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EDUCATION DECISIONS AND CHINESE HOUSEHOLD FINANCE

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ABSTRACT

Does increased higher education attainment among Chinese households cause greater stock market participation rates? In this paper, a three-period, lifetime model is constructed to explain data facts about household finance and education outcomes in rural and urban China. Utility-maximizing functions are compared to evaluate households' optimal education and investment strategies. Stock market entry costs are estimated as inverse functions of household ability, a heterogeneous parameter. Based on this estimated model, we conclude that higher, average household disposable incomes in urban Chinese regions cause their greater stock market participation rates. Additionally, more-educated Chinese households in both regions generally have lower stock market entry costs and therefore gain easier access to stock markets.

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1 Introduction

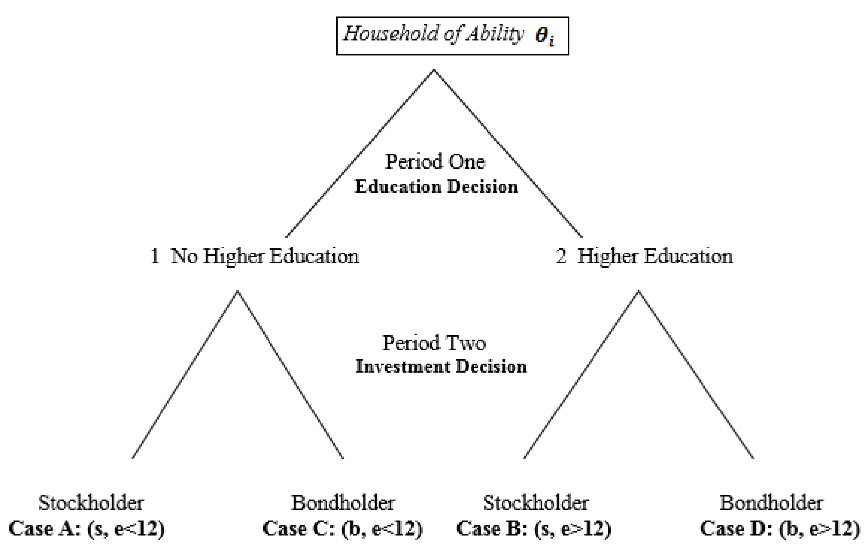
We explore Chinese household finance decisions by analyzing an estimated three-period model involving utility-of-consumption functions. Impacts of stock market entry costs on participation rates are analyzed for both rural and urban Chinese households. We model higher education attainment and stock market participation to fit data from the *China Household Finance Survey* from the Southwestern University of Finance and Economics of Chengdu, China. Chinese households' expected utilities are maximized by one of the following joint decisions:

Table 1. Higher Education and Investment Cases

Case A	Stockholder and No Higher Education (s, e < 12)
Case B	Stockholder and Higher Education (s, e > 12)
Case C	Bondholder and No Higher Education (b, e < 12)
Case D	Bondholder and Higher Education (b, e > 12)

Note: To simplify the analysis, all non-stockholders are defined as bondholders.

Figure 1. Joint Decision Tree



2 Motivation

Existing research on Chinese household finance, entry costs, and Chinese higher education has shaped the development of our three-period, lifetime model of Chinese household finances. Past research has sought to explain the effects of entry costs on stock market participation. We look to further this conversation by also examining the relationship between higher education and stock market participation, specifically in China.

Connecting well to our data facts from the *China Household Finance Survey*, Vissing-Jorgensen (2002b) sheds ideas on analyzing stock market nonparticipation rates. In her study, Vissing-Jorgensen uses PSID data on income and asset holdings in the United State to estimate stock market participation costs. Based on the *China Household Finance Survey* data set, we observe that 95.93% and 93.53% of rural and urban Chinese households, respectively, do not participate in stock markets. We use entry cost and mean household income analyses to explain this phenomena of nonparticipation.

Also related to our model, Alan (2006) describes entry costs as causal factors of market frictions. In her paper, Alan sets up a life cycle model that includes fixed stock market entry costs to explain PSID wealth supplement data from 1984 and 1989. She ultimately concludes that entry costs cause concentrations of stockholders' wealth to aggregate in upper distribution tails. This connects to our entry cost model since higher ability households typically have greater wealth due partly to lower stock market entry costs and due to higher expected returns on education.

Related to the provision for heterogeneity in our model, Nirei and Aoki (2013) use a Pareto distribution to account for distributions of wealth and income. Similar to their model, we use a Pareto cumulative distribution function (CDF) to estimate stock market entry costs by estimating various parameters including mean household ability. Whereas Nirei and Aoki use their distribution to study the effects of changes in tax rates on the dispersion of upper-tailed income, we study the effects of differences in households' abilities on the distribution of stockholders in China.

Building off Gomes and Michaelides (2005), we create a lifetime model to observe households' stock market behavior. Gomes and Michaelides include variables such as Epstein–Zin preferences, fixed entry costs, and heterogeneous household risk aversion variables in their lifetime, household finance model. Contrarily, we incorporate heterogeneity by including variable entry costs based on households' abilities.

Based on their structural model mapping different education groups to household financial decisions, Cooper and Zhu (2014) point out that an important determinant of stock market participation rates is mean income. This observation is consistent with our estimated model, where we observe the main driver of greater stock market participation in urban versus rural regions is due to greater household disposable income. This discovery also brings to surface the subject of economic division between rural and urban Chinese regions (Wang, Liu, Zhang, and Luo, 2011).

Lastly, in reference to incorporating higher education into our model, the estimated return on Chinese higher education steadily increased from 2003 to 2010 based on Hu and Hibel's (2013) regression of higher education attainment on social background variables from the *China General Social Survey*. Hu and Hibel's finding is consistent with our belief that college graduates earn returns on higher education in the form of higher wages. In our model, the product of return on education, $h(\bar{e})$, and ability, θ_i, is set to the constraint of producing a 75% return on higher education, consistent with data from *China Household Finance Survey.*

3 Data Facts

The three-period, lifetime household model will explain data facts from the *China Household Finance Survey* by Southwestern University of Finance and Economics in Chengdu, China. To obtain data, 80 counties out of 2,585 total Chinese counties were randomly selected to participate based on per capita GDP estimates. Within each selected Chinese county, four communities were selected to participate. 8,438 total households total were then surveyed via phone and in-person interviews in the summer of 2011 and were later followed up on a quarterly basis. The response rate from these surveys was 83.5% in urban regions and 96.8% in rural regions (Gan). We assume 56% of the Chinese population is urban according to 2016 Chinese population statistics presented by Worldometers.

Based off survey data, we set reasonable parameters for income replacement ratios, median and average household disposable income data and returns on higher education. Additional parameters, such as historical returns of the Shanghai Stock Exchange Composite Index, are also set based off other publically available sources including the Wall Street Journal.

The following target matrices represent data from the *China Household Finance Survey* and from a research presentation on Chinese household finance by Cooper and Zhu (2014). We categorize the data facts by rural and urban regions and derive their values based on data from these previously listed sources.

Table 2. Rural Data Facts

3.1 Rural Data Facts	**Bondholders**	**Stockholders**	***Higher Education Rate***
No Higher Education	94.96%	4.27%	**99.23%**
Higher Education	0.57%	0.21%	**0.78%**
Asset Market Participation Rate	**95.53%**	**4.48%**	

Table 3. Urban Data Facts

3.2 Urban Data Facts	Bondholders	Stockholders	*Higher Education Rate*
No Higher Education	86.41%	3.88%	**90.29%**
Higher Education	7.12%	2.59%	**9.71%**
Asset Market Participation Rate	**93.53%**	**6.47%**	

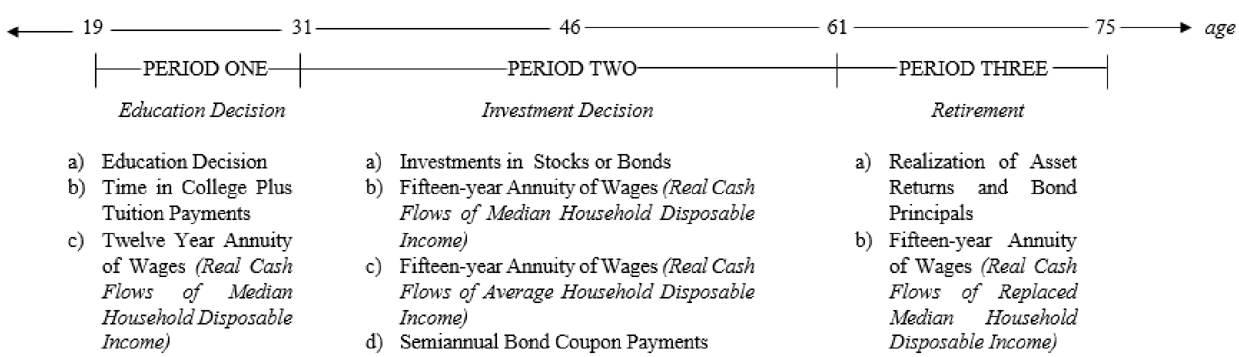
In order to simplify analysis, all non-stockholders are defined as bondholders. Therefore, the total number of bondholders in our model is inflated compared to actual data from the *China Household Finance Survey*.

4 Model

4.1 Three-Period Optimization Problem

This model accounts for joint education-and-investment decisions made by Chinese households over their expected lifetimes:

Figure 2. Chinese Household Finance Timeline



Period One: Higher Education Decision

a. Ages 19 – 30 (twelve-year period)

b. Higher education decisions made by households

    a. If households select higher education, then they incur tuition costs and the opportunity time cost of earning full, household disposable income during period one

c. Households earn median, household disposable income annually for twelve years, discounted by the expected inflation rate

Period Two: Investment Decision

a. Ages 31– 60 (thirty-year period)

b. Investment decisions made by households

    a. We assume households fully invest in either stocks or bonds

c. College-educated households receive returns on education through higher household disposable income

d. Households earn median, household disposable income for the first half of period two (fifteen-year sub-period)

e. Entry costs are applied to stock market participants and represent time costs of participation as portions of wages during the first fifteen years of period two

f. Households earn average, household disposable income annually for the second half of period two (fifteen-year sub-period). This represents a raise in real wages.

Period Three: Retirement

a. Ages 61 – 75 (fifteen-year period)
    a. Average Chinese life expectancies assumed to be 75 years
    b. Retirement age assumed to be 60 years
        i. in reality, retirement age for Chinese men is 60 years and for women is 55 years

b. Households realize compounded Chinese stocks returns or bond returns plus principal

c. Households earn median, household disposable income multiplied by an income replacement ratio

The goal of the estimated model is to simulate distributions of asset market participants across education levels and regions by fitting data facts from the *China Household Finance Survey* listed in **Section 2** to the model. We estimate parameters for average household ability, return on education, and the Pareto distribution parameter to fit the simulated model to the data facts.

In the following **Section 4.2**, Chinese households' utility-of-consumption functions are detailed. First-order conditions are solved in **Section 5.2** in order to maximize households' utility functions.

4.2 Utility Functions

Households' general utility functions, encapsulating both their education and household finance decisions, are given by the function below:

$$V_{b,0}\ (\theta) = max\ (\ ln(c_1) + [\beta \times ln(c_2)] + [(d \times \beta) \times ln(c_3)])\ )$$

The utility functions of the four cases listed below in **Table 4** are detailed in **Sections 4.3** through **4.6.** Explanations for parameter assumptions are provided in **Sections 4.3.1** through **4.3.7** and apply to cases, A, B, C, and D.

Table 4. Higher Education and Investment Cases

Case A	Stockholder and No Higher Education (s, e < 12)
Case B	Stockholder and Higher Education (s, e > 12)
Case C	Bondholder and No Higher Education (b, e < 12)
Case D	Bondholder and Higher Education (b, e > 12)

4.3 Case A: Stockholder and No Higher Education (s, e < 12)

$$V_{s,0}\,(\theta) = max\,(\,ln(c_1) + [\beta \times ln(c_2)] + [(d \times \beta) \times ln(c_3)]\,)$$

$$c_1 = \omega_1$$

$$c_2 = (\omega_2 \times f(\theta)) + \omega_3 - s$$

$$c_3 = (s \times R_s\,) + \gamma_{0,\boldsymbol{\omega_4}} \times \omega_4$$

a. Utility Function:

$$V_{s,0}\,(\theta) = max\,(\,ln(\omega_1) + [\beta \times ln((\omega_2 \times f(\theta)) + \omega_3 - s)] + [(d \times \beta) \times ln((s \times R_s\,) + (\gamma_{0,\boldsymbol{\omega_4}} \times \omega_4))]\,)$$

$$Where\ f(\theta) = \left(1 - \left(\frac{1}{\theta}\right)^{\alpha \times \frac{\theta}{\bar{\theta}}}\right)$$

In Case A, households receive twelve-year, present-value annuities of median, household disposable income, ω_1, during period one. At the beginning of period two, they make investments in stocks, s. Households incur stock market entry costs which are given by $(1 - f(\theta) \times \omega_2)$ which represents the time cost of participation taken as a percentage of ω_2, the fifteen-year, present-value annuities of median, household disposable income during the first fifteen years of period two. During the second half of period two, households receive a raise in wages which is stated by the present value of a fifteen year annuity of average, household disposable income, ω_3. In both urban and rural models, average household disposable income is greater than median household disposable income to account for a wage raise. Lastly, during period three, households replace part of their period-three, median household disposable income, ω_4, at a rate of $\gamma_{0,\boldsymbol{\omega_4}}$. Returns on stocks, R_s , are also realized during period three.

In **Sections 4.3.1** through **4.3.7**, we explain parameter assumptions related to Case A. These same assumptions also apply to Cases B, C, and D as discussed in **Sections 4.4** through **4.6.**

4.3.1 Variable of Household Heterogeneity

Table 5. Ability Variable

Variable	Description
$\boldsymbol{\theta_i}$	Ability

The heterogeneity in the model comes from a simulation of a normal distribution of household abilities. Both rural and urban models follow this distribution around an estimated, mean ability parameter, described in **Section 5.4**. Individual household abilities are used in calculations of returns on education by multiplying θ_i by $h(\bar{e})$, or the return-on-education estimated parameter (see **Section 4.3**). The ability variable is also incorporated into the calculation of stock market entry costs, as described below in **Section 4.3.2.** The domain of ability is $\theta_i > 0$.

4.3.2 Endogenous Variables

Table 6. Entry Cost Variable

Endogenous Variable	Description
$f(\theta) = \left(1 - \left(\frac{1}{\theta}\right)^{\alpha \times \frac{\theta}{\bar{\theta}}}\right)$	Time Cost of Participation (%)

Stock market entry costs are given by 1-*(time cost of participation)*, or 1 - $f(\theta)$. We multiply $f(\theta)$ by ω_2 to represent the time cost of stock market participation in terms of ω_2, or the accumulated household disposable income for the first half of period two (when the household investor is in between the ages of 31 and 45). The time cost of participation is given by a Pareto cumulative distribution function to estimate a range of stock market entry costs between 0 and 1. We set the numerator of the cumulative distribution function equal to 1. We then estimate parameters for the Pareto distribution parameter, α, and average ability, $\bar{\theta}$. Additionally, the α parameter is multiplied by $\frac{\theta}{\bar{\theta}}$ to generate higher kurtosis in the entry cost distribution. It is important to note that entry costs are only applied to stockholders and not bondholders in this model.

4.3.3 Unique Income Parameters

Table 7. Unique Income Parameters

Rural Chinese Model			Urban Chinese Model		
Parameter	**Description**	**Value**	**Parameter**	**Description**	**Value**
$\boldsymbol{\omega_{1,r}}$	Rural, median HH D.I. annuity (period 1)	¥ 235,428	$\boldsymbol{\omega_{1,u}}$	Urban, median HH D.I. annuity (period 1)	¥ 450,000
$\boldsymbol{\omega_{2,r}}$	Rural, median HH D.I. annuity (first half of period 2)	¥ 419,580	$\boldsymbol{\omega_{2,u}}$	Urban, median HH D.I. annuity (first half of period 2)	¥ 801,990
$\boldsymbol{\omega_{3,r}}$	Rural, median HH D.I. annuity (second half of period 2)	¥ 765,762	$\omega_{3,u}$	Urban, median HH D.I. annuity (second half of period 2)	¥ 1,709,715
$\boldsymbol{\omega_{4,r}}$	Rural, median HH D.I. annuity (period 3)	¥ 1,018,431	$\omega_{4,u}$	Urban, median HH D.I. annuity (period 3)	¥ 1,946,641

Major differences between the rural and urban models come from variations in the median and average household disposable income levels listed below in **Section 4.3.4.**

4.3.4 Rural model assumptions:

$\omega_{1,r}$ is based off the median disposable income value for rural Chinese households according to the *China Household Finance Survey* – ¥ 19,619 (Gan). We assume that real values of annual cash flows remain constant for twelve years. Therefore, we multiply the median household disposable income in rural China, ¥ 19,619, by 12 to calculate the aggregate rural household disposable income in period one, ¥ 235,428.

$\omega_{2,r}$ is also based off the median disposable income value for rural Chinese households. We assume that real values of annual cash flows remain constant for fifteen years. Therefore, we multiply the future value of median household disposable income at the start of period two, (¥ 19,619) x 1.03^{12}, by 15 to calculate the aggregate, rural household disposable income for the first half of period two, ¥ 419,580.

$\omega_{3,r}$ is based off the average disposable income value for rural Chinese households according to the *China Household Finance Survey* – ¥ 35,806 (Gan). By using average instead of median values, this represents a raise in wages halfway through period two. We assume that real values of annual cash flows remain constant for fifteen years. Therefore, we multiply the future value of average household disposable income at the start of period two, ¥ 35,806 x 1.03^{12}, by 15 to get the rural household disposable income for the second half of period two, ¥ 765,762.

$\omega_{4,r}$ is based off the median disposable income value for rural Chinese households – ¥ 19,619 (Gan). Assuming that real values of annual cash flows are constant for fifteen years, we multiply the future value of median household disposable income at the start of period three, ¥ 19,619 x 1.03^{42}, by 15 to get the rural household disposable income in period three, ¥ 1,018,431. It is important to note that $\omega_{4,r}$ is not the net household disposable income during retirement, since $\omega_{4,r}$ is multiplied by households' income replacement ratios specific to their education levels.

4.3.5 Urban model assumptions:

$\boldsymbol{\omega_{1,u}}$ is based off the median disposable income value for urban Chinese households according to the *China Household Finance Survey* – ¥ 37,500 (Gan). We assume that real values of annual cash flows remain constant for twelve years. Therefore, we multiply ¥ 37,500 by 12 to get the rural household disposable income in period one, ¥ 450,000.

$\boldsymbol{\omega_{2,u}}$ is also based off the median disposable income value for urban Chinese households. We assume that real values of annual cash flows remain constant for fifteen years. Therefore, we multiply the future value of median household disposable income at the start of period two, ¥ 37,500 x 1.03^{12}, by 15 to get the rural household disposable income for the first half of period two, ¥ 801,990.

$\omega_{3,u}$ is based off the average disposable income value for urban Chinese households according to the *China Household Finance Survey* – ¥ 79,944 (Gan). By using average household disposable income, this represents a raise wage halfway through period two. Assuming that real values of annual cash flows remain constant for fifteen years, we multiply the future value of average household disposable income at the start of period two, ¥ 79,944 x 1.03^{12}, by 15 to get the rural household disposable income for the second half of period two, ¥ 1,709,715.

$\omega_{4,u}$ is based off the median disposable income value for urban Chinese households - ¥ 37,500 (Gan). We assume that real values of annual cash flows remain constant for fifteen years. Therefore, we multiply the future value of median household disposable income at the start of period three, ¥ 37,500 x 1.03^{42}, by 15 to get the rural household disposable income in period three. It is important to note that this is not the net household disposable income during retirement, since the resulting income annuity values are multiplied by households' income replacement ratios given their education levels.

4.3.6 Consistent Parameters across Models

Table 8. Consistent Parameters across Models

Parameter	Description	Value	Parameter	Description	Value
β	Discount Rate	0.7014	γ_{e,ω_4}	Inc Rep Ratio (e > 12)	0.878
d	Compound Discount Rate	0.412	γ_{0,ω_4}	Inc Rep Ratio (e < 12)	0.688
v	Future Value Coefficient	2.427	i	Inflation Rate	0.03
R_s	Stock Returns	5.743	A_b	Bond Annuity Coefficient	34.631
$R_{b\,semi}$	Semiannual Yield	0.0215	$\bar{e}$	Time in College	0.33
C_b	Coupon Rate	0.0374	p	Total Tuition	¥ 80,000

Key: *HH = Household; D.I. = Disposable Income; Inc Rep Ratio = Income Replacement Ratio*

4.3.7 Parameter Assumptions

β discounts the future value of cash flows at the start of period two. It is calculated by $\frac{1}{(1+i)^{12}}$.

d , a compound discount factor, is multiplied by the discount rate β to discount the future value of cash flows at the start of period three. This value, d , is calculated by dividing the discount rate at the start of period three, $\frac{1}{(1+i)^{42}}$, by β .

$\boldsymbol{v}$ is calculated by $(1+i)^{30}$. $\boldsymbol{v}$ is a future value coefficient and is used to project the future value of semi-annual bond coupon payments at the start of period three.

$\boldsymbol{R_s}$ represents risk-adjusted, compound over thirty years. $\boldsymbol{R_s}$ is based off historical returns of the Shanghai Stock Exchange Composite Index (SHCOMP). We assume that stockholders do not diversify internationally and returns are solely based of SHCOMP historical returns. We calculate the average SHCOMP annual return from 1/4/00 (close) to 12/31/15 (close) to be approximately 9%. In order to calculate risk-adjusted, expected returns, we use the Sharpe Ratio, $\frac{r_{s-r_f}}{\sigma}$. As inputs to the Sharpe ratio, we use a risk-free rate of 3% based off an approximated, long-term average return of 10 year Chinese government bonds and a standard deviation assumed to be 1. Therefore, the risk-adjusted, expected annual return, 6%. This value is compounded over thirty years to approximate $\boldsymbol{R_s}$.

$\boldsymbol{R_{b\,semi}}$ is calculated by dividing the average Chinese 30-year bond yield from its close on 12/3/10 to its close on 3/25/16 by 2; $\left(\frac{4.310\%}{2}\right)$.

$\boldsymbol{C_b}$, the 30-year Chinese bond coupon rate, is based off the Chinese 30-year bond coupon rate as of 3/26/16.

$\boldsymbol{i}$, the rate of inflation, is based off the annual change in the Chinese consumer price index from February 2007 to February 2016.

$\boldsymbol{A_b}$ is a bond annuity coefficient given by $\frac{1-(1+i)^{-n}}{i}$. $\boldsymbol{A_b}$ is based off the cash flow coefficient from the equation for the present value of an annuity, where $PV = C \times \frac{1-(1+i)^{-n}}{i}$. Assuming semiannual bond payments, we insert $\boldsymbol{R_{b\,semi}}$ in for $\boldsymbol{i}$ and multiply n = 30 by 2 to calculate $\boldsymbol{A_b}$.

$\bar{\boldsymbol{e}}$ represents the average time spent in school by Chinese households. Assuming it takes four years to complete an undergraduate degree in China, the time spent in college would then be 4/12 or 33% with 12 representing the total years in period one.

$\boldsymbol{P}$, the average annual college tuition in China, is assumed to be ¥ 20,000 based on University World News. We assume the real value of the annual tuition is constant over the enrollment period due to tuition growth rates assumed to equal inflation. Since the average number of years in college is assumed to be four, we multiply ¥ 20,000 by 4 to estimate total tuition. We assume that households attend Chinese universities. This tuition rate also does not account for the tuitions of Chinese students studying abroad.

γ_e is based off data from the *China Household Finance Survey*.

γ_o is also based off data from the *China Household Finance Survey*.

4.4 Case B: Stockholder and Higher Education (s, e < 12)

$$V_{s,e}\ (\theta) = max\ (\ ln(c_1) + [\beta \times ln(c_2)] + [(d \times \beta) \times ln(c_3)]\ )$$

$$c_1 = \ (\omega_1 \times (1 - \bar{e})) - p$$

$$c_2 = \ (\omega_2 \times \mathrm{h}(\bar{e}) \times \theta \times f(\theta)) + (\omega_3 \times \mathrm{h}(\bar{e}) \times \theta) - s$$

$$c_3 = (s \times R_s\ ) + \ (\gamma_{e,\omega_4} \times \omega_4 \times \mathrm{h}(\bar{e}) \times \theta)$$

a. Utility Function:

$$V_{s,e}\ (\theta) = max\ (\ ln((\omega_1 \times (1 - \bar{e})) - p) + [\beta \times ln((\omega_2 \times \mathrm{h}(\bar{e}) \times \theta \times f(\theta)) + (\omega_3 \times \mathrm{h}(\bar{e}) \times \theta) - s)] + [(d \times \beta) \times ln(sR_s + (\gamma_{e,\omega_4} \times \omega_4 \times \mathrm{h}(\bar{e}) \times \theta))]\ )$$

$$Where\ f(\theta) = \left(1 - \left(\frac{1}{\theta}\right)^{\alpha \times \frac{\theta}{\bar{\theta}}}\right)$$

Unlike Case A, in Case B, stockholders pay four years of college tuition, p, as well as opportunity costs of time spent in school, $(\omega_1 \times (1 - \bar{e}))$, rather than earning their full potential income in period one. In period two, they receive 75% greater household disposable income values of ω_2 and ω_3 (based on the constraint that $\mathrm{h}(\bar{e}) \times \theta = 1.75$). Stock investments, s, are made at the start of period two and entry costs, $f(\theta)$, are applied to household disposable income earned during the first half of period two, ω_2. Lastly, during period three, households replace part of their median household disposable income, ω_4, at a rate of γ_{e,ω_4} Returns on stocks, R_s, are also realized at the start of period three.

Parameter assumptions as well as entry cost theory previously explained in **Sections 4.3.1** through **4.3.7** are still upheld in Cases B, C, and D.

4.5 Case C: Bondholder and No Higher Education (b, e < 12)

$$V_{b,0}\,(\theta) = max\ (\ ln(c_1) + [\beta \times ln(c_2)] + (d \times \beta) \times \ln(c_3)]\ )$$

$$c_1 = \ \omega_1$$

$$c_2 = \ \omega_2 + \omega_3 - b$$

$$c_3 = (\ b \times .5 \times C_b\ \times A_b \times v) + (\gamma_{0,\boldsymbol{\omega_4}} \times \omega_4) + b$$

a. Utility Function:

$$V_{b,0}\,(\theta) = max\ (\ ln(\omega_1) + [\beta \times ln(\omega_2 + \omega_3 - b)] + [(d \times \beta) \times ln((\ b \times .5 \times C_b\ \times A_b \times v) + (\gamma_{0,\boldsymbol{\omega_4}} \times \omega_4) + b)]\ )$$

$$Where\ A_b = \frac{1 - (1 + R_{b\ semi})^{(-2 \times n)}}{2 \times n}$$

$$And\ v = (1 + i)^n$$

In Case C, households receive twelve-year, present-value annuities of median, household disposable income, ω_1, during period one. During period two, they receive fifteen-year annuities based on median household disposable income values, ω_2, and fifteen year annuities based on average household disposable income values, ω_3. Bond investments, b, are made at the start of period two and no entry costs are applied. During period three, households replace part of the present-value annuities of median, household disposable income ω_4 at a rate of $\gamma_{0,\boldsymbol{\omega_4}}$. Present-value sums of semiannual coupon payments, as well as bond principal values, are also realized at the start of period three, given by $(b \times .5 \times C_b \times A_b \times v)$ and b, respectively.

Note: parameter assumptions as well as entry cost theory explained in **Sections 4.3.1** through **4.3.7** are upheld in Case C.

4.6 Case D: Bondholder and Higher Education (b, e > 12)

$$V_{b,e}(\theta) = max\ (\ ln(c_1) + [\beta \times ln(c_2)] + [(d \times \beta) \times ln(c_3)]\ )$$

$$c_1 = (\omega_1 \times (1 - \bar{e})) - p$$

$$c_2 = (\omega_2 \times \mathrm{h}(\bar{e}) \times \theta) + (\omega_3 \times \mathrm{h}(\bar{e}) \times \theta) - b$$

$$c_3 = (\ b \times .5 \times C_b \times A_b \times v) + (\gamma_{e,\omega_4} \times \omega_4 \times \mathrm{h}(\bar{e}) \times \theta) + b$$

a. Utility Function:

$$V_{b,e}(\theta) = max\ (\ ln((\omega_1 \times (1 - \bar{e})) - p) + [\beta \times ln((\omega_2 \times \mathrm{h}(\bar{e}) \times \theta) + (\omega_3 \times \mathrm{h}(\bar{e}) \times \theta) - b)] + \left[(d \times \beta) \times \ln\left((\ b \times .5 \times C_b \times A_b \times v) + (\gamma_{e,\omega_4} \times \omega_4 \times \mathrm{h}(\bar{e}) \times \theta) + b\right)\right]\ )$$

$$Where\ A_b = \frac{1 - (1 + R_{b\ semi})^{(-2 \times n)}}{2 \times n}$$

$$And\ v = (1 + i)^n$$

In Case D, bondholders pay four years of college tuition, p, as well as opportunity costs of time spent in school $(\omega_1 \times (1 - \bar{e}))$ rather than earning their full potential income in period one. In period two, they receive 75% greater household disposable income values of ω_2 and ω_3 (subject to the constraint that $\mathrm{h}(\bar{e}) \times \theta = 1.75$). Bond investments, b, are made at the beginning of period two and no entry costs are necessary. Lastly, households replace part of the present-value annuities of median, household disposable income, ω_4, during retirement (period three) at a rate of γ_{e,ω_4}.

Present-value sums of semiannual coupon payments, ($b \times .5 \times C_b \times A_b \times v$), as well as bond principal values, b, are also realized at the start of period three.

Note: parameter assumptions as well as entry cost theory explained in **Sections 4.3.1** through **4.3.7** are upheld.

4.7 General parameter assumptions

Education decision parameters are set with respect to period one; investment decision parameters are set with respect to period two; and lastly, retirement parameters are set with respect to period three. Reasonable parameters are set based off historical data. Since households realize cash flows as future values, annual income and expenses are therefore discounted by the Chinese rate of inflation, which is estimated by long-term, average annual changes in the Chinese consumer price index.

We assume the rate of growth in household disposable income is equal to the rate of inflation. Therefore, the real values of annual household disposable income are held constant throughout each income annuity cycle given by $\boldsymbol{\omega_1}, \boldsymbol{\omega_2}, \boldsymbol{\omega_3},$ and $\boldsymbol{\omega_4}$. Household disposable income parameters are used rather than wage parameters since our model incorporates utility-of-consumption functions.

In this model, households' investment periods occur from ages 31-60 (period two). Stockholders receive capital gains on stocks at a risk-adjusted compound rate of return. They also do not receive dividend payments. On the other hand, bondholders receive semiannual bond coupons at retirement.

5 Analysis

5.1 Utility Maximization Variables

Table 9. Utility Maximization Variables

Utility Maximizing Variable	Description
s^*	Utility-Maximizing Stock Investment (¥)
b^*	Utility-Maximizing Bond Investment (¥)
V	Maximum Utility Value

First, we solve for the utility-maximizing investment quantities, either s^*or b^*, and then reinsert those values into their respective utility functions to optimize households' lifetime utilities, given by V. In this model, households maximize their utility of consumption by choosing desired levels of higher education attainment and investment quantities in stocks or bonds.

Below are the first-order conditions applicable to households' expected utility functions. The utility-maximizing investment quantities are solved using differential calculus to solve for simple logarithmic derivatives. The utility functions are maximized by substituting the first-order condition levels of stock and bond investments above into their respective utility functions. The maximized utility functions are then compared to one another to determine which outcome would generate the highest expected utility value and therefore indicate the optimal education-and-investment joint decision for each household.

5.2 Utility Maximization

5.3 Case A: Stockholder and No Higher Education (s, e < 12)

$$V_{s,0}\ (\theta) = max\ (\ ln(\omega_1) + [\beta \times ln((\omega_2 \times f(\theta)) + \omega_3 - s)] + [(d \times \beta) \times ln((s \times R_s\ ) + (\gamma_{0,\boldsymbol{\omega_4}} \times \omega_4))]\ )$$

First-Order Condition:

$$FOC\ \rightarrow\ s_{s,0}{}^{*} = \frac{(\omega_2 \times\ d \times R_s \times f(\theta)) + (\omega_3 \times d \times R_s) - (\gamma_{0,\boldsymbol{\omega_4}} \times\ \omega_4)}{R_s + d \times R_s}$$

$$Where\ f(\theta) = \left(1 - \left(\frac{1}{\theta}\right)^{\alpha \times \frac{\theta}{\bar{\theta}}}\right)$$

At levels of stock investment $\boldsymbol{s_{s,0}}^{*}$ in yuan, non-college-educated stockholders minimize the tradeoffs between their marginal costs of stock investing and their marginal benefits of expected lifetime stock returns.

5.4 Case B: Stockholder and Higher Education (s, e > 12)

$$V_{s,e}\ (\theta) = max\ (\ ln((\omega_1 \times (1-\bar{e})) - p) + [\beta \times ln((\omega_2 \times \mathrm{h}(\bar{e}) \times \theta \times f(\theta)) + (\omega_3 \times \mathrm{h}(\bar{e}) \times \theta) - s)] + [(d \times \beta) \times ln(sR_s + (\gamma_{e,\omega_4} \times \omega_4 \times \mathrm{h}(\bar{e}) \times \theta))])$$

First-Order Condition:

$$FOC \ \rightarrow \ {s_{s,e}}^{*} \ =$$

$$\frac{(d \times R_s \times \omega_2 \times \mathrm{h}(\bar{e}) \times \theta \times f(\theta)) + (d \times R_s \times \omega_3 \times \mathrm{h}(\bar{e}) \times \theta) - (\gamma_{e,\omega_4} \times \omega_4 \times \mathrm{h}(\bar{e}) \times \theta)}{R_s + R_s \times d}$$

$$Where\ f(\theta) = \left(1 - \left(\frac{1}{\theta}\right)^{\alpha \times \frac{\theta}{\bar{\theta}}}\right)$$

At levels of stock investment $\boldsymbol{{s_{s,e}}^{*}}$ in yuan, college-educated stockholders minimize the tradeoffs between their marginal costs of tuition, time spent in school, and stock investments with their marginal benefits of receiving returns on education and expected stock returns.

5.5 Case C: Bondholder and No Higher Education (b, e < 12)

$$V_{b,0}\ (\theta) = max\ \ (\ ln(\omega_1) + [\beta \times ln(\omega_2 + \omega_3 - b)] + [(d \times \beta) \times ln((\ b \times .5 \times C_b \times A_b \times v) + (\gamma_{0,\boldsymbol{\omega_4}} \times \omega_4) + b)]\ )$$

First-Order Condition:

$$FOC\ \rightarrow\ b_{b,0}{}^{*} =$$

$$\frac{-(\gamma_{0,\boldsymbol{\omega_4}} \times \omega_4) + (.5 \times C_b\ \times A_b \times v \times d \times \omega_2) + (d \times \omega_2) + (.5 \times C_b\ \times A_b \times v \times d \times \omega_3) + (d \times \omega_3)}{(.5 \times C_b\ \times A_b \times v) + 1 + (.5 \times C_b\ \times A_b \times v \times d) + d}$$

$$Where\ A_b = \frac{1 - (1 + R_{b\ semi})^{(-2 \times n)}}{2 \times n}$$

$$And\ v = (1 + i)^n$$

At levels of bond investment $\boldsymbol{b_{b,0}}^{*}$ in yuan, non-college-educated bondholders minimize the tradeoffs between their marginal costs of bond investments with their marginal benefits of expected, thirty-year bond returns.

5.6 Case D: Bondholder with higher education (b, e < 12)

$$V_{b,e}\,(\theta) = max\ \left(ln((\omega_1 \times (1 - \bar{e})) - p) + [\beta \times ln((\omega_2 \times \mathrm{h}(\bar{e}) \times \theta) + (\omega_3 \times \mathrm{h}(\bar{e}) \times \theta) - b)] + \left[(d \times \beta) \times \ln\left((b \times .5 \times C_b \times A_b \times v) + (\gamma_{e,\omega_4} \times \omega_4 \times \mathrm{h}(\bar{e}) \times \theta) + b\right)\right]\right)$$

First-Order Condition:

$$FOC \rightarrow b_{b,e}{}^{*} = \frac{-(\gamma_{e,\omega_4} \times \omega_4 \times h(e^{-}) \times \theta) + (.5 \times C_b \times A_b \times v \times d \times \omega_2 \times h(e^{-}) \times \theta) + (d \times \omega_2 \times h(e^{-}) \times \theta) + (.5 \times C_b \times A_b \times v \times d \times \omega_3 \times h(e^{-}) \times \theta) + (d \times \omega_3 \times h(e^{-}) \times \theta)}{(.5 \times C_b \times A_b \times v) + 1 + (.5 \times C_b \times A_b \times v \times d) + d}$$

$$Where\ A_b = \frac{1 - (1 + R_{b\,semi})^{(-2 \times n)}}{2 \times n}$$

$$And\ v = (1 + i)^n$$

At levels of bond investment of $\boldsymbol{b_{b,e}}^{*}$ in yuan, college-educated bondholders minimize the tradeoffs between their marginal costs of tuition, time spent in school, and bond investments with their marginal benefits of receiving returns on education and expected future bond returns.

5.7 Model Estimation

We create this three-period, lifetime model simulation using a Microsoft Excel spreadsheet. 8,438 households are randomly generated for both rural and urban regions. Households' abilities follow a normal distribution and are generated using Excel's RAND function and the normal distribution generator =MAX(-5,NORM.INV(RAND(),[insert σ here] ,1)).

The objective of the estimated model is to fit the simulated model to the target rural and urban data facts from **Section 2**. We achieve this by estimating parameters below for average household ability, return on education, and the Pareto distribution factor, $\boldsymbol{\alpha}$.

5.7.1 Estimated Parameters

Table 10. Estimated Parameters

Estimated Parameter	**Description**
$\bar{\theta}$	Mean Household Ability
$h(\bar{e})$	Return on Education
α	Pareto Distribution Parameter

The normal distribution of abilities is set around an estimated, mean household ability, $\bar{\theta}$. The return on education variable, $h(\bar{e})$, is multiplied by θ_i for each unique household and is subject to the constraint that $h(\bar{e})$ x $\bar{\theta}$ = 1.75. The 1.75 value represents a 75% return on higher education for the average, college-educated household.

$h(\bar{e})$, $\bar{\theta}$, and α are estimated to fit the model to the Chinese Household Finance Survey data. The following **Sections 5.8** and **5.9** show the results of our model estimation in relation to the original data facts from **Section 2.**

5.8 Rural Model Estimation

Table 11. Rural Data Facts

5.8.1 Rural Data Facts	**Bondholders**	**Stockholders**	***Higher Education Rate***
No Higher Education	94.96%	4.27%	**99.23%**
Higher Education	0.57%	0.21%	**0.78%**
Asset Market Participation Rate	**95.53%**	**4.48%**	

Table 12. Rural Simulation Results

5.8.2 Rural Simulation	**Bondholders**	**Stockholders**	***Higher Education Rate***
No Higher Education	95.33%	4.43%	**99.76%**
Higher Education	0.00%	0.23%	**0.23%**
Asset Market Participation Rate	**95.33%**	**4.66%**	

Where estimated parameters are given by:
$h(\bar{e})$ = *Return on Education* = 0.449
θ = *Average Ability* = 3.9
α = *Pareto Distribution Factor (CDF)* = 0.405

Note: subject to the constraint that the product of $h(\bar{e})$ and θ is 1.75.

5.9 Urban Model Estimation

Table 13. Urban Data Facts

5.9.1 Urban Data Facts	**Bondholders**	**Stockholders**	***Higher Education Rate***
No Higher Education	86.41%	3.88%	**90.29%**
Higher Education	7.12%	2.59%	**9.71%**
Asset Market Participation Rate	**93.53%**	**6.47%**	

Table 14. Urban Simulation Results

5.9.2 Urban Simulation	**Bondholders**	**Stockholders**	***Higher Education Rate***
No Higher Education	82.22%	3.89%	**86.11%**
Higher Education	11.22%	2.47%	**13.69%**
Asset Market Participation Rate	**93.44%**	**6.36%**	

Where estimated parameters are given by:

$h(\bar{e})$ = *Return on Education* = 0.219

θ = *Average Ability* = 7.99

α = *Pareto distribution factor* = 0.340

Subject to the constraint that the product of $h(\bar{e})$ and θ is 1.75.

5.10 Estimated Stock Market Entry Costs

Based on the rural model, we estimate the time cost of participation for rural stockholders without higher education to be approximately 35% of their median household disposable income earned from ages 31-45 in period two, or 35% × ¥ 419,580 = ¥ 146,853 for opportunity costs of period two wages. This would represent ¥ 9,790.20 in annual entry costs over the fifteen-year period. Converted to USD at an exchange rate of 6.48 yuan = 1 USD, this would be $1,510.83 in annual entry costs. Discounted back to its present value twelve years earlier, the entry costs for non-college educated, rural for rural stockholders without higher education would be $1,059.67 annually for fifteen years.

On the other hand, we estimate the time cost of participation of rural stockholders with higher education to be approximately 25% of their median household disposable income earned from ages 31-45 in period two, or 25% × ¥ 419,580 = ¥ 104,895 for opportunity costs of period two wages. This would represent a ¥ 6,993.00 in annual entry costs over a fifteen-year period. Converted to USD at an exchange rate of 6.48 yuan = 1 USD, this would be $1,079.17 in annual entry costs. Discounted back to its present value twelve years earlier, the annual stock market entry cost for college-educated, rural stockholders with higher education would be $756.91, annually for over fifteen years.

Now turning to the urban model, we estimate the time cost of participation of urban stockholders without higher education to be approximately 43% of their median household disposable income earned from ages 31-45 in period two, or 43% × ¥ 801,990 = ¥ 344,855.70 for opportunity costs of period two wages. This would represent ¥ 22,990 in annual entry costs estimated on an annualized basis over a fifteen-year period. Converted to USD at an exchange rate of 6.48 yuan = 1 USD, this would be $3,548 in annual entry costs. Discounted back to its present value twelve years earlier, the annual stock market entry cost for rural stockholders without higher education over a fifteen-year period would be $2,488.42 annually.

Lastly, we estimate the time cost of participation of urban stockholders with higher education to be approximately 37% of their median household disposable income earned from ages 31-45 in period two, or 37% × ¥ 801,990 = ¥ 296,736.30 for opportunity costs of period two wages. This would represent ¥ 19,782.42 in annual entry costs over a fifteen-year period. Converted to USD at an exchange rate of 6.48 yuan = 1 USD, this would be $3,052.84 in annual entry costs. Discounted back to its present value twelve years earlier, the annual stock market entry cost for rural stockholders with higher education over a fifteen-year period would be $2,141.20 annually.

Table 15. Stock Market Entry Cost Estimates

	Rural	Urban
No Higher Education	$1,059.67	$2,488.42
Higher Education	$756.91	$2,141.20

Note: entry costs include only stockholders. Table values are presented on a present-value, annualized basis in USD. According to the *China Household Finance Survey*, stockholders only represent 4.48% and 6.47% of the rural and urban populations, respectively.

6 Conclusion

6.1 Results

We calculate an inverse relationship between stock market entry costs and household abilities. In both urban and rural models, it is noticeable that higher-ability, more-educated households are typically those that gravitate towards stock markets due to decreased entry costs. The majority of households in both rural and urban models favor bondholding without higher education (94.96% in rural and 86.41% in urban China). Based off the normal distribution of ability, the model predicts that stockholders in the urban model are approximately one standard deviation away from the estimated mean ability, or in the 84th percentile or greater of ability. On the other hand, in the rural model, stockholders' abilities are typically two standard deviations away from the estimated mean ability, or in roughly the 98th percentile of ability. This finding would explain why stockholders from rural China are typically of elite ability relative to others in their population segment.

Unexpectedly, we also calculate that stock market entry costs are greater for urban than rural households. This result is surprising since urban Chinese households typically have easier access to stock markets. Since stock market entry costs are linked to households' disposable income in this estimated model, it would make sense that urban households would actually have greater opportunity costs of time spent searching to invest in stocks since they are giving up more in terms of higher disposable income.

If urban households have greater stock market entry costs than rural households according to the estimated model, then we can conclude that entry costs do not play a major role in explaining why there are more urban than rural stockholders in the data from the *China Household Finance*

Survey. According to the estimated model, a primary driver of a greater percentage of urban than rural stockholders is due to higher, average household disposable income among urban Chinese households. This result is consistent with Cooper and Zhu's (2014) finding that mean income is a strong determinant of stock market participation rates. Differences in households' disposable income levels among rural and urban Chinese households was a major differentiator between the two estimated models. This income difference incentivizes urban households to be more inclined to participate in stock markets relative to rural households.

Urban households are typically of higher ability than rural households and are more likely to pursue higher education. Higher-educated populations within both rural and urban populations typically have lower entry costs relative to their peers. Lastly, both college-educated and non-college educated households in urban China have easier access to markets than their urban counterparts.

6.2 Limitations

Limitations to the estimated model include that stock returns, bond returns, and inflation parameters are all based off historical prices, typically within the past fifteen years. Therefore, this lifetime model should not be used as a predictor for short-term, asset market returns. Similarly, since these parameters are based off historical returns, this does not guarantee that the previous rates of return will be carried forward into the future.

Additional limitations come from parameter assumptions that do not account for all sample data fluctuations. For example, households with master's degrees typically have 73% greater, average household disposable income than households with bachelor's degree according to the

China Household Finance Survey. However, in our estimated model, master's students and bachelor's students are grouped in the same category. Furthermore, in the case of stock returns, an additional limitation is that stock returns are only assessed off capital gains and dividends are not factored into returns.

A final limitation to the model is that the rural model estimation of **Section 5.8.2** does not bring up results for college-educated bondholders, given by Case D. This shows how this three-period model is an indicator of general relationships between higher education and Chinese households; however, the model does not exactly match the target data facts from the *China Household Finance Survey*. Estimated data for entry costs and utility-maximizing points of bond and stock investments should therefore be mainly assessed by their relative and not exact values.

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