixed and few can pinpoint the mechanism through which it works.

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6 1 USD ≈ 6.35 RMB or 3.95 RMB in PPP; the annual per capita net income is around 6,500 RMB in 2010 in my study site (Municipal Bureau of Statistics 2011). This is 1,024 USD or 1,646 USD in PPP.
7 In the benchmark model, we assume that they trust in the contract and there is no other channel to save for retirement except bank savings accounts. The details are discussed in Section 3.
8 Some studies find small or no effects of financial education on individual decisions (Duflo and Saez 2003; Cole et al. 2011; Carter et al. 2008), while others find positive and significant effects (Bayer et al. 2007b).
One possible mechanism is our focus here: there is evidence that individuals tend to linearize exponential functions when assessing them intuitively (Eisenstein and Hoch 2005; Stango and Zinman 2009; McKenzie and Liersch 2011). For savings, such an error implies a systematic tendency to underestimate interest accrued in the future, in which case individuals will underestimate the value of saving. Stango and Zinman (2009) use the Survey of Consumer Finance to show that households with greater neglect of compound interest save less and borrow more. Yet there is little evidence on the causal effect of the neglect of compound interest on actual financial decisions.

We designed a field experiment to evaluate whether the neglect of compound interest is partially responsible for low level of contribution to pension plans in rural China. We randomly assigned more than 1000 Chinese households into three groups: the Control group, the Calculation group, and the Education group. In the Control group, we visited households, explained the pension contract and did the survey. In the Calculation treatment, we calculated for the respondents the expected pension benefit levels after age 60 if they contributed at various levels with starting age 30. In the Education treatment, we asked them questions about compound interest, told them the correct answers, taught them the basic concept of compound interest, and did the calculation treatment. We then collected administrative data on their subsequent actual pension contributions.

To the best of our knowledge, this paper is the first to use a field experiment to identify the causal effect of the neglect of compound interest on real financial decisions.

We find that 56% of rural households in our sample were unable to provide a response to the simplest compound-interest question (after repeated prompting), and 73% of those who answered the question underestimated compound interest. Only 12% of rural households correctly estimated the compound interest or overestimated it. The result is similar to that in Lusardi and Mitchell (2007b), who find that only 18% of subjects in the Health and Retirement Study answered the compound interest question correctly.

Our experiment reveals that, although financial education had no effect on individual participation rates in the pension, it increased the annual contribution from 2 percentage
points to 2.8 percentage points of annual per capita income, resulting in an increase of 40% relative to the average contribution of 133 RMB in the Control group. The increase accounts for 51% of the gap between the Control group’s contribution and the level implied by the benchmark model, with a 95% bootstrapped confidence interval of 27% to 69%.

We then investigate the underlying mechanisms. We consider two possible explanations: learning the benefits of pensions in general, or better understanding of compound interest.

To assess the role of learning the level of pension benefits, we randomly assigned some households to a group in which we calculated for the respondents the expected pension benefit levels after age 60 if they contributed at various levels with starting age 30; we did not teach them about compound interest. We find that just doing the calculations and explaining the benefits increased the contribution by 20 to 25 RMB. This effect is significantly smaller than the treatment effect of education about compound interest discussed above. There might be two explanations: explaining why the benefit is large might increase the credibility of the described benefits, or increase the ability of translating the described benefits of age 30 into their own situation. We find that the treatment effects of education and calculation are similar for those who are around age 30, but differ when age increases. The treatment effect of calculation is lower than that of education for those who are around age 40, 50 or 60. Therefore, the different treatment effects between the education treatment and the calculation treatment are likely to be due to the ability to translate the benefit into their own situation.

To test whether this effect derives from a better understanding of compound interest, we measured financial literacy in the follow-up survey, and analyzed the relationship between the education intervention and financial literacy. We find that the neglect of compound interest is correlated with low contributions to the pension plans, and financial education on compound interest can help people improve their understanding. We then test whether education increases the understanding of compound interest to an extent that could generate the observed 53 RMB increase in contributions. We find that 34% to 81% of the treatment effects can be explained by a better understanding of compound interest, depending on the specification. The result suggests that understanding compound interest is a leading factor of the treatment effects, given the potential measurement error.

Welfare analysis shows that financial education increases total consumer welfare by 30%
compared to the Control group, which is equivalent to a 3% increase in consumption each year after age 60. The welfare changes are heterogeneous: those who should save more do save more while some households end up saving more than the level implied by the benchmark model.

This paper contributes to the literature in the following ways. First, it helps to identify the barriers to the diffusion of new financial products, and contributes to the literature on technology adoption in developing countries. Financial products, such as pensions, can potentially help rural households smooth consumption, increase investment in human capital, and reduce poverty and vulnerability amongst the elderly.\footnote{For example, in Brazil, rural households containing pension receivers are less likely to experience income poverty than those without pension receivers (Barrientos et. al., 2003). In South Africa, the Old Age Pension program increases children’s school attendance (Edmonds 2006) and improve their health and nutrition (Duflo 2000) because the pension is shared with them.} The existing literature suggests that the use of these products is not widespread and provides evidence for a number of explanations (Gine et al. 2008; Cole et al. 2011). Yet the neglect of compound interest remains less explored as a possible explanation for the low utilization of savings products. We provide evidence that rural households in China underestimate compound interest and contribute less to pension plans.

Second, this paper adds to the existing evidence on the effect of financial education and identifies the mechanism through which it works. Although there is correlational evidence suggesting that individuals with low levels of financial literacy are less likely to participate in financial markets, plan for retirement, or transact in low-cost manners (Lusardi and Mitchell 2007a, 2007b; Lusardi and Tufano 2008), the experimental evidence on financial education is mixed. We provide more evidence that financial education can be effective in a real world intervention. More important, we show that just explaining the benefits of pensions is less effective than explaining the benefits plus providing specific education on compound interest. This suggests that teaching the underlying concepts can be particularly effective in changing behavior, which might be due to increases in the credibility of the described benefits.

Third, our results also contribute to the literature on consumer bias and pension savings. Existing literature suggests that many people do not save enough voluntarily to maximize their lifetime utility (Barr and Diamond 2008). Low savings for retirement can be driven by
consumer biases, such as procrastination (Choi et al. 2001; Madrian and Shea 2001). Neglect of compound interest is another plausible explanation for low savings that has not drawn much attention in the literature. If individuals neglect compound interest, they might underestimate the value of pension plans and thus contribute less than they should. This could lead to large welfare losses for them when they are older and have insufficient income. We build on previous studies that analyze the relationship between neglect of compound interest and saving decisions with laboratory experiments (Eisenstein and Hoch 2005) or observational data (Stango and Zinman 2009). Our approach goes beyond those studies by using a field experiment to identify a causal relationship between neglect of compound interest and actual saving decisions.

Furthermore, we show that we can improve consumers’ financial decisions by correcting their erroneous understanding of compound interest. The psychology and economics literature has documented many individual biases. But whether these biases can be weakened is less explored. We build on the study of Eisenstein and Hoch (2005) and provide the evidence that we can debias the individual bias of neglecting compound interest.

Fourth, our paper adds to the growing literature that uses field experiments to test theory. We lay out a simple model of neglecting compound interest and test the qualitative implications of the model.\footnote{The literature on the role of theory in field experiments is reviewed in Card et al. (2011). Under their categorization, our experiment is a \textit{Single Model} experiment.}

The paper proceeds as follows. In Section 2, we provide background information on the rural pensions in China. In Section 3, we simulate the optimal level of pension savings. In Section 4, we describe the experimental design and survey data. The main empirical results are discussed in Section 5. In Section 6, we develop a simple model to explain the results. Welfare analysis is discussed in Section 7. Finally, we discuss alternative explanations in Section 8 and conclude in Section 9.

2. The New Rural Social Pension Insurance Program in China

China's population has been aging rapidly during the past few decades due to a fall in the population growth rate and an increase in life expectancy (see Appendix Table A1). By the
year 2010, 12% of China's population was aged 60 years or over, and it is predicted that the number will increase to 34% by 2050 (United Nations 2011). Aging magnifies the burden on children to support their parents. Moreover, about 60% of the elderly people in China live in rural areas (State Council of the People's Republic of China 2006); they have accumulated relatively low incomes and savings during their working years. These facts cause many social problems in rural areas such as increasing tensions between the old and the young, and even suicides of old farmers (Zhang and Tang 2008; Sun Yefang Economic Science Fund Association 2010). Therefore, how to improve the standard of living of rural elderly has become a critical issue for the Chinese government, especially in recent years.

The New Rural Social Pension Insurance Program was introduced in a few pilot rural counties in 2009, and will expand to the whole country by the end of 2012. The new scheme is highly subsidized by the central and local governments. Farmers who are 16 years old or above, are not students, and are not enrolled in urban pension plans are eligible for the pension. The details of the plan are as follows. An individual lifetime bank account is established for the pension recipients. Each individual account of the pension fund is composed of individual contributions and government subsidies. Individuals can choose one of five annual contribution levels: 100 RMB, 200 RMB, 300 RMB, 400 RMB, or 500 RMB, which range from 2% to 8% of annual per capita net income in 2010. The Chinese government will provide subsidies to match the contribution according to Table 1, Panel A:

Note that the marginal rate of subsidy decreases if individuals contribute more. All individual contributions and government subsidies will be deposited in the individual account. The interest rate is the one-year base rate according to the People’s Bank of China, the central

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12Before 2009, there were few alternative pension plans that were beneficial and affordable. There was the Rural Old-Age Pension Program, which was initiated in 1991 as an institutional framework for administering a pension program based on voluntary-contribution, defined-contribution, and fully funded individual accounts (Shi 2006). The proportion of rural farmers insured under the program peaked in 1997 at 15.4%, but it declined to around 11% in 2004. The decline in the development of the rural old age security system was not only the result of mismanagement and the low coverage rate of the rural old age insurance system, but also stemmed from the government's unwillingness to make a financial commitment to set up such a system (Wang 2006). There were also pension plans offered by insurance companies, but they were too expensive and thus take-up was low.
bank, which is 2.5% as of 2011. The interest is compounded yearly.

Pensioners will receive their pension monthly after reaching age 60. The amount received includes two parts: a basic pension from the government and a portion from the individual account balance. The current basic pension is 80 RMB per month, or 960 RMB per year, which was 15% of per capita net income in 2010. The basic pension will be adjusted according to the price level of a given year. The amount paid out per month from individual accounts equals the individual account balance divided by 139 months. Therefore, the total amount received is:

\[
\text{amount received per month} = \text{basic pension} + \frac{\text{individual account balance}}{139}
\]

The new pension plans are highly subsidized by the central and local governments.\(^{13}\) To illustrate, consider a farmer who is 30 years old and contributes the minimum amount (100 RMB) each year for 15 years. Assuming the interest rate is 2.5%, after age 60 the farmer is supposed to receive 1,259 RMB per year, of which about 82% comes from the government subsidy and its interest. If the farmer contributes 500 RMB, then approximately 56% would come from the government subsidy.

There are several special features of this pension program. For those who are already 60 or older, as long as all their eligible children living in the same village participate in the program, the parents can receive the basic pension every month without making any contributions. People between 45 and 60 years old are expected to contribute each year until they reach 60. Those under 45 years old should contribute each year for 15 years or more. Pension contributors may stop contributing for a few years and make up the contribution later. They can also cancel the pension and withdraw their savings. There is no subsidy if pensioners make up the contribution or cancel the pension. If pensioners die, their heirs will receive a lump sum payment that equals the remaining balance in the individual account minus the government subsidies.

3. Theoretical Framework

\(^{13}\) In 2010, the contribution from farmers only accounted for about 25% of the total fund in my study county. The central government provides about 50% and the local government provides the other 25%.
3.1 The Household Problem

To explain the pattern of pension savings, we apply a basic discrete-time, life-cycle model, augmented to incorporate uncertain lifetimes and uncertain incomes. We assume a finite horizon model in which individuals live to a maximum age $N$. Between ages 0 and $S - 1$, individuals are children and make no consumption decisions. Adults start working at age $S$. At every age $S \leq t \leq T$, adults receive a stochastic income and decide how much to consume and how much to save for the future. Individuals stop working exogenously at the end of age $T$ and thereafter have no income if they do not participate in the pension program. There is one asset in the economy, with a constant interest rate $R$. We impose liquidity constraint so that illiquid assets cannot be borrowed against and liquid wealth must be weakly positive. Individuals also face a probability of death in each year of life. Individuals maximize their expected lifetime utility

$$E[u(C_N) + \sum_{t=S}^{N} \beta^{t-S} u(C_t) \prod_{j=S}^{t-1} p_j]$$  \hspace{1cm} (1)

Subject to

$$X_{t+1} = R(X_t - C_t - Q_t) + Y_{t+1} + Z_{t+1}, \quad \text{and} \quad X_{t+1} \geq 0$$

where $C_t$ represents total consumption at age $t$, $p_t$ is the probability that the individual at age $t$ survives age $t+1$, $\beta$ is the discount factor, $X_t$ is cash on hand (total liquid wealth), $Q_t$ is the contribution to the pension at age $t$, $Y_{t+1}$ is the income at age $t+1$ and $Z_{t+1}$ is the amount received from the pension fund after retirement.

The utility function is assumed to exhibit Constant Relative Risk Aversion:

$$u(C) = \frac{C^{1-\rho}}{1-\rho} \hspace{1cm} (2)$$

To model the income uncertainty, we adopt Gourinchas and Parker’s (2002) formulation, and decompose the labor income into a permanent component, $P_t$, and a transitory component, $U_t$:

$$Y_t = P_t U_t$$

$$P_t = G_t P_{t-1} N_t \hspace{1cm} (3)$$
The transitory shocks, \( U_t \), are independently and identically log-normal distributed, \( \ln U_t \sim N(0, \sigma^2_u) \). The log of the permanent component of income, \( \ln P_t \), evolves as a random walk with age specific expected income growth, \( \ln G_t \). The shocks to the permanent component of income, \( N_t \), are independently and identically log-normal distributed, \( \ln N_t \sim N(0, \sigma^2_n) \).

Note that there are some limitations in the benchmark model: we assume that the individual trusts in the contract and there is no other channel to save for retirement except bank savings accounts. In section 8, we will present some suggestive evidence that is consistent with these assumptions for our study sample.

### 3.2 Model Solution

Following Gourinchas and Parker (2002), we write the optimal consumption rule as a function of age, \( t \), and normalized cash on hand, \( x_t \equiv x_t / P_t \). The budget constraint becomes

\[
x_{t+1} = (x_t - c_t - q_t) \frac{R}{G_{t+1} N_{t+1}} + U_{t+1} + z_{t+1}
\]

where lowercase letters are normalized by the permanent component of income. The Euler equation is:

\[
u'(c_t(x_t)) = \beta R p_t E[u'(c_{t+1}(x_{t+1}G_{t+1} N_{t+1}))]
\]

where \( c_t(x_t) \) represents the optimal consumption rule at age \( t \) (normalized).

We estimate the real interest rate from return on Treasury bond and CPI. From 1981 to 2010, the average real interest is 2.26 percent, so \( R = 1.0226 \). The number of patient options taken in Table A2 can be transformed to a range of discount factor \( \beta \) in Table A3. Under the CRRA utility function, the number of riskless options taken in Table A2 can be transformed to a range of risk aversion parameters \( \rho \) in Table A3. Both \( \beta \) and \( \rho \) are assumed to be the median of each range.\(^{14}\)

\(^{14}\) Although there is no evidence that we can use elicited time and risk preference to calibrate lifecycle

We then solve the dynamic programming problem by solving the Euler equation for each choice of contribution level. We solve optimal consumption rules for each household based on age, time preference, and risk attitude. Then we simulate optimal consumption (and therefore wealth) each period for each household.

Finally, given the optimal life-cycle consumption path for each choice of contribution level, we can calculate the lifetime utility for each choice of contribution level and thus find the optimal contribution level in the rural pension program.\textsuperscript{15} A complete description of the solution method is provided in Appendix A.

If the individual starts contribution at age \( s \), the consumption at age \( t \) will be

\[
C_{t,s} = \begin{cases} 
C_t(X_t - q), & \text{if } s \leq t < s + 15 \text{ and } t < 60 \\
C_t(X_t), & \text{if } s + 15 \leq t < 60 \\
C_t(X_t) + \frac{12}{139} B_s(q) + 960, & \text{if } t \geq 60
\end{cases} \tag{6}
\]

Individuals are assumed to contribute the same amount for no more than 15 years before age 60. \( G \) is the ratio between consumption after 60 and before 60. \( B_s(q) \) is the individual account balance at 60 if the individual starts to contribute at age \( s \) and contributes \( q \) for 15 years. Since the individual account balance will be distributed over 139 months, the amount received per year is \( \frac{12}{139} B_s(q) \). The basic pension per year is 960 RMB. The individual account balance is calculated according to the pension contract:

\[
B_s(q) = \sum_{t=s}^{s+14} (q + \tau(q)) \cdot (1 + r)^{(60-t)} \tag{7}
\]

\textsuperscript{15} In the simulation, we assume that people cannot change their contribution levels over time.
\( \tau(q) \) is the subsidy for the contribution level \( q \). \( r \) is the one-year base rate from the People’s Bank of China.

[Insert Figure 1]

The above figure compares the distributions of the actual contribution and the calibrated contribution level. The left figure shows that around 90% of rural households chose the lowest contribution level. The right figure shows the prediction of the benchmark model. The benchmark model captures some aspects pretty well: most individuals participate in the pension. But the model captures other aspects poorly: individuals save more in the calibration than what we observe in practice.

We bootstrap the confidence interval of the calibrated contribution levels. To account for the correlation within each village, we use block bootstrap with each village as a block. The detailed procedure is discussed in Appendix A. We find the mean of the contribution level is 234 RMB, with a 95% confidence interval [213 RMB, 258 RMB]. The average actual contribution level is 104 RMB. Therefore, these calibration results suggest that rural households should save more in their pension plans.

If we try to use the benchmark model to explain the baseline contribution levels, one of the following three have to be true: (1) pensioners believe that the government or their grown children will give them 6000 RMB per year, which is roughly the annual per capita net income in 2010; (2) pensioners are extremely impatient with discount factors equal to 0.5; (3) pensioners believe that the government will deliver only 30% of their pension benefits. Therefore, the robustness checks suggest that the benchmark model is unlikely to explain the pattern of actual retirement savings. Rural households should save more in their pension plans.

4. Experimental Design and Survey Data

Our research site is in Shaanxi Province, whose economic development is around the mean of China, ranking 14th out of 34 provinces in 2009.\(^{16}\) In 2011, 14 villages were

\(^{16}\)Shaanxi Province is in the north-central part of China with two-thirds of its population from the rural area. By 2009, 12.8% of the rural population was aged 60 years or over (Municipal Bureau of Statistics 2011), which is slightly higher than the percentage for the whole nation. The income and consumption
randomly selected as experiment sites. The author, together with 14 hired enumerators who are college students, visited each village and conducted surveys of 1,153 households during the registration of new rural pension plans. Randomization of intervention was conducted at the household level. The timeline and intervention are presented in Figure 2 below.

During the household visits, the enumerators first gave households flyers with information about the new rural pension plans. We then asked households to fill out a survey about their socioeconomic background. Households were randomly assigned to three groups: the Control group, the Calculation group and the Education group (discussed below). For each group, we elicited risk attitudes, time preferences, and financial literacy (also discussed below). At the end of the visit, the enumerators asked sample households to indicate their contribution decisions. The decisions were passed to local village coordinators, who would collect the contributions later. We made clear that we were not employees of the government but independent researchers.

The details of the experiment are now discussed. In each village, households were randomly assigned to one of the three groups. In the Control group, the enumerators gave households the pension flyers and went over information about the contract. Then households were asked to fill out a short survey about their age, education, wealth, family members, risk attitudes, time preferences, and financial literacy.

In the Calculation group, the enumerators followed the same procedure but additionally calculated the expected pension benefits after age 60 if households were to contribute at various levels. The expected benefits are described in Table 1, Panel B. Enumerators went through the benefits of each contribution level with households and explained the range of differences. The purpose was to provide the explicit benefit amount of each contribution level without explaining the concept of compound interest. Comparing the Control group and the Calculation group will suggest whether explaining the benefits in general can increase the take-up and contribution level of pension plans.

In the Education group, the enumerators followed the same procedure as in the Control levels in this county are slightly higher than the national average of rural areas, ranging from 3% to 7% (Municipal Statistical Yearbook 2010; China Statistical Yearbook 2010).
group and then asked questions about compound interest, taught the basic concept, and provided the calculated benefit for each contribution level. One key question about compound interest is adapted from Eisenstein and Hoch (2005):

“You deposit 100 RMB as a Certificate of Deposit this year at a constant interest rate of 9% per year. Interest is compounded annually. How much money could you receive in 30 years?

1) Less than 300 2) 300-500 3) 500-1000 4) 1000-1500 5) More than 1500.”

No matter what participants’ answers were, enumerators told them the right answer, 1,327 RMB, which is option 4. Then we briefly explained the basic concept of compound interest in a manner similar to Eisenstein and Hoch (2005): “Compound interest means that when interest is earned, it is left in the account. In future years, interest accumulates on the full amount that is in the account, so you earn interest on the interest as well as on the original principal amount.” The other two questions are described in Table 3, Panel A. The purpose of this approach is first to document whether the farmers underestimate the value of savings from compound interest, and then to teach them about compound interest in order to debias them. Moreover, we also calculated expected benefits after age 60, as in the Calculation group.

To summarize, the Calculation treatment provides households with information about the expected benefits of each contribution level. The Education treatment makes households estimate interest, teaches the principle of compound interest, and provides households with information about the benefits.

Risk attitudes, time preferences, and financial literacy were elicited for all households. For those assigned to the Education group, the above three measures were elicited after education about compound interest. The comparison of these measures between the Education group and the other groups allows us to test whether education changes these parameters.17 Risk attitudes were elicited by asking sample households to choose between increasing amounts of certain money (riskless option A) and risky gambles (risky option B) (see

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17 We did not ask the households the same questions before education, because households might be consistent within themselves so that we cannot see the treatment effects of these measures.
We used the number of riskless options as a measurement of risk aversion.

Time preferences were elicited by asking sample households to choose between receiving some amount of money now (option A) and an increased amount of money one year later (option B) (see Appendix Table A2 Panel B). We used the number of patient options (option B) as a measurement of patience.

We also asked five questions to measure numeracy and financial literacy. These questions are described in Table 3 Panel B.\textsuperscript{19} Note that Question 3 is similar to the compound-interest question in the education treatment.

Table 2 presents summary statistics for the different groups. In total, we reached 1,330 households. A total of 177 households were not found, 32 households declined to participate in our study, and 17 households who were over 60 years old and cannot contribute to pension plans were mistakenly surveyed. Therefore, we have 1,104 surveys total. The overall attrition rate was 17.0%. The differences in attrition between groups are not statistically significant.

From Table 2, we see that the average education level of households is 8.69 years, which is close to graduation from secondary school. 13% of households have a private pension plan, which suggests that most households do not save for retirement in other pension plans. A total of 14% of households own a business, No household in my sample has any stock investment.\textsuperscript{20} These results suggest that most households do not have other investments. Before our interventions, the take-up was 93% and the average contribution was 104 RMB (including those who did not participate), so most farmers participated in the pension plans but chose the lowest contribution level.

The last column shows the p-values for the Wald test of equal means of the three groups. Most control variables are balanced. The only exception is that the households in the Education group own fewer cars than those in the Control group and the Calculation group.

\textsuperscript{18} Both time preference and risk attitude are elicited without money incentive.
\textsuperscript{19} These questions were adopted from Banks et al. (2010), Lusardi and Mitchell (2006), Eisenstein and Hoch (2005), and Cole et al. (2011).
\textsuperscript{20} There is a concern that households do not like to report their investments and wealth. For the question of business ownership, most businesses are local and we actually visited their shops or factories to interview the owners. So it is unlikely that they lied to us. For questions about investment, given the financial knowledge rural people have, the misreporting is unlikely to be high.
However, the regressions in the next section show that the relationship between the contribution level and owning a car is in any case positive. Thus, this will not influence the validation of my randomization.

[Insert Table 3]

Table 3 presents the financial literacy of households. For different questions, the percentage of households that responded to the question and the percentage of households that answered it correctly vary. A total of 57.7% of households answered Question 4 correctly, which suggests that they have a basic understanding of inflation and purchasing power. A total of 13% of households answered Question 2 correctly and 5.6% of households answered Question 3 correctly, which suggests that most households have a poor understanding of compound interest.

5. Empirical Results

In this section, we first document the fact that rural households underestimate the value of savings from compound interest. Then we show that financial education about compound interest can increase the households’ contribution level. We also analyze the possible channels of the effects of financial education about compound interest.

5.1 Neglect of Compound Interest

We measure neglect of compound interest using the compound-interest question before intervention in the Education group. The response to the question is described in Figure 3A.

[Insert Figure 3]

Out of 369 households in the Education group, 201 households were unable to provide the answer. Figure 3A only includes the 155 households that answered the question. The right answer is 1,327 RMB, which is option 4. A total of 18% of the 155 households chose the correct answer. 73% chose option 1 to 3, which can be characterized as underestimating the value from compound interest. And 9% chose option 5, which can be characterized as overestimating the value from compound interest. From Figure 3A, we can see clearly that rural households underestimate the value of savings from compound interest.
It is possible that households just randomly answered the compound-interest questions. In this case, the average should be 2.5 and the answer should distribute evenly across the five options. However, a t-test suggests that the average is different from 2.5 and it is significant at the 10% level. A chi-square goodness of fit test also rejects the hypothesis that the answers are uniformly distributed at the 1% level. Therefore, it is unlikely that households just randomly answer the question; the evidence suggests that rural households underestimate the value of savings from compound interest.

5.2 The Impact of Education on the Take-up and the Contribution Level

Figure 4A shows that almost all the households in the three groups participate in the pension plans and there is no significant treatment effect. Figure 4B shows the treatment effect on the contributions. In the Control group, the average contribution is 133 RMB. In the Calculation group, the average contribution increases to 156 RMB. In the Education group, the average contribution increases to 182 RMB. This suggests that both the education treatment and the calculation treatment increase the contribution level, and the education treatment is more effective.

[Insert Figure 4]

Figure 5 shows the distribution of contribution levels for different groups. Contribution level 1 is corresponding to 100 RMB contributions. Contributions level 2 to 5 are corresponding to 200 RMB to 500 RMB contributions, respectively. After the intervention, most individuals still contribute 100 RMB in the pension. In the Education group, there are more households contributing at 300 RMB and 500 RMB relative to the other two groups.

[Insert Figure 5]

We estimate the treatment effect on the contributions through an OLS regression in (8):

\[ q_{ij} = \alpha_j + \alpha_k + \beta_e \cdot T_{e_{ij}} + \beta_c \cdot T_{c_{ij}} + \phi \cdot X_{ij} + \epsilon_{ij} \tag{8} \]

where \( q_{ij} \) is the contribution levels or the changes of contribution levels for household \( i \) in natural village \( j \). \( T_{e_{ij}} \) is an indicator for the education treatment and \( T_{c_{ij}} \) is an indicator for the calculation treatment. Random assignment implies that \( \beta_e \) is an unbiased estimate of the
reduced-form intention-to-treat (ITT) education treatment effect and $\beta_c$ is an unbiased estimate of the ITT calculation treatment effect. $X_{ij}$ are household characteristics (e.g. gender, age, years of education, household size, land for production, car ownership, etc). $\alpha_j$ and $\alpha_k$ are village fixed effects and enumerator fixed effects, respectively. The covariates ($X$) and fixed effects are included to improve estimation precision and to account for chance differences between groups in the distribution of pre-random assignment (Kling, Liebman, and Katz 2007). The results are reported in Table 4.

[Insert Table 4]

In columns 1 to 2, the dependent variable is individual take-up after our intervention. There is no evidence of treatment effect on take-up.

In columns 3 to 4, the dependent variable is the individual contribution level after our intervention. Column 3 presents results from the simplest possible specification, where the only right hand side variables are the indicators for the education treatment, the calculation treatment, and the fixed effects of natural villages and enumerators. The effect of the education treatment (49.14) is positive and significant at the 1% level. So the education treatment increases the contribution by 49 RMB; and it is around a 37% increase relative to the average contribution of 133 RMB in the Control group. The effect of the calculation treatment (22.81) is positive and it is statistically significant at the 5% level.

We calculate the degree to which these treatment effects can explain the gap between the Control group and the level implied by the benchmark model. We bootstrap the confidence interval of the percentage with a similar procedure in Section 3.2. We find that the treatment effect accounts for 51% of the gap between the Control group and the benchmark model prediction, with a 95% bootstrap confidence interval [27%, 69%].

In column 4, we add socioeconomic variables and dummies for missing values in the regression. The effects of the education treatment and the calculation treatment are similar to those in column 3. Years of education are positively correlated with the contribution level. Wealth, measured by owning a car or motorcycle, is also positively correlated with the contribution level.
In columns 5 to 6, the dependent variable is changes in individual contribution level, and we run the same regression as in column 3 to 4. Most coefficients have the similar magnitude and the same direction to those in the regression in which the dependent variables are individual contribution levels.

In sum, the education treatment increases the contribution by 49 to 53 RMB, resulting in an increase of around 37% to 40% relative to the average contribution of 133 RMB in the Control group. This suggests that our financial education has a positive and significant effect on retirement savings for rural households.

5.3 Possible Channels

In order for these findings to inform theory, more information is needed to analyze the mechanisms through which this effect could work. Possible explanations include: (1) learning the expected benefits of pensions in general, or (2) learning the expected benefits of pensions through better understanding of compound interest. The experiment is designed to be able to tell these mechanisms apart.

5.3.1 Learning the Benefits of the Pension Program

It is possible that the education treatment provides direct information about the benefits of the pension. In Table 4, we find that the effect of the calculation treatment is positive and significant, which suggests that learning the benefits in general contributes to the overall effects. In order to test whether learning the benefits in general can fully explain the overall effect, we compare the treatment effect of the education treatment and the calculation treatment. The difference between those two interventions should indicate whether households acquire information about compound interest during the education. We report the p-value of the Wald test $\beta_e = \beta_c$ from Equation (8) in column 3 to column 6 in Table 4. The differences between $\beta_e$ and $\beta_c$ are between 26 RMB and 32 RMB. The impact of the education treatment is greater than the calculation treatment, and it is significant at the 1% level.

There might be two explanations for the difference between the education and the
calculation treatment: explaining why the benefit is large might increase the credibility of the
described benefits, or increase the ability of translating the described benefits of age 30 into
their own situation. Figure 6 shows the treatment effects of those two treatments for
different ages.

[Insert Figure 6]

We find that the treatment effects of education and calculation are similar for those who
are around age 30, but differ when age increases. The treatment effect of calculation is lower
than that of education for those who are around age 40, 50 or 60. For those who are around
age 30, the difference between the treatment effect of education and calculation is only 1
RMB. The differences are 19 RMB, 37 RMB and 39 RMB for those who are around age 40,
50 and 60. The difference is significant at the 5% level for those who are around age 50, but
not significant for other age groups. Therefore, the different treatment effects between the
education treatment and the calculation treatment are likely to be due to the ability to translate
the benefit into their own situation.

5.3.2 Learning the Concept of Compound Interest

Another hypothesis is that individuals learn the concept of compound interest. Individuals may underestimate the value of savings from compound interest and thus contribute less to their pension plans. Financial education might increase household contribution levels by helping households correct their erroneous understanding of compound interest. This hypothesis implies that the education treatment should correct households’ erroneous answers to the compound-interest questions.

Figure 3B shows the response to the compound-interest question (Question 3) after intervention in different groups. Out of 1,104 households in the Education group, 725 households were unable to provide the answer. Figure 3B only includes the 369 households that answered the question, and excludes those that did not know. The right answer is 574 RMB, which is option 4. From Figure 3B, we can see clearly that rural households underestimate the value of savings from compound interest after intervention. A chi-square

21 In the Calculation treatment, we calculated for the respondents the expected pension benefit levels after age 60 if they contributed at various levels with starting age 30. For those who are around 50, they need to infer their benefits by themselves.
goodness of fit test also rejects the hypothesis that the answers are uniformly distributed at the 1% level. Therefore, it is unlikely that households just randomly answer the question, and the evidence suggests that rural households still underestimate the value of savings from compound interest.

Although neglect of compound interest still exists after intervention, there are fewer extremely wrong answers (option 1) and more correct answers (option 4) in the Education group than in the other groups. In order to take into account village fixed effects and other controls, we estimate the following equations:

$$q_{ij} = \alpha_{4i} + \alpha_{4k} + \beta_{f} \cdot F_{ij} + u_{ij} \quad (11)$$

$$F_{ij} = \alpha_{5j} + \alpha_{5k} + \delta_{c} \cdot Te_{ij} + \delta_{c} \cdot Tc_{ij} + \phi_{f} \cdot X_{ij} + \nu_{ij} \quad (12)$$

where $F_{ij}$ is the dependent variable measuring financial literacy. We use absolute distance to correct answer to measure financial literacy. Absolute distance measures how close the respondents’ answers are to the correct ones. The absolute distance for each individual and each question is calculated in the following formula:

$$E(|x - x_{c}|) = \int_{x_{c}}^{x} |x - x_{c}| f(x) dx \quad (13)$$

where $x$ is the chosen answer and $x_{c}$ is the correct answer. A complete description of the measurement is provided in Appendix B. Table 5 presents the estimation results in Equation (11) and (12).

[Insert Table 5]

In columns 1 and 2, estimates from (11) are presented. Better understanding of compound interest is correlated with higher contributions. In columns 3 to 7, the dependent variables are the absolute distance between the chosen answer and the correct answer for Questions 1 to 5 (Questions 1 to 5 are described in Table 3), normalized by standard deviation of the Control group. The effects of education on the financial literacy questions are all positive, but most are not significant. The only exception is Question 3, the compound-interest question. In column 5, the effect is positive and significant at the 5% level. So education reduces the distance from the correct answer by about one-sixth of a standard deviation. Therefore, financial education increases individuals’ understanding about
compound interest. Those in the Calculation group also have a better understanding of compound interest. It is likely that they infer large future benefits from the calculation treatment.

To illustrate the impact of the intervention on overall financial literacy, we follow Kling et al. (2004) and construct summary measures. Equation (14) defines average standardized treatment effects, \( \tilde{\beta} \).

\[
\tilde{\beta} = \frac{1}{K} \sum_{k=1}^{K} \frac{\hat{\beta}_k}{\hat{\sigma}_k}
\]  

(14)

where \( \hat{\beta}_k \) is the point estimate for the treatment effect of outcome \( k \) and \( \hat{\sigma}_k \) is the Control group standard deviation of outcome \( k \). To calculate the standard error for \( \tilde{\beta} \), we need to account for the covariance of the estimates \( \hat{\beta}_k \). We obtain this covariance matrix using the seemingly unrelated regression system shown in Equation (15).

\[
Y = [I_K \otimes (T_c T_c^T)] \theta + \nu
\]  

(15)

where \( I_K \) is a \( K \) by \( K \) identity matrix. The standard error and p-value for \( \tilde{\beta} \) are based on the parameters, \( \hat{\beta}_k \), jointly estimated as elements of \( \theta \) in Equation (15).

In columns 8 to 10, we report average standardized treatment effects on three combinations of questions. In column 8, we report average standardized treatment effects on Questions 2 and 3, which are both compound-interest questions. The effect of financial education is positive and significant at the 10% level. In column 9, we report average standardized treatment effects on Questions 1, 4, and 5, none of which is related to compound interest. The effect of financial education is positive but not significant. In column 10, we report average standardized treatment effects on all questions, which is positive and significant at the 10% level. This suggests that financial education has a positive and significant effect on overall financial literacy, especially on the understanding of compound interest.\(^{22}\)

To determine whether the education treatment increases understanding of compound

\(^{22}\) Robustness checks suggest that other measures of financial literacy show similar results, such as squared distance, whether they answer the questions correctly and whether they answer the question.
interest and also increases the contribution level, we stack Equations (8), (11), and (12); generate indicators for each equation; and estimate the regression system following the same procedure in Section 5.3.1. We further replace Equation (11) with Equation (16), where we replace linear regression with quadratic functions because the relationship between the contribution level and understanding of compound interest is likely to be nonlinear.

\[ q_{ij} = \alpha_{4j} + \alpha_{2k} + \beta_{f1} \cdot F_{ij} + \beta_{f2} \cdot F_{ij}^2 + u_{ij} \]  

(16)

We find that a better understanding of compound interest is unlikely to fully explain the main treatment effects. This might be due to a measurement error of financial literacy. A better understanding of compound interest can explain 7.4% of the treatment effects in the linear form and 33.8% of the treatment effects in the quadratic form. And they are both positive and significant at the 10% level.

We also run a 2SLS regression with Equation (12) as first stage and Equation (11) as second stage. We find that a better understanding of compound interest can explain 87% of the treatment effects in this specification.

To summarize, we find that although rural households underestimate the compound interest and contribute less to pension plans, education about compound interest can improve people’s understanding of compound interest, and understanding compound interest is a leading factor of the treatment effects, given the potential measurement error.

6. Models with Neglect of Compound Interest

The evidence so far implies that education about compound interest can help to increase the contribution level by improving understanding of compound interest. In this section, we present a structural model to characterize neglect of compound interest, following Stango and Zinman (2009).

Consider an individual who saves an amount of money with present value \( PV \) at a periodic interest rate \( i \) over time horizon \( t \), with periodic compounding. The future value \( FV \) is

\[ FV = PV \cdot f(i, t) \]  

(17)
Following Stango and Zinman (2009), the term \( f(i, t) = (1 + r)^t \) is an exponential function, and an individual who neglects compound interest will underestimate \((1 + r)^t\).

Consider the individual who underestimates compound interest with the following form:

\[
f(i, t, \theta) = (1 + r)^{(1-\theta)t}
\]  

(18)

\( \theta \) measures the magnitude of neglect of compound interest: Unbiased consumers have \( \theta = 0 \) and correctly perceive compound interest, while those with \( 0 < \theta < 1 \) neglect compound interest. Higher \( \theta \) indicates greater neglect of compound interest.\(^{23} \)

Then perceived future values are calculated using

\[
FV = PV \cdot f(i, t, \theta)
\]

(19)

If we incorporate neglect of compound interest into an intertemporal consumption model, the individual account balance is calculated in the following formula:

\[
B_s(q) = \sum_{t=s}^{s+14} (q + \tau(q)) \cdot (1 + r)^{(1-\theta)(60-t)}
\]

(20)

[Insert Figure 7]

The above figure compares the distributions of the actual contribution in two groups, the calibrated contribution with neglect of compound interest, and the calibrated contribution with correct perception of compound interest. This shows that the calibrated contribution with neglect of compound interest can explain the change of the actual contribution in the Control and Calculation groups. This suggests that correction of erroneous understanding of compound interest can explain the effect of financial education about compound interest. Note the calibrated contribution with neglect of compound interest cannot fully explain the actual contribution in the Education group.

7. Welfare Analysis

7.1 Total Effects

\(^{23} \) This range of \( \theta \) is relatively larger to that estimated by Stango and Zinman (2009), which is 0.2. This range of \( \theta \) is relatively smaller to that estimated by Eisenstein and Hoch (2005) for savings, though they fit the slightly more flexible function \( f(i, t, \alpha, \beta) = \alpha(1 + r)^\beta \) and estimate \( \alpha = 0.35 \) and \( \beta = 0.36 \).
In this section, we consider the welfare effect if households neglect compound interest based on the model in Section 6. We follow the framework of Liebman and Zeckhauser (2008). The basic idea is that if households correctly perceive compound interest, they should make the decision that maximizes their utility. However, if households neglect compound interest, they make their decisions to maximize their perceived utility \( (0 < \theta < 1) \) but might make better decisions if they correctly perceive compound interest \( (\theta = 0) \). The policy intervention of financial education should reduce their biases and thus help them make close to optimal decisions for their situation.

We use the benchmark model in Section 3 to calculate the welfare in each group. We find that the education treatment increased total consumer welfare by 30% compared to the Control group, which is equivalent to a 3% increase in consumption each year after age 60. This suggests that financial education increases total welfare.

### 7.2 The Distribution of the Effects: Targeting

A good policy intervention should increase total welfare of individuals. Ideally, policies should help people who behave suboptimally, but should have little negative impact on those who behave optimally (Camerer et al. 2003).

We check whether those households that should increase retirement savings really contribute more. We use our benchmark model in Section 3 to predict their contribution levels in the retirement plans. Then we divide the households into four groups: those who should not save more, those who should save 100 more, those who should save 200-300 more, and those who should save 400-500 more. We use Equation (1) to estimate the treatment effects \( \beta_{no\ more} \), \( \beta_{100} \), \( \beta_{200-300} \), and \( \beta_{400-500} \) separately in these four groups, and compare the treatment effects. Figure 8 shows the heterogeneous treatment effects.

[Insert Figure 8 here]

The horizontal axis represents four groups based on the difference between the calibrated contribution and the actual contribution. The vertical axis is the treatment effects. We find that \( \beta_{400-500} > \beta_{200-300} \approx \beta_{100} \approx \beta_{no\ more} > 0 \). Therefore, the welfare changes are heterogeneous: based on the benchmark model, those who should save more do save more while some
households end up saving more than the level implied by the benchmark model.\textsuperscript{24}

8. Alternative Explanations

There are some alternative explanations for why rural households save little in pensions. Although we cannot rule out these explanations, in this section we show evidence that they are unlikely to be the main explanations in my setting.

First, households might save for retirement in other ways. For example, they can save in private pension plans or invest in their own business. Although we cannot rule out this explanation, our survey suggests that this is not likely to be the case. Only 13\% of households have a private pension plan, and only 14\% of households own a business. Most households do not save for retirement via other sources.

Second, rural elderly might rely for old age on their children. China is a country which has a tradition of “rearing children for old age.” In the China Health and Retirement Longitudinal Study, 86\% of rural elderly reported that they relied on their children for old-age support (Zhao et al. 2009). However, population aging substantially increases the children’s burden to support their parents. For example, by 2010, six working persons were supporting one old person in China, but fewer than two will support each old person by 2050.\textsuperscript{25} Given China's rapid population aging, relying solely on children, without enough retirement savings might not suffice for living during old age.

Third, it is possible that rural households save little in pensions because they lack trust in the government. They might think that they will not receive the pension benefits when they are old. If so, financial education about compound interest should be less effective in the group with less trust in the government. In our survey, we asked about households’ previous experience with the New Rural Co-operative Medical Care System, and use this to measure their trust.\textsuperscript{26} For example, if people go to the hospital and do receive reimbursement from the

\textsuperscript{24} There might be two reasons. First, there might be experimental demand effects so that all households save more in the pension. Second, there are some unrealistic assumptions in the benchmark model.

\textsuperscript{25} I define “working persons” as those aged 15 to 60 and “old person” as those aged 60 or over.

\textsuperscript{26} The New Rural Co-operative Medical Care System was a government program introduced in 2005 to overhaul the healthcare system in rural China. The annual cost of medical coverage is 50 RMB per person, of which 10 RMB is paid by the patient. The scheme will cover from 30\% to 80\% of their medical bill if patients go to a hospital.
government, they are likely to trust the government. If they go to the hospital but do not receive reimbursement, they are likely not to trust the government. We find that among people who have visited a hospital, only 8.6% did not receive reimbursement. Even in the group with lower measured trust, the treatment effect is positive and larger than the treatment effect in the whole sample but it is not significant due to small sample size. These findings suggest that trust in the government is unlikely to be the key reason for low pension savings.

Fourth, it is also possible that rural households save little in pensions because of liquidity constraints. If so, financial education about compound interest should be less effective in the group with less wealth. We use whether households own a business, and whether they own a car or motorcycle to measure their wealth. We find that even in the group with lowest measured wealth, the treatment effect is still positive, significant and close to the treatment effect in the whole sample. Moreover, the income per capita in my research site in 2010 was around 6,500 RMB (Municipal Bureau of Statistics 2011), of which the maximum contribution is less than 10%. And my benchmark model takes into account liquidity constraints. These findings suggest that liquidity constraints are unlikely to be the key reason for low pension savings.

Another alternative explanation is procrastination. Households might want to contribute more but procrastinate because of the immediate cost. However, there is no default, and everyone has to make a decision at a given time. Moreover, almost everyone participates in the pension plan but most only contribute 100 RMB. Therefore, procrastination is unlikely to be the key reason for low pension savings.

9. Conclusion

As rural households in developing countries tend to become old before they become rich, saving for retirement has become an increasingly important research and policy topic. Lack of pension savings can have significant consequences for the standard of living of the rural elderly. In this paper, we provide working age individuals with financial education about compound interest, and attempt to test for the role of neglect of compound interest in rural pension savings in China. We find that the education treatment increases contributions by 49
to 53 RMB, resulting in an increase of around 37% to 40% relative to the average contribution of 133 RMB in the Control group. We also investigate the possible mechanisms through which this effect might work, and find that learning the concept of compound interest is a primary factor.

Future research includes follow-up surveys of the pension and insurance programs to evaluate the long-term effects of financial education. Moreover, we will evaluate whether financial education influences households’ behavior regrading other financial products. For example, theory predicts that better understanding of compound interest not only increases retirement savings but also other long-term savings.

The evidence on whether financial education can effectively change individual decisions is mixed, in the literature. This paper shows that learning the concept of compound interest can help to increase retirement savings in rural areas. Gaurav et al. (2011), and Cai and Song (2011) find that financial education with simulated experiences has a positive and significant effect on weather insurance adoption in developing countries. These findings suggest that we should first identify the barriers to individual participation and then apply specific financial education to remove the barriers. This seems to work better than general financial education.

From a policy perspective, this paper suggests that policy makers should take into account individuals' biases when designing policies, especially in rural areas where most people are poorly educated. In particular, policy makers can provide cheap financial education to overcome individual constraints, and thus improve individual welfare.
References:


Wang, Yicai (2000), “Family pension, land security and social insurance is a combination of a natural choice to solve the rural old-age”, *Population Research, 25*(5)
### Table 1. Pension Contract

**Panel A: Pension subsidy**

<table>
<thead>
<tr>
<th>Options</th>
<th>Contribution level (RMB/year)</th>
<th>Government Subsidy (RMB/year)</th>
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<tr>
<td>1</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>200</td>
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</tr>
<tr>
<td>3</td>
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<td>5</td>
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<td>50</td>
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**Panel B: Example of Pension Benefit**

<table>
<thead>
<tr>
<th>Age when you start to contribute</th>
<th>Annual Contribution level</th>
<th>Annual Subsidy (RMB/year)</th>
<th>A: Basic pension after 60 years old</th>
<th>B: Amount from individual account balance (RMB/year)</th>
<th>C=A+B: Amount received annually after 60 years old (RMB/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>100</td>
<td>30</td>
<td>960</td>
<td>299</td>
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<td>960</td>
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<td>2224</td>
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</table>

Note: Panel A shows the corresponding government subsidy to each contribution level in the pension plans. Panel B provides an example to describe the explicit benefit of each contribution level for one who starts to contribute at age 30 and contribute for the next 15 years. The interest rate is assumed to be 2.5%, which is the one year interest rate in China at the time of this study.
## Table 2. Summary Statistics

<table>
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<th>Education Treatment</th>
<th>p value</th>
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<tr>
<td>Male</td>
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<td>(0.46)</td>
<td>(0.47)</td>
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<td>(9.66)</td>
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<td>(2.56)</td>
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<td>(1.34)</td>
<td>(1.37)</td>
<td>(1.38)</td>
<td>(1.29)</td>
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<td>Land for production</td>
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<td>3.75</td>
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<td>(1.61)</td>
<td>(1.66)</td>
<td>(1.59)</td>
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<td>Share of agricultural income in total</td>
<td>17.12</td>
<td>15.83</td>
<td>17.65</td>
<td>17.89</td>
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<td></td>
<td>(16.64)</td>
<td>(14.17)</td>
<td>(17.30)</td>
<td>(18.18)</td>
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<td>Own business</td>
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<td>0.16</td>
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<td>0.13</td>
<td>0.32</td>
</tr>
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<td>(0.34)</td>
<td>(0.36)</td>
<td>(0.32)</td>
<td>(0.34)</td>
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<td>Own a car</td>
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<td>(0.30)</td>
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<td>Own a motorcycle</td>
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<tr>
<td>Saving for children</td>
<td>0.81</td>
<td>0.79</td>
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<td>0.80</td>
<td>0.50</td>
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<td>(0.39)</td>
<td>(0.40)</td>
<td>(0.38)</td>
<td>(0.40)</td>
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<tr>
<td>Saving for future when she/he is old</td>
<td>0.25</td>
<td>0.26</td>
<td>0.26</td>
<td>0.25</td>
<td>0.92</td>
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<td>(0.44)</td>
<td>(0.44)</td>
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<td>Number of children</td>
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<td>1.96</td>
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<td></td>
<td>(0.84)</td>
<td>(0.90)</td>
<td>(0.80)</td>
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<td>Number of working children</td>
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<td>(1.03)</td>
<td>(1.01)</td>
<td>(1.05)</td>
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<td>Number of dependent old</td>
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<td>(0.89)</td>
<td>(0.87)</td>
<td>(0.91)</td>
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<td>Have a private pension plan</td>
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<td>0.13</td>
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<td>0.83</td>
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<td>(0.34)</td>
<td>(0.35)</td>
<td>(0.33)</td>
<td>(0.33)</td>
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<tr>
<td>Take-up</td>
<td>0.93</td>
<td>0.92</td>
<td>0.93</td>
<td>0.94</td>
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<td>(0.26)</td>
<td>(0.28)</td>
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<tr>
<td>Contribution level</td>
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<td>104.57</td>
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<td>(65.28)</td>
<td>(71.23)</td>
<td>(70.03)</td>
<td>(53.14)</td>
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<tr>
<td><strong>Panel B: Post-intervention</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>Risk aversion</td>
<td>4.04</td>
<td>4.11</td>
<td>3.98</td>
<td>4.03</td>
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<td></td>
<td>(1.68)</td>
<td>(1.65)</td>
<td>(1.71)</td>
<td>(1.69)</td>
<td></td>
</tr>
<tr>
<td>Patience</td>
<td>2.82</td>
<td>2.64</td>
<td>2.86</td>
<td>2.95</td>
<td>0.26</td>
</tr>
<tr>
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<td>(2.61)</td>
<td>(2.64)</td>
<td>(2.61)</td>
<td>(2.59)</td>
<td></td>
</tr>
<tr>
<td>Take-up</td>
<td>0.98</td>
<td>0.98</td>
<td>0.98</td>
<td>0.99</td>
<td>0.83</td>
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<tr>
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<td>(0.13)</td>
<td>(0.13)</td>
<td>(0.14)</td>
<td>(0.12)</td>
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<tr>
<td>Contribution level</td>
<td>157.16</td>
<td>133.06</td>
<td>156.19</td>
<td>182.38</td>
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<td>(123.72)</td>
<td>(96.62)</td>
<td>(125.19)</td>
<td>(140.80)</td>
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<tr>
<td><strong>Observations</strong></td>
<td>1104</td>
<td>372</td>
<td>363</td>
<td>369</td>
<td></td>
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</table>

Note: standard deviations are in the parentheses. P-values are for Wald test of equal means of three groups. *** significant at 1% level; ** significant at 5% level; * significant at 10% level
### Panel A: Questions used during the education treatment

You deposit 100 RMB as a Certificate of Deposit this year at a constant interest rate of 9% per year. Interest is compounded annually. How much money could you receive in 30 years?

1) Less than 300 2) 300-500 3) 500-1000 4) 1000-1500 5) More than 1500

Suppose you were 45 years old and you deposit 100 RMB every year for 15 years at a constant interest rate of 2.5% per year. Interest is compounded annually. How much could you withdraw when you are 60 years old?

1) Less than 1800 2) 1800-2000 3) 2000-2500 4) 2500-3000 5) More than 3000

Suppose you were 30 years old and you deposit 100 RMB every year for 15 years at a constant interest rate of 2.5% per year. Interest is compounded annually. How much could you withdraw when you are 60 years old?

1) Less than 1800 2) 1800-2000 3) 2000-2500 4) 2500-3000 5) More than 3000

### Panel B: Post-intervention questions

A second hand car is selling at 60000 RMB, which is 2/3 of the new one. What is the price of a new car?

1) 90000 2) 40000 3) 80000 4) 120000 5) 180000 6) other

If you borrowed 100000 RMB from the bank, the interest rate is 2% per month and compounded monthly. How much do you owe the bank in three months?

1) Less than 102000 2) 102000 3) 102000-106000 4) 106000 5) More than 106000

You deposit 100 RMB as a Certificate of Deposit this year at a constant interest rate of 6% per year. Interest is compounded annually. How much money could you receive in 30 years?

1) Less than 300 2) 300-400 3) 400-500 4) 500-600 5) More than 600

You deposited 10000 RMB in the bank and the interest rate is 2% per year. If the price level increases 3% per year, can you buy more than, less than, or the same amount of goods in 1 year as you could today?

You have two choices if you want to borrow 500000 RMB from the bank. Bank 1 requires you to pay back 600000 RMB in one month. Bank 2 requires you to pay back in one month 500000 RMB plus 15% interest. Which bank represents a better deal for you?

### Table 3. Financial Literacy

<table>
<thead>
<tr>
<th>Question</th>
<th>Total</th>
<th>Control</th>
<th>Education Treatment</th>
<th>Calculation Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%answer %correct</td>
<td>%answer %correct</td>
<td>%answer %correct</td>
<td>%answer %correct</td>
</tr>
<tr>
<td>You deposit 100 RMB as a Certificate of Deposit this year at a constant</td>
<td>42.0</td>
<td>7.6</td>
<td>43.0</td>
<td>7.9</td>
</tr>
<tr>
<td>interest rate of 9% per year. Interest is compounded annually. How much</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>money could you receive in 30 years?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) 1) Less than 300 2) 300-500 3) 500-1000 4) 1000-1500 5) More than 1500</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suppose you were 45 years old and you deposit 100 RMB every year for</td>
<td>30.6</td>
<td>14.1</td>
<td>31.4</td>
<td>14.8</td>
</tr>
<tr>
<td>15 years at a constant interest rate of 2.5% per year. Interest is</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>compounded annually. How much could you withdraw when you are 60 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>old?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) 1) Less than 1800 2) 1800-2000 3) 2000-2500 4) 2500-3000 5) More than 3000</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suppose you were 30 years old and you deposit 100 RMB every year for</td>
<td>29.3</td>
<td>7.3</td>
<td>30.2</td>
<td>7.6</td>
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<tr>
<td>15 years at a constant interest rate of 2.5% per year. Interest is</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>compounded annually. How much could you withdraw when you are 60 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>old?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) 1) Less than 1800 2) 1800-2000 3) 2000-2500 4) 2500-3000 5) More than 3000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A second hand car is selling at 60000 RMB, which is 2/3 of the new one.</td>
<td>58.4</td>
<td>34.7</td>
<td>60.6</td>
<td>35.9</td>
</tr>
<tr>
<td>What is the price of a new car?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) 90000 2) 40000 3) 80000 4) 120000 5) 180000 6) other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If you borrowed 100000 RMB from the bank, the interest rate is 2% per</td>
<td>37.9</td>
<td>13.0</td>
<td>40.2</td>
<td>13.5</td>
</tr>
<tr>
<td>month and compounded monthly. How much do you owe the bank in three</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>months?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) 1) Less than 102000 2) 102000 3) 102000-106000 4) 106000 5) More than 106000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>You deposit 100 RMB as a Certificate of Deposit this year at a constant</td>
<td>33.4</td>
<td>5.6</td>
<td>35.7</td>
<td>5.9</td>
</tr>
<tr>
<td>interest rate of 6% per year. Interest is compounded annually. How much</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>money could you receive in 30 years?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) 1) Less than 300 2) 300-400 3) 400-500 4) 500-600 5) More than 600</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>You deposited 10000 RMB in the bank and the interest rate is 2% per year</td>
<td>70.5</td>
<td>57.7</td>
<td>73.1</td>
<td>58.0</td>
</tr>
<tr>
<td>If the price level increases 3% per year, can you buy more than, less</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>than, or the same amount of goods in 1 year as you could today?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>You have two choices if you want to borrow 500000 RMB from the bank.</td>
<td>52.5</td>
<td>22.8</td>
<td>55.7</td>
<td>23.4</td>
</tr>
<tr>
<td>Bank 1 requires you to pay back 600000 RMB in one month. Bank 2 requires</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>you to pay back in one month 500000 RMB plus 15% interest. Which bank</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>represents a better deal for you?</td>
<td></td>
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</tbody>
</table>

Note: The “%answer” equals the number of individuals who respond to the question divided by the number of observations in that column. The “%correct” equals the number of individuals who answer the question correctly divided by the number of observations in that column.
### Table 4. The Effect of the Education and Calculation Interventions on Contribution Level

<table>
<thead>
<tr>
<th>Specification:</th>
<th>OLS regression</th>
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</thead>
<tbody>
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<td>Dep. Var.: Individual Adoption of Pension</td>
<td>Individual Contribution Level of Pension</td>
</tr>
<tr>
<td>Sample:</td>
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</tr>
<tr>
<td>Education</td>
<td>0.002</td>
</tr>
<tr>
<td>(0.009)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>Calculation</td>
<td>-0.004</td>
</tr>
<tr>
<td>(0.009)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>Male</td>
<td>-0.011</td>
</tr>
<tr>
<td>(0.006)*</td>
<td>(10.18)</td>
</tr>
<tr>
<td>Age (younger than 45)</td>
<td>0.0003</td>
</tr>
<tr>
<td>(0.001)</td>
<td>(0.79)**</td>
</tr>
<tr>
<td>Age (older than 45)</td>
<td>0.0008</td>
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<tr>
<td>(0.001)</td>
<td>(0.87)*</td>
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<tr>
<td>Years of education</td>
<td>0.0003</td>
</tr>
<tr>
<td>(0.002)</td>
<td>(1.39)***</td>
</tr>
<tr>
<td>Household size</td>
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<tr>
<td>(0.004)</td>
<td>(3.59)</td>
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<tr>
<td>Land for production</td>
<td>0.003</td>
</tr>
<tr>
<td>(0.004)</td>
<td>(3.90)</td>
</tr>
<tr>
<td>Own a car</td>
<td>0.012</td>
</tr>
<tr>
<td>(0.007)</td>
<td>(16.00)</td>
</tr>
<tr>
<td>Own a motorcycle</td>
<td>0.007</td>
</tr>
<tr>
<td>(0.009)</td>
<td>(8.38)*</td>
</tr>
</tbody>
</table>

**Wald test: $\beta_e = \beta_c$**

| p-value | 0.4855 | 0.5009 | 0.0104** | 0.0064*** | 0.0007*** | 0.0004*** |

Obs. | 1104 | 1104 | 1104 | 1104 | 1104 | 1104 |

Omitted treatment

Mean of Dep. Var. for omitted treatment: 0.0984 133.06 28.49

Fixed effects for village and enumerator: Y Y Y Y Y Y

R-square: 0.0600 0.0648 0.0519 0.0895 0.0577 0.0963

Notes: Standard errors are clustered by 93 natural villages. Robust clustered standard errors are in the parentheses. *** significant at 1% level; ** significant at 5% level; * significant at 10% level. In columns 1 and 2, the dependent variable is individual contribution level. In columns 2 and 4, we add dummies for missing values of control variables in the regression. In columns 3 and 4, the dependent variable is changes in individual contribution level and we run the same regression as in column 1 and 2. $\beta_e$ is the coefficient of the education treatment and $\beta_c$ is the coefficient of the calculation treatment.
<table>
<thead>
<tr>
<th>Specification:</th>
<th>OLS regression</th>
<th>SUR regression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dep. Var.:</td>
<td>Individual Contribution Level of Pension</td>
<td>Change in Individual Contribution Level of Pension</td>
</tr>
<tr>
<td>Sample:</td>
<td>Control</td>
<td>Control</td>
</tr>
<tr>
<td>Question 1</td>
<td>0.078</td>
<td>0.072</td>
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<tr>
<td>(0.067)</td>
<td>(0.068)</td>
<td>(0.071)**</td>
</tr>
<tr>
<td>Question 2</td>
<td>0.072</td>
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<tr>
<td>(0.067)</td>
<td>(0.068)</td>
<td>(0.071)*</td>
</tr>
<tr>
<td>Absolute distance of Question 2</td>
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<tr>
<td>(9.65)</td>
<td>(5.37)</td>
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<tr>
<td>Absolute distance of Question 3</td>
<td>31.75</td>
<td>17.51</td>
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<tr>
<td>(8.71)**</td>
<td>(5.93)**</td>
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<tr>
<td>Obs.</td>
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<td>372</td>
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<tr>
<td>Control</td>
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<tr>
<td>Mean of Dep. Var. for omitted treatment:</td>
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<td>-1.58</td>
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<tr>
<td>Social-economic variables</td>
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<td>Y</td>
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<tr>
<td>Fixed effects for village and enumerator</td>
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<td>Y</td>
</tr>
<tr>
<td>R-square</td>
<td>0.2013</td>
<td>0.2527</td>
</tr>
</tbody>
</table>

Notes: Standard errors are clustered by 93 natural villages. Robust clustered standard errors are in the parentheses. *** significant at 1% level; ** significant at 5% level; * significant at 10% level. In columns 1 and 2, we restrict the sample to the Control group and the Calculation group. In columns 3 to 7, the dependent variables are the absolute distance between the chosen answer and the correct answer for Question 1 to 5, normalized by standard deviation of Control group. In column 8, we report average standardized treatment effects on Question 2 and 3, of which both are compound-interest questions. The effect of financial education is positive and significant at the 10% level. In column 9, we report average standardized treatment effects on Question 1, 4 and 5, of which none of them are related to compound interest. The effect of financial education is positive but not significant. In column 10, we report average standardized treatment effects on all questions.
Figure 1 Distribution of Actual and Calibrated Contribution Levels from Benchmark Model

Note: The figures compare the distributions of the actual contribution and the calibrated contribution level from the model with correct perception of compound interest. The left figure shows the distribution of the actual contribution. The right figure shows the distribution of the calibrated contribution. The vertical axis is the density of the distribution. The horizontal axis is the contribution level from 1 to 5. The mean of actual contribution is 104 RMB and the mean of calibrated contribution is 234 RMB.
- Flyers: explain new rural pension
- Survey (N=1104)

Control: do nothing (N=372)

Calculation: calculate the expected benefit of pension (N=363)

Education: teach compound interest + calculation (N=369)

- Measures of risk attitudes
- Measures of time preference
- Financial literacy questions

Actual take-up and contribution decisions

Figure 2 Timeline
Figure 3A Response to Compound-Interest Question during the education treatment

Note: The figure shows the distribution of responses to compound interest rate question before intervention. The question is: “You deposit 100 RMB as a Certificate of Deposit this year at a constant interest rate of 9% per year. Interest is compounded annually. How much money could you receive in 30 years? 1) Less than 300 2) 300-500 3) 500-1000 4) 1000-1500 5) More than 1500” The figure only includes those who answered the question and excludes those who did not know.

Figure 3B Response to compound-interest question after intervention

Note: The figure shows the distribution of responses to compound interest rate question after intervention. The question is: “You deposit 100 RMB as a Certificate of Deposit this year at a constant interest rate of 6% per year. Interest is compounded annually. How much money could you receive in 30 years? 1) Less than 300 2) 300-400 3) 400-500 4) 500-600 5) More than 600” The figure only includes those who answered the question and excludes those who did not know.
Figure 4A Treatment effect on Take-up

Note: This figure shows the treatment effect on the take-up of pension plans. In the Control group, the take-up is 98.4%. In the Calculation group, the take-up is 98.1%. In the Education group, the take-up is 98.6%. It suggests that almost all the households in the three groups participate in the pension plans.

Figure 4B Treatment Effect on Contribution Levels

Note: This figure shows the treatment effect on the contributions of pension plans. In the Control group, the average contribution is 133 RMB. In the Calculation group, the average contribution increases to 156 RMB. In the Education group, the average contribution increases to 182 RMB. It suggests that both the education treatment and the calculation treatment increase the contribution level and the education treatment is more effective.
Figure 5 Distributions of Contribution Levels

Note: The figure shows the distribution of contribution levels for different groups. Contribution level 1 is corresponding to 100 RMB contributions. Contributions level 2 to 5 are corresponding to 200 RMB to 500 RMB contributions, respectively. It suggests that most individuals contribute 100 RMB and those in the Education group contribute more relative to the other two groups.
Figure 6 Heterogeneous Treatment Effects of Age

Note: The figure shows the heterogeneous treatment effects of age for the education treatment and the calculation treatment. The horizontal axis represents four age groups. The vertical axis is the treatment effects. The treatment effects of education and calculation are similar for those who are around age 30, but differ when age increases. The treatment effect of calculation is lower than that of education for those who are around age 40, 50 or 60. Therefore, the different treatment effects between the education treatment and the calculation treatment are likely to be due to the ability to translate the benefit into their own situation.
Figure 7 Distribution of Actual and Calibrated Contribution level

Note: The figures compare the distributions of the actual contribution in two groups, the calibrated contribution with neglect of compound interest and the calibrated contribution with correct perception of compound interest. The vertical axis is the fraction of each contribution. The horizontal axis is the contribution.
Figure 8 Heterogeneous Effects of the Education Treatment

Note: The figure shows the heterogeneous effects of the education treatment. The horizontal axis represents four groups based on the difference between the calibrated contribution and the actual contribution: those who should not save more, those who should save 100 more, those who should save 200-300 more, and those who should save 400-500 more. The vertical axis is the treatment effects.
Appendix A: Numerical Solution of Consumer Problem

A.1 Timing of event in the life-cycle model

An individual has cash on hand $X_t$ at the beginning of age $t$, and consumes $C_t$ during age $t$. At the end of age $t$, the remaining cash on hand is $X_t - C_t - Q_t$. At the beginning of age $t+1$, we first resolve the lifetime uncertainty and then resolve income uncertainty, if individual survives. Nature takes a draw with probability $p_t$ that the individual survives in age $t+1$. If individual survives, nature takes a draw of income $Y_{t+1}$ according to the income process. The individual also receives the return from assets, $R(X_t - C_t - Q_t)$ and pension $Z_{t+1}$ if they are age 60 or over. Therefore, the individual has cash on hand $X_{t+1}$ at the beginning of age $t+1$.

A.2 Estimation of Exogenous Process

Survival probabilities are based on 2009 life tables from the World Health Organization (http://www.who.int/healthinfo/statistics/mortality_life_tables/en/). Survival probabilities can be calculated at any age by simply dividing the number of survivors at the terminal age by the number at the beginning age. The data has only five year intervals, so we interpolate the survival probability at each age using Piecewise cubic Hermite interpolation to preserve the shape of the data.

Income uncertainty and age-specific income growth are estimated from the China Health and Nutrition Study (CHNS) (http://www.cpc.unc.edu/projects/china), a large scale longitudinal survey conducted in nine provinces of China in 1989, 1991, 1993, 1997, 2000, 2004, 2006 and 2009. The survey covers coastal, middle, northeastern, and western provinces. The CHNS also includes cities with different income levels, and surveys both rural and urban residents. Although the CHNS is not a nationally representative sample, the provinces covered vary substantially in terms of geography and economic development. The CHNS collects information on a wide range of individual socioeconomic, health and nutritional characteristics. The CHNS also includes information on income and wealth, which is the key information we use in our study.

We estimate the variance of the permanent and transitory component of shocks, $\sigma_n^2$ and
\( \sigma^2_u \), using CHNS and the methodology of Carroll and Samwick (1997).

To estimate the age-specific expected income growth, we need to decompose age, cohort, and year effects from the panel data, and to construct age-profiles of income. As discussed in Deaton (1997), it is not possible to decompose these three effects without further restrictions. This follows from the identity that interview year less age equals birth year. Following Deaton (1997), we define year dummies in a way that makes the year effects orthogonal to a time trend:

\[
D_t = d_t - [(t-1)d_2 - (t-1)d_1]
\]

where \( t=3,\ldots,T \), \( d_t \) is the usual year dummy, equal to 1 if the year is \( t \) and 0 otherwise.

We then estimate the following regression:

\[
\ln Y_i = a_i \pi_1 + a_i^2 \pi_2 + c_i \pi_3 + D_i \pi_4 + f_i \pi_5 + u
\]

where \( a_i \) is the age, \( c_i \) is a complete set of cohort dummies (less the middle one), and \( f_i \) is the household size. The coefficients of the regressions give the third through final year coefficients; the first and second can be recovered from the fact that all year effects add up to zero.

With these estimates, we construct household-level income uncontaminated by cohort and time effects:

\[
\ln \hat{Y}_i = a_i \hat{\pi}_1 + a_i^2 \hat{\pi}_2 + f_i \hat{\pi}_5 + \hat{u}
\]

\( \ln \hat{Y}_i \) is the income of household with family size \( f_i \) and born in the middle cohort. The average age-profiles of income can be constructed by averaging these data across households:

\[
\ln \hat{Y}_a = a \hat{\pi}_1 + a^2 \hat{\pi}_2 + f \hat{\pi}_5
\]

We can calculate the expected income growth rate by first differencing the log-average income.

A.3 Consumption Rules

We solve the optimal consumption rule by solving the Euler equation. We start at age \( N \), assumed to be 100, and solve the Euler equation with all possible states (the problem at this stage is trivial, since the household will simply consume all income). We move backward to the previous period and solve for the consumption rule by the Euler equation. We go all the
The problem consists in evaluating the expectation. Since \( N \) and \( U \) are log normally distributed, a natural way to evaluate these integrals is to perform a two dimensional Gauss-Hermite quadrature using the product rule:

\[
\mathbb{E}[u'(c_{t+1}(x_{t+1})G_{t+1}N_{t+1})] = \int u'(c_{t+1}(x_{t+1})G_{t+1}N_{t+1})dF(N)dF(U) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} f_i(n,u)e^{-n^2}e^{-u^2}dn du = \sum_{i,j} \omega_i \omega_j f_i(n_j,u_j)
\]

where \( f_i(n,u) = \frac{1}{\pi} u'(c_{t+1}((x_i - c_i) \frac{R}{G_{t+1}} e^{\sqrt{\sigma^2 u}} + e^{\sqrt{\sigma^2 u}}))G_{t+1}e^{\sqrt{\sigma^2 u}}, \quad u = \frac{\log(U)}{\sqrt{2\sigma^2}} \) and

\[n = \frac{\log(N)}{\sqrt{2\sigma^2}}.
\]

The weights \( \omega_{ij} \) and nodes \( n_i, u_j \) are tabulated in Judd (1998). In practice, we performed a quadrature with 10 nodes.

We use a standard discretization method to solve the optimal consumption rule. We specify an exogenous grid for cash on hand, \( \{x^j\}_{j=1}^{J} \subset [0,x^{\max}] \). In practice, for each value on the grid, \( x^j \), we find the associated consumption, \( c^j \), that satisfies the Euler equation. We constrain the associated consumption to be positive and less than \( x \). In practice, with 50 points on the grid and 80 time periods, we must solve the Euler equation 4,000 times. Consumption will be evaluated using interpolation or extrapolation methods.

Then we simulate optimal consumption (and therefore wealth) each period for each household by simulating income. Consider a household \( h \) with age \( S \), the first working age. The household is assumed to begin with zero assets and zero income. We then simulate the income according to the income process in Equation (3), and calculate consumption in age \( S \) according to the consumption rule in age \( S \). We move forward to the next period to simulate income and calculate consumption until we have a complete consumption path. For those with age \( t > S \), their initial assets are assumed to be the wealth of household \( h \) at age \( t \). Thus, we can simulate optimal consumption path for each household.

**A.4 Bootstrapping the Confidence Interval**

We bootstrap the confidence interval of the calibrated contribution levels. The detailed
block bootstrapping procedure takes the following steps:

1. Choose the block. We assume each village is independent, and choose the village as a block.

2. Resample the blocks and generate a bootstrap resample. The number of villages in the bootstrap resample is the same as in the original data.

3. Calibrate the contribution level for the bootstrap resample. Given the optimal life-cycle consumption path, for the households in the resample we can calculate the lifetime utility for each choice of contribution level, and thus find the optimal contribution level in the rural pension program.

4. We resample the blocks for NB=100 and calculate the mean and confidence interval.

**Appendix B: Measure of Financial Literacy**

We use absolute distance to the correct answer to measure how close the respondents’ answers are to the correct ones. The absolute distance for each individual and each question is calculated in the following formula:

$$E(|x - c_x|) = \int_{x_l}^{x_u} |x - c_x| f(x) dx$$

where $x$ is the chosen answer and $c_x$ is the correct answer. Since all the questions are multiple-choice questions, we assume the chosen answer $x$ is a uniform distribution on $[x_l, x_u]$, where $x_l$ and $x_u$ are two boundaries of the chosen option. For example, the correct answer for Question 3 is $c_x = 574$. If a subject choose the option 1 (100-300 RMB), we assume his/her answer is a uniform distribution on [100, 300]. Then we apply the Monte Carlo integration method to calculate the expected absolute distance. Note that the options for Questions 4 and 5 are qualitative, and thus we just measure whether a subject answers them correctly. If a subject does not answer the question, we assume the absolute distance is the same as that of the worst option in the question in order to distinguish him/her from those who answer the question. We reverse the sign for absolute distance so that a higher value of the measure represents an answer closer to the correct one.
### Table A1. Population Aging in China

<table>
<thead>
<tr>
<th></th>
<th>1970</th>
<th>1990</th>
<th>2010</th>
<th>2030</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (thousands)</td>
<td>814,623</td>
<td>1,145,195</td>
<td>1,341,335</td>
<td>1,393,076</td>
<td>1,295,604</td>
</tr>
<tr>
<td>Population growth rate (%)</td>
<td>2.74</td>
<td>1.61</td>
<td>0.51</td>
<td>-0.03</td>
<td>-0.55</td>
</tr>
<tr>
<td>Life expectancy at birth</td>
<td>59.4</td>
<td>68.9</td>
<td>72.7</td>
<td>76.4</td>
<td>79.1</td>
</tr>
<tr>
<td>Percentage aged 60 or over</td>
<td>6.6</td>
<td>8.9</td>
<td>12.3</td>
<td>24.4</td>
<td>33.9</td>
</tr>
</tbody>
</table>

Source: United Nations

*The number is the average of five years before the year
### Table A2. Risk Attitude and Time Preference Questions

<table>
<thead>
<tr>
<th>Panel A: Risk Attitude</th>
<th>Panel B: Time Preference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Option A</strong></td>
<td><strong>Option B</strong></td>
</tr>
<tr>
<td>50 RMB</td>
<td>Toss a coin. If it is heads, you get 200RMB. If it is tails, you get nothing.</td>
</tr>
<tr>
<td>80 RMB</td>
<td>Toss a coin. If it is heads, you get 200RMB. If it is tails, you get nothing.</td>
</tr>
<tr>
<td>100 RMB</td>
<td>Toss a coin. If it is heads, you get 200RMB. If it is tails, you get nothing.</td>
</tr>
<tr>
<td>120 RMB</td>
<td>Toss a coin. If it is heads, you get 200RMB. If it is tails, you get nothing.</td>
</tr>
<tr>
<td>150 RMB</td>
<td>Toss a coin. If it is heads, you get 200RMB. If it is tails, you get nothing.</td>
</tr>
<tr>
<td>1000 RMB today</td>
<td>1063 RMB in one year</td>
</tr>
<tr>
<td>1000 RMB today</td>
<td>1188 RMB in one year</td>
</tr>
<tr>
<td>1000 RMB today</td>
<td>1313 RMB in one year</td>
</tr>
<tr>
<td>1000 RMB today</td>
<td>1437 RMB in one year</td>
</tr>
<tr>
<td>1000 RMB today</td>
<td>1563 RMB in one year</td>
</tr>
<tr>
<td>1000 RMB today</td>
<td>1688 RMB in one year</td>
</tr>
<tr>
<td>1000 RMB in 2 years</td>
<td>1063 RMB in 3 years</td>
</tr>
<tr>
<td>1000 RMB in 2 years</td>
<td>1188 RMB in 3 years</td>
</tr>
<tr>
<td>1000 RMB in 2 years</td>
<td>1313 RMB in 3 years</td>
</tr>
<tr>
<td>1000 RMB in 2 years</td>
<td>1437 RMB in 3 years</td>
</tr>
<tr>
<td>1000 RMB in 2 years</td>
<td>1563 RMB in 3 years</td>
</tr>
<tr>
<td>1000 RMB in 2 years</td>
<td>1688 RMB in 3 years</td>
</tr>
</tbody>
</table>

Note: Risk attitudes were elicited for all the households with questions in Panel A. For those who were assigned to the Education group, risk attitudes were elicited after the education. Households were asked to make five hypothetical decisions to choose between riskless option A and risky option B. We use the number of riskless options as a measurement of risk averse. The more the riskless options are chosen, the more the risk averse is. Time preferences were elicited for all the households with questions in Panel B. For those who were assigned to the Education group, time preferences were elicited after the education. Time preferences were elicited by asking sample households to choose between receiving some amount of money now (option A) and increasing amount of money one year later (option B) in Table A2. We use the number of patient options (option B) as a measurement of patience. The more the patient options are chosen, the more the patience it is
Table A3. Range of Risk Aversion and Time Preference

<table>
<thead>
<tr>
<th>Panel A: Risk Attitude</th>
<th>Number of riskless options</th>
<th>Number of observation</th>
<th>Range of $\alpha$ for CRRA $u(x)=x^{1-\alpha}/(1-\alpha)$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>117</td>
<td>$\rho &lt; -1.4$</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>19</td>
<td>$-1.4 &lt; \rho &lt; -0.35$</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>57</td>
<td>$-0.35 &lt; \rho &lt; 0$</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>83</td>
<td>$0 &lt; \rho &lt; 0.25$</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>61</td>
<td>$0.25 &lt; \rho &lt; 0.5$</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>763</td>
<td>$\rho &gt; 0.5$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Time Preference</th>
<th>Number of patient options</th>
<th>Number of observation</th>
<th>Range $\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>442</td>
<td>$\beta &lt; 0.59$</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>25</td>
<td>$0.59 &lt; \beta &lt; 0.64$</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>59</td>
<td>$0.64 &lt; \beta &lt; 0.70$</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>79</td>
<td>$0.70 &lt; \beta &lt; 0.76$</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>83</td>
<td>$0.76 &lt; \beta &lt; 0.84$</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>75</td>
<td>$0.84 &lt; \beta &lt; 0.94$</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>334</td>
<td>$\beta &gt; 0.94$</td>
</tr>
</tbody>
</table>