

Household Finance in China*

Russell Cooper[†] and Guozhong Zhu[‡]

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Abstract

This paper studies household finance in China, focusing on the high saving rate, the low participation rate in the equity market, and the low equity share in household portfolios. These salient features are studied in a lifecycle model in which households are heterogenous in age, income, education and health status. Parameters of the structural model are estimated to match the financial decision patterns of different education groups. The estimation explicitly takes into account important structural changes in China, such as the re-opening of the stock market around 1990, the privatization of housing markets and the completion of state-owned enterprise reform at around 2000. The effects of these structural changes on household finance are further studied in the counterfactual analysis. The paper also compares household finance patterns in China to those obtained from a parallel study using US data, and show that between-country differences in time preference and elasticity of inter-temporal substitution explain the larger part of differences in household finance patterns. The higher entry cost of the equity market and lower consumption floor in China also play important roles in explaining the cross-country differences.

1 Introduction

As is well understood, Chinese households tend to save more than their US counterparts.¹ As a result, total household net worth in China as a percentage of that of the US household rose from 10.6% in 2002 to 47% in 2012.

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[†]Department of Economics, the Pennsylvania State University and NBER, russellcoop@gmail.com

[‡]School of Business, University of Alberta, guozhong@ualberta.ca

¹For examples, see Wei and Zhang (2011), Curtis, Lugauer, and Mark (2015) and Jin and Coeurdacier (2016).

²In 2002, total household net worth is 4.01 billions of USD (3128.8 USD per person) as documented in Li and Zhao (2008). In 2012, total net worth in China is 181.3 trillion Yuan (29.1 trillion USD) based on China Family Panel Studies, documented in Xie and Jin (2015). Total net worth for the US is 37.8 USD in 2002 and 62 trillion USD in 2012 according to the Federal Reserve Board Flow of Fund Accounts. Using China Household Finance Survey data, Gan, Yin, Jia, Xu, Ma, and Zheng (2013) estimates a much higher net worth for China in 2012: 69.1 trillion USD.

This paper studies the high wealth accumulation and its composition of Chinese households. The analysis focuses on the following features of Chinese household financial choices: (i) low participation rates in the stock market, (ii) low shares of wealth in the stock market condition on participation, and (iii) high wealth-to-income ratios. Relative to the US household finance patterns, which serve as a benchmark in our analysis, the low participation rates and high wealth-to-income ratios in China are particularly striking as shown in Table 1. The unique features have at least three contributing factors: the major structural changes experienced by the Chinese households, the underdeveloped equity market and social safety net in China, and the different time preference and/or risk preference of Chinese household compared to those of the US households. This paper studies the relative importance of these factors in a model of household's optimal decisions over the lifecycle.

The model is estimated via the Simulated Method of Moments, exploiting the variations of household finance patterns by education attainment and age. The estimation is challenging for a few reasons. First, there is only one single cross section of household data publicly available for China with enough details and coverage to study financial choices – the 2012 CHFS.³ Second, substantial cohort effects exist because households in the single cross sectional data have experienced important structural changes at different stages in their lives. For example, the cohort aged 40 in the survey were college age when the stock market in China re-opened around 1990 so their financial decisions are little affected by this structural change, but they should be strongly affected by the housing reform around 2000 when they were 30, an age of home purchases. On the other hand, the cohort aged 65 in the survey should be little affected by the housing reform because they were retiring around 2000, but their financial decisions should be strongly affected by the re-opening of stock market around 1990 when they were 45, an age when portfolio investment is an important decision.

A novel element of our analysis is to design an estimation strategy to cope with the cohort effect resulting from multiple structural changes in China using a single cross section of data. Specifically, for different cohorts in the 2012 CHFS, we solve their lifecycle optimization problem, taking the structural changes at different ages explicitly into account. Then we calculate their household finance moments in 2012 which summarizes the effects of various structural changes that are cohort-specific. These moments are comparable to the data counterparts which also summarizes the cohort-specific impacts of the structural changes. Therefore the cohort effect does not bias our estimation results which are based on matching the moments from the model and the data.

Chinese household finance patterns vary considerably with education, income, sector of employment and region (urban versus rural). In the structural estimation we focus on the heterogeneity by education for a number of reasons. First, education is highly correlated with the other variables. Better educated households typically have higher income, live in urban area and have high percentage of employment with the state sector. Second, the college premium has changed significantly over time and the changes are taken into account when the model admits heterogeneity in education attainment. Third, the results are compared with a parallel study on the US household finance, i.e. Cooper and Zhu (2015), where heterogeneity in education is also explicit. We also carry out structural estimation with heterogeneity by region or sector of employment.

³CHFS conducted several follow-up surveys since 2012, but only the 2012 wave is publicly available.

Using the estimated model, we study the quantitative effect of structural changes in China on household financial choices. Counterfactual analysis reveals that housing reform has a much larger impact than other structural changes. Without the privatization of housing market and the ensuing house price run-up, the equity market participation rate and equity share in total wealth would both be significantly higher, but the wealth-income ratio would be much lower. The changes of income processes resulting from SOE reforms and other reforms also play a role in shaping the household finance patterns. Using the pre-2000 income processes which feature lower income uncertainty, households would have lower participation rate, lower equity share and lower wealth-income ratio, which is consistent with the predictions of precautionary saving theory. We also show that the return on housing and to a lesser extent changes in income processes have had a large impact on the wealth distribution in China.

We isolate the more important drivers of the large difference between China and the US in household finance patterns. Between-country differences in time preferences and elasticity of inter-temporal substitution explain a large part of differences in household finance patterns. The estimation reveals that better educated households in China tend to be significantly more patient than less educated households, with a discount factor of 0.946 for the former and 0.834 for the latter. As a comparison, the corresponding discount factors are 0.887 and 0.868 based on the US data. The equity market underdevelopment, represented by the high entry cost and the high volatility of stock return, also contribute to the large cross-country differences.

The rest of the paper is organized as follows. Section 2 presents data facts about household finance in China and compares them with the US household finance patterns. Section 3 introduces the structural model in which the optimization problem of households and the key market frictions are laid out. Section 4 discusses the estimation strategy. Section 5 reports estimation results both from the baseline case and from the robustness analysis. Section 6 further studies how the structural has shaped household finance patterns and wealth distribution in China. Section 7 studies what are the more important factors contributing to the large difference between China and the US. Section 8 concludes.

2 Data Facts

This section presents facts about household financial decisions, for both China and the US.⁴ As household decisions are driven, in part, by the processes for income and medical expenses, these are presented as well. For both China and the US, the processes and financial decisions are presented for two educational attainment levels: (i) high school and below (≤ 12) and (ii) beyond high school (> 12).

2.1 Patterns of Household Finance: China

The patterns of household financial decisions are shown in Table 1. The moments for China are computed from the Chinese Household Financial Survey conducted in 2011, described in the Appendix.⁵

⁴Further details for China are in the Appendix. Further details for the US are contained in Cooper and Zhu (2015).

⁵Calculation of these moments for the US is presented in Cooper and Zhu (2015).

Table 1: Household Facts by Education and Age

Age Education	China				US			
	Pre-retirement Low	High	Post-retirement Low	High	Pre-retirement Low	High	Post-retirement Low	High
part.	0.075 (0.01)	0.337 (0.012)	0.070 (0.011)	0.229 (0.021)	0.174 (0.01)	0.550 (0.004)	0.209 (0.011)	0.646 (0.004)
share	0.435 (0.039)	0.502 (0.024)	0.511 (0.046)	0.515 (0.043)	0.522 (0.021)	0.572 (0.003)	0.444 (0.02)	0.551 (0.003)
share(h)	0.126 (0.023)	0.135 (0.014)	0.085 (0.026)	0.172 (0.025)	0.258 (0.025)	0.379 (0.015)	0.232 (0.015)	0.364 (0.003)
W/I	1.580 (0.199)	2.038 (0.235)	1.363 (0.217)	2.473 (0.398)	0.071 (0.039)	0.377 (0.04)	0.500 (0.158)	2.805 (0.078)
W/I(h)	11.169 (1.112)	17.137 (1.308)	14.502 (1.206)	17.756 (2.216)	0.313 (0.124)	1.260 (0.107)	3.867 (0.431)	6.454 (0.144)

This table displays the participation rate (direct and indirect stock holdings), the share of stocks (for participants), the mean wealth income ratio (W/I) for Chinese and US households by age and education group. Data for China is from the CHFS. Data for the US is from the SCF. Households whose heads have at least high school diploma are defined as high education households which account for 89% of the US households in SCF sample and 36.4% of the Chinese households in CHFS.

Detailed information about the CHFS is available at <http://www.chfsdata.org/>. The intent of the survey was to gather household finance information from the individuals with most knowledge about their household’s financial status. For each household in the sample, the survey identifies a respondent which is defined as the member who knows best about a household’s financial situation.⁶ For 86.22% of the households in the survey, the respondents and their spouses make decisions regarding stock market investment.⁷

We focus on three dimensions of household financial decisions: (i) the participation rate, (ii) the share of stock in the household portfolio conditional on participating in asset markets, and (iii) a ratio of wealth to income. The table presents two measures of these last two ratios. One, labeled ‘share(h)’ is the stock share relative to the sum of financial and housing wealth while ‘share’ is just stocks relative to financial wealth. Likewise, ‘W/I(h)’, includes housing in wealth. The other measure, ‘W/I’ excludes housing wealth, thus focusing on financial wealth.

These moments are presented for two education groups. One, termed low education, is for households with less than 12 years of education and the other, termed high education, is for households with 12 or more years of education.⁸ Further, the moments are presented for two components of the life cycle: before and after retirement. One should keep in mind that these are the averages without any control for cohort, year or housing effects. These effects will be addressed in detail in the estimation.

As is well appreciated, the wealth to income ratio is higher in China than in the US for various representations of the data. For example, the median wealth to income ratio for low education workers is about 10 times higher than in the US when housing is included in wealth. The wealth to income ratio is also higher for post-retirement

⁶See question [A1013] in the questionnaire.

⁷This is calculated from question [D3112] in the survey.

⁸In CHFS2012, only 0.9% of the individuals have post-graduate education and only 7.4% have bachelor’s degrees. So a finer breakdown by education attainment is not feasible for Chinese households. Thus the estimation results are not directly comparable to those reported in Cooper and Zhu (2015) for the US households.

households though the differences across countries by education group are not as stark. Once housing is excluded from wealth, the wealth to income ratios naturally are lower. It is noteworthy that housing is a much more important component of wealth for Chinese households, particularly the less educated. Table 1 makes clear that the manner of wealth accumulation also differs across these countries. This difference is a key part of our analysis.

The asset market participation rate (both direct and indirect holdings) is much lower in China. This is the case for all age and education groups. In China, as in the US, participation rises with education attainment but, unlike the US, is lower for retirees.

Table 2: by Total Family Income Group

	part.	share	W/I	share(h)	W/I(h)	home owner- ship rate	age	fraction of high-edu
lower 10%	0.029 (0.006)	0.375 (0.012)	3.70 (0.59)	0.100 (0.005)	52.83 (7.04)	0.86 (0.01)	55.00 (0.52)	0.13 (0.01)
median	0.088 (0.028)	0.608 (0.034)	0.70 (0.12)	0.118 (0.013)	7.58 (1.3)	0.85 (0.04)	49.11 (1.14)	0.31 (0.05)
top 10%	0.425 (0.019)	0.490 (0.011)	1.28 (0.09)	0.117 (0.006)	8.67 (0.38)	0.79 (0.02)	44.14 (0.45)	0.71 (0.02)
top 1%	0.500 (0.059)	0.490 (0.036)	1.33 (0.36)	0.178 (0.025)	4.07 (0.55)	0.69 (0.05)	42.53 (1.24)	0.76 (0.05)

This table displays household choices by income groups in China. Standard errors are reported in parenthesis. The statistics of median income households are based on 100 households in the sample whose income is closest to sample median income

The stock share of US households, defined as the share of stock in total financial assets for participants, is almost double that of Chinese households. For both countries, the stock share rises with education, though this effect is barely evident for pre-retirement Chinese households.

The tables that follow present different dimensions of household financial decisions in China. Table 2 shows these choices by family income. Clearly the participation rate rises with the level of family income. Households with the bottom 10 percentile income have significantly higher wealth-income ratio than the other groups, which is partly caused by the high degree of income uncertainty in China – the low income household observed in the survey could have had high income earlier. In addition, the education premium was much lower pre-2000, so a low income household in CHFS2012 may have been high income one in 1990s and accumulated a large stock of wealth.

There are also potentially interesting differences conditioning on the sector of employment. In particular, households with employment in the public sector may have more stable income and higher benefits.⁹ Table 3 shows financial decisions for public and private sector workers. The wealth to income ratio is actually higher for public sector workers as is the participation rate.¹⁰ These workers tend, on average, to have higher education attainment compare to private sector workers. This translates into a higher participation rate as well as a higher wealth to income ratio and more homeownership.

⁹See the discussion of this point and related references in He, Huang, Liu, and Zhu (2014).

¹⁰Only 28.6% of respondents in the sample provide valid information on their sector of employment, among them 17.9% are rural residents.

Table 3: Sectors and Regions

	part.	share	W/I	share(h)	W/I(h)	home owner- ship rate	age	fraction of high-ed
public	0.316 (0.014)	0.514 (0.01)	1.22 (0.09)	0.129 (0.006)	11.17 (0.57)	0.86 (0.01)	42.25 (0.29)	0.81 (0.01)
private	0.145 (0.011)	0.498 (0.009)	0.76 (0.05)	0.124 (0.006)	10.03 (0.56)	0.76 (0.01)	41.73 (0.3)	0.42 (0.02)
urban	0.185 (0.006)	0.512 (0.005)	1.64 (0.11)	0.125 (0.003)	19.02 (1.06)	0.81 (0.01)	49.10 (0.21)	0.50 (0.01)
rural	0.027 (0.003)	0.468 (0.006)	0.72 (0.04)	0.118 (0.003)	9.43 (1.03)	0.94 (0.004)	52.25 (0.23)	0.14 (0.01)

This table displays household finance by employment sector. Public sector employees include those employed by the government and state-owned enterprises. Private sector includes workers in rural area, collectively owned firms, private firms and firms with joint ownership with foreigners.

Another potentially important distinction is between urban and rural households. The bottom panel of Table 3 summarizes household financial decisions by region. The participation rate is much higher in the urban sector as is the wealth to income ratio. The homeownership rate is higher in the rural sector. Further, the fraction of high education households is significantly higher in the urban sector.

2.2 Patterns of Household Finance: US

The basic facts and moment for US household finance are taken from Cooper and Zhu (2015). For that analysis, the data moments included the participation rate, stock share, wealth to income ratio, as in the data from China. In addition, the estimation made use of information on the frequency of stock adjustment. Finally, the US analysis contained a finer breakdown of household choice by education attainment: (i) less than 12, (ii) exactly 12, (iii) between 12 and 16, and (iv) in excess of 16.

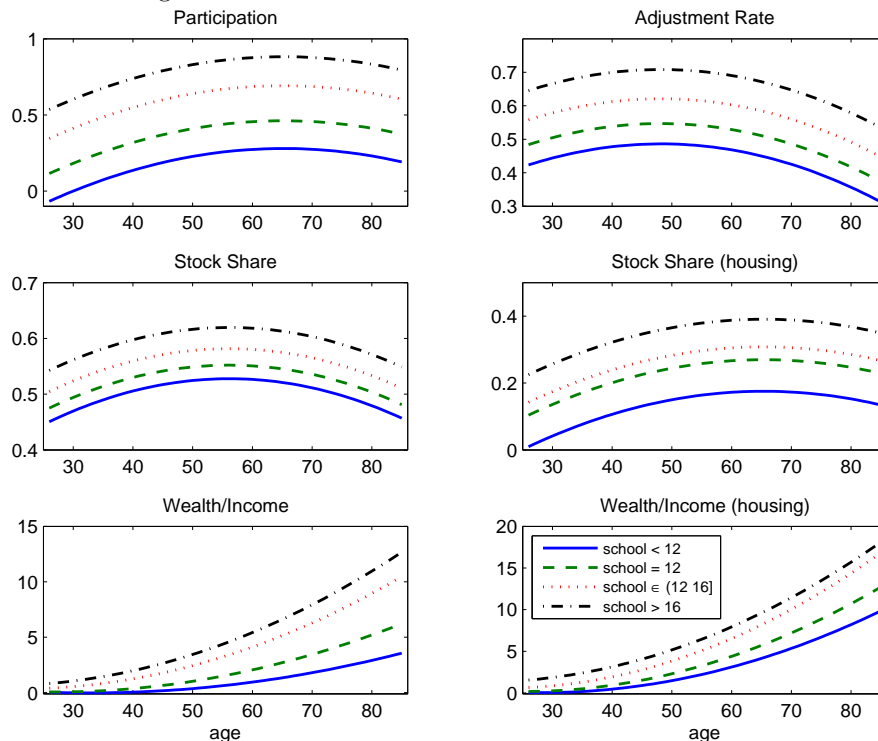
Figure 1 summarizes lifecycle patterns.¹¹ There is a distinct ordering by education: participation, stock share and the adjustment rate all increase with education. Further, there are clear life cycle effects with participation, the stock share and the adjustment rate all exhibiting hump-shaped patterns.

Note that there are two measures of the stock share and the wealth income ratio, depending on whether housing is included in wealth. Obviously, the stock share is lower on average and the wealth income ratio is higher on average once housing wealth is included. Still the basic patterns are independent of how housing wealth is included.

One of the challenges in matching the US data is the rising wealth to income ratio over the life cycle. Though income falls at the end of the life cycle, there is also an increase in wealth. In the model, this will be explained jointly by a bequest motive and medical risk.

¹¹The underlying regressions are presented in section 4.5.

Figure 1: US: Profiles of Household Financial Decisions



These profiles show the age dependence of household financial decisions. The regressions underlying these figures are explained below. For the figures labelled 'housing', home equity is included in wealth.

3 Household Dynamic Optimization

The dynamic optimization model for the household is a modified version of that presented in Cooper and Zhu (2015). The parameters of this model are estimated using a simulated methods of moments approach for both the US and China. The model emphasizes two key discrete choices of the household: participation in asset markets and adjustment of its portfolio.

A household lives for T periods, working for the first $T^r < T$ periods of life. During the working phase of life, households earn income governed by the stochastic process in (15). Upon retirement, household income is deterministic. Also, during retirement, the household faces out of pocket medical expenses. To be clear, these exogenous processes differ across the two countries and are, in part, a source of difference in financial choices.

In the presentation of the household optimization problem, there is no explicit index of education nor any indicator of the country. It is implicit that a household from country i with education e will face the stochastic processes for income, medical shocks and asset returns that were estimated for that education group in that particular country. The same applies for sub-groups within a country, such as the low-education rural households and the high-education urban households that we study separately.

3.1 Participant

Let Ω represent the current state of the household. This includes the current income of the household as well as its holdings of financial assets and its current medical expenses. That is, $\Omega = (y, m, A)$, where $A = (A^b, A^s)$ summarizes the current value of the holdings of bonds and stocks respectively.¹²

A household that is currently holding stocks, i.e. is a participant, chooses between three alternatives: (i) portfolio adjustment, (ii) no adjustment and (iii) exiting the assets markets by selling all stocks. This choice is given:

$$v_t(\Omega) = \max\{v_t^a(\Omega), v_t^n(\Omega), v_t^x(\Omega)\} \quad (1)$$

for all Ω .

If the household chooses to adjust, it chooses stock and bonds solve:

$$\begin{aligned} v_t^a(\Omega) &= \max_{A^{b'} \geq \underline{A}^b, A^{s'} \geq 0} u(c) + \beta E_{y', m' | y, m} \left\{ (1 - \nu_{t+1}) v_{t+1}(\Omega') + \nu_{t+1} B(R^b A^{b'} + R^{s'} A^{s'}) \right\} \\ \text{s.t.} \quad c &= y + TR - m + \sum_{i=b,s} R^i A^i - \sum_{i=b,s} A^{i'} - F \\ TR &= \max\{0, \underline{c} - (y + \sum_{i=b,s} R^i A^i - m)\}. \end{aligned} \quad (2)$$

Here ν_{t+1} is the survival probability, which depends on both age and, implicitly, the education of the agent. There is a transfer allowed from the government to the household to create a consumption floor of \underline{c} . This feature of the model is taken from Hubbard, Skinner, and Zeldes (1995) and DeNardi, French, and Jones (2010). Based upon the results reported in Cooper and Zhu (2015) this institutional feature is important for matching the wealth income ratio of relatively poor households. Here $B(R^b A^{b'})$ is the value of leaving a bequest of size $A^{b'}$ and is explained below.

For ease of exposition, this problem is stated time separable preferences. As reported in Cooper and Zhu (2015), a recursive utility formulation, as in Epstein and Zin (1989) and Weil (1990), fit the moments for the US best. We return to allowing this alternative specification in our estimation section.

In this problem, there is a lower bound to bond holdings, \underline{A}^b . Short sales of stocks is not allowed.

The F in (2) represents the cost of stock adjustment account, including fees paid as well as time costs incurred. In Bonaparte, Cooper, and Zhu (2012) and Cooper and Zhu (2015), this cost was used, in part, to match portfolio adjustment rates. But no data exists on adjustment rates for Chinese asset market participants. In addition, the stock adjustment costs motivate a lower stock share for participants and helps to match that aspect of the data for both countries. A household that participates in asset markets but chooses not to adjust its stock account is able to freely adjust its bond account.

If the household chooses not to adjust its portfolio, then the cost F is avoided and there is re-optimization over

¹²By value we mean that, for example, A^s , is the product of amount of stock purchased in the previous period and its realized return.

bond holdings alone. The household chooses bonds to maximize:

$$v_t^n(\Omega) = \max_{A^{b'} \geq A^b} u(c) + \beta E_{y', m' | y, m} \left\{ (1 - \nu_{t+1}) v_{t+1}(\Omega') + \nu_{t+1} B(R^b A^{b'} + R^{s'} A^{s'}) \right\}$$

s.t.

$$c = y + TR - m + R^b A^b - A^{b'} \quad (3)$$

$$A^{s'} = R^s A^s \quad (4)$$

$$TR = \max\{0, \underline{c} - (y + \sum_{i=b, s} R^i A^i - m)\} \quad (5)$$

Here we assume that if there is no portfolio rebalancing, any return on stocks is automatically put into the stock account, i.e. $A^{s'} = R^s A^s$.

A household currently participating may choose to end its stock holdings. Though there is no flow cost of participating, household will exit financial markets when a large shock, such as an adverse medical expense, leads to the liquidation of stock holdings. The value from exit is given by:

$$v_t^x(\Omega) = \max_{A^{b'} \geq A^b} u(c) + \beta E_{y', m' | y, m} \left\{ (1 - \nu_{t+1}) w_{t+1}(\Omega') + \nu_{t+1} B(R^b A^{b'}) \right\} \quad (6)$$

s.t.

$$c = y + TR - m + \sum_{i=b, s} R^i A^i - A^{b'} \quad (7)$$

$$TR = \max\{0, \underline{c} - (y + \sum_{i=b, s} R^i A^i - m)\}. \quad (8)$$

3.2 Non-Participant

A household currently not holding stocks can, at a cost, enter into financial markets. Or the household can remain a non-participant. The values for this participation decision are given by:

$$w_t(\Omega) = \max\{w_t^n(\Omega), w_t^p(\Omega)\} \quad (9)$$

for all Ω .

Even if does not hold stocks, it can adjust its bond account in response to income shocks. The optimization problem of non-participants is:

$$w_t^n(\Omega) = \max_{A^{b'} \geq A^b} u(c) + \beta E_{y', m' | y, m} \left\{ (1 - \nu_{t+1}) w_{t+1}(\Omega') + \nu_{t+1} B(R^b A^{b'}) \right\} \quad (10)$$

for all Ω . Consumption is given by

$$c = y + TR - m + R^b A^b - A^{b'}. \quad (11)$$

If a household switches its status and decides to purchase stocks, it must pay an entry cost of Γ . There is no lag so that the household can instantly trade in the stock market. The value from participating for the first time

is given by:

$$w_t^p(\Omega) = \max_{A^b \geq \underline{A}^b, A^{s'} \geq 0} u(c) + \beta E_{y', m' | y, m} \left\{ (1 - \nu_{t+1}) v_{t+1}(\Omega') + \nu_{t+1} B(R^b A^b + R^{s'} A^{s'}) \right\}$$

s.t.

$$c = y + TR - m + R^b A^b - A^{b'} - A^{s'} - \Gamma \quad (12)$$

$$TR = \max\{0, \underline{c} - (y + R^b A^b - m)\}. \quad (13)$$

Here the bequest value is a function of total wealth, including the liquidated value of stocks. The household chooses a bequest portfolio without knowing the stock return that will determine the full value of the inheritance.

4 Quantitative Approach

The parameters of the household optimization problem are estimated via simulated method of moments. The estimates of the incomes processes, return processes, mortality and household medical expenditures, described below, are estimated outside of the household optimization problem.

For the simulated method of moments approach, the vector of parameters $\Theta \equiv (\beta_i, \gamma, \Gamma, F, L, \phi, \underline{c}, \kappa, \theta)$, solve the following problem:

$$\mathcal{L} = \min_{\Theta} (M^s(\Theta) - M^d)' W (M^s(\Theta) - M^d) \quad (14)$$

where W , the weighting matrix, is the inverse of the variance-covariance matrix of the moments. Note that the discount factor, β_i , is indexed by education attainment $i = 1, 2$ where $i = 1$ is the low education group.¹³ The simulated moments, $M^s(\Theta)$, are calculated from simulated data set created by solving the household optimization problem.

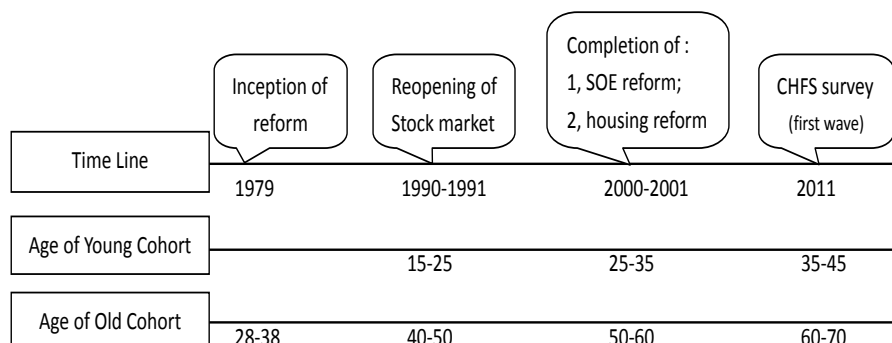
In the presence of stock market participation costs, the status of being a participant itself has value. Therefore the initial distribution of assets in the economy could be important. But this is not a concern in the current study since our estimation is based on two cohorts that enter the economy at around 1970 and 1990 while the stock market became active after 1990. Thus we assume households enter the economy with zero holding of either stock or bond at age 21. By contrast, Cooper and Zhu (2015) calculates the initial distribution of asset holdings from data as initial conditions matter for household choices.

4.1 Regime Change

In working with the Chinese data there is an important challenge: there is only a single cross-section of CHFS data available. The data cover households having very different live experiences. Contrary to the standard assumptions

¹³In experiments where, in addition to the difference in the discount factor by education, we also allow difference in either the participation cost or the adjustment cost. The estimation results indicate that these additional difference are statistically insignificant.

Figure 2: Time line and cohorts



of stationarity made in both theory and quantitative models, the huge changes in the structure of the Chinese economy make inference from a single cross sectional exceptionally difficult. The timing of these structural changes are illustrated in Figure 2.¹⁴

To appreciate this issue, compare two single men from the sample. One is 35-45 years old with a college education living in Shanghai. This person has a job in the private sector and is a participant in the Shanghai stock market. The other is 60-70 years old. He is now working in the private sector though he began his career working in the public sector. When he was young, there were very few private sector jobs and there was no access to stock markets. Nowadays, nearing retirement, things are very different due to the privatization and other reforms that started in the early 1980s and ended about 20 years later, the re-opening of stock markets around 1990 and a higher return to education.

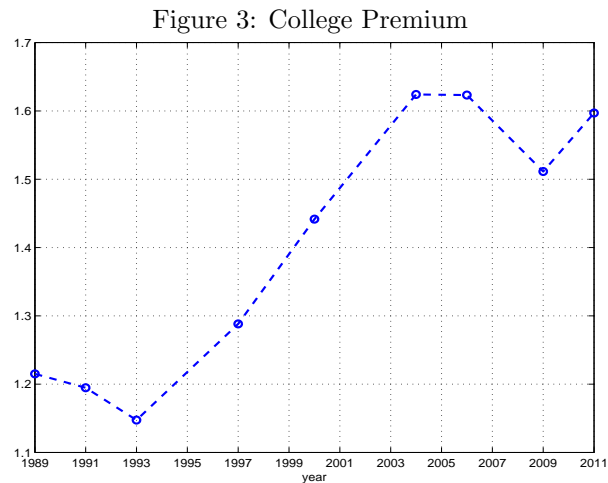
Figure 3 shows the college premium over time in China. As a consequence of labor market reform, the college premium rose dramatically from 1989 to 2011. This type of structural change dramatically separates the groups in the single cross section.

The stochastic process of income has also changed dramatically in China. This can be seen in Table 4. The income process for China is based on CHNS data. Comparing the pre- and post-2000 period, one can see that income shocks has been both larger and more persistent. This is especially true for the more educated group. Similar changes about unemployment risk are documented in He, Huang, Liu, and Zhu (2014).

These changes in labor market are related to the rise of private and foreign enterprises, the privatization of collectively owned enterprises, as well as the reform of state-owned enterprises (SOEs). The reform of SOEs, implemented mainly by Premier Rongji Zhu, is particularly impactful. By the beginning of 2000s, the SOEs have mostly been transform into so-called “modern enterprises” that seek profit maximization to a large extent, with the freedom to set wages and fire workers.

In addition, the participation of stock market was essentially not possible before 1990. Shanghai Stock Exchange

¹⁴Another potentially important structural change is the implementation of *the new rural cooperative medical insurance* since 2003 which provide rural households with the basic medical insurance coverage. Since the CHARLS data started only in 2008 on the trail basis, we are not able to measure the impact of this new policy on medical expense process. Data from CHARLS 2011-2013 shows that out-of-pocket medical expense relative to income is still much higher for rural households.



The figure shows the average profiles of post-retirement to post-retirement income by education attainment. not sure what this figure is given this description

started to operate on December 19, 1990. The Shenzhen Stock Exchange also started to operate on December 1, 1990. Thus for the cohort born in 1950, stock market was simply not accessible until they were 40 years old.¹⁵

Further, prior to the 2000 housing reform, there was not an active residential housing market. Instead, houses were mostly allocated through the employment relationship rather than through trades. After the reform, house prices started to take off, and the average real growth rate of house price in cities has exceeded 10% since 2005.¹⁶ Therefore the housing reform is an important structural change which we take into account explicitly in the estimation.

Our approach to estimation is to include these changes in our model, rather than remove them from the data. That is, instead of attempting to remove these effects of this regime change from the data, we instead allow for regime change in the model. So the current old in the data are viewed as having lived through these regime changes while the current young spend most of their lives in the more modern China.

Agents start their lives in one regime and then switch to the other one, staying in the new regime permanently. The switch is a surprise and the new regime is believed to last forever. To obtain simulated moments, given parameters, the decision rules are used to create a simulated panel and then moments are calculated as in the data by age.

To implement this, for each education group we solve the dynamic optimization problem for two cohorts who experienced the structural changes at different ages, as illustrated in Figure 2. For the young cohort, the stock market is always accessible, and the structural change in the labor market occurs ten years after they enter the economy. Their household finance information is represented by those aged 35-45 in the CHFS data. For the old cohort, the stock market is not accessible until they are 45 years of age, and the structural change in labor market

¹⁵The security market in Shanghai dates back to the 1860s. It was closed 1950 as part of the socialist transformation.

¹⁶Most of existing house price indices in China dates back to 2005 or later.

occurs when they are 55. Their financial decisions are reflected by household finance moments of those aged 60-70 in the CHFS data.

4.2 Exogenous Processes

As presented here, Chinese and US households differ in the exogenous income processes they face over the life-cycle. In addition, there are important differences in medical expenses between the two countries.

4.2.1 Income

To characterize the stochastic component of income, let $\tilde{y}_{i,t}$ denote the stochastic component of income for household i in period t . We decompose it into transitory and persistent shocks.

$$\begin{aligned}\tilde{y}_{i,t} &= z_{i,t} + \epsilon_{i,t} \\ z_{i,t} &= \rho z_{i,t-1} + \eta_{i,t}\end{aligned}\tag{15}$$

where $\epsilon_{i,t}$ and $\eta_{i,t}$ are independent zero-mean random shocks, with variance σ_ϵ^2 and σ_η^2 respectively. The shock $\eta_{i,t}$ is persistent, with persistence parameter of ρ .

The stochastic process of labor income is estimated using data from China Health and Nutrition Survey (CHNS) between 1989 and 2009. The process for the US is estimated from the Panel Study of Income Dynamics (PSID) between 1989-2009. More details about the data are in the Appendix. Table 4 reports the estimates for both China and the US.

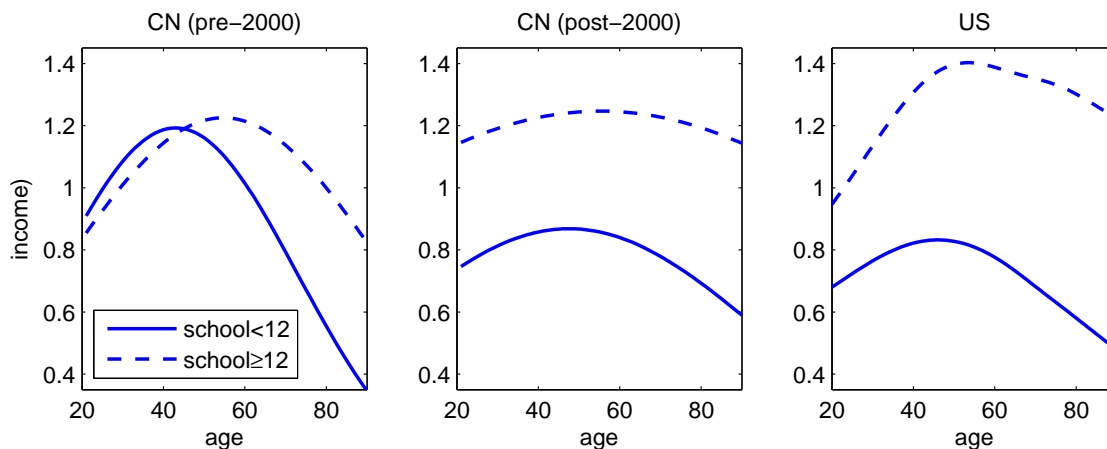
Table 4: Stochastic Income Processes

Schooling	China pre-2000			China post-2000			US		
	ρ	$\text{var}(\eta)$	$\text{var}(\epsilon)$	ρ	$\text{var}(\eta)$	$\text{var}(\epsilon)$	ρ	$\text{var}(\eta)$	$\text{var}(\epsilon)$
<12	0.736 (0.023)	0.124 (0.023)	0.382 (0.035)	0.844 (0.012)	0.134 (0.013)	0.329 (0.026)	0.956 (0.010)	0.021 (0.005)	0.152 (0.026)
≥ 12	0.708 (0.038)	0.059 (0.021)	0.235 (0.039)	0.832 (0.024)	0.076 (0.014)	0.204 (0.028)	0.946 (0.004)	0.028 (0.003)	0.089 (0.006)

There are a couple of notable differences. First, income shocks are more persistent in the US relative to China. Second, the income process for both education groups is significantly more variable in China.

The deterministic components of income over the life cycle are shown in Figure 4. For China, the rising education premium is apparent. Estimation based on 1989-2000 data shows a negative education premium before age 45, while the education premium is always positive in post-2000 data. On average income of the high education group is 18% higher than the low education group in pre-2000 data, but the difference becomes 54% in post-2000 period. For the US the differential is 78% in our PSID sample. Therefore despite the fact that education premium has risen considerably in China, it is still small compared to the US. Compared to the post-2000 income in China, the

Figure 4: Age Profile of Income



The figure shows the average profiles of income by education attainment.

hump shape in income is more pronounced for the US. This would, all else the same, lead to higher saving in the US.

4.2.2 Medical Expenses

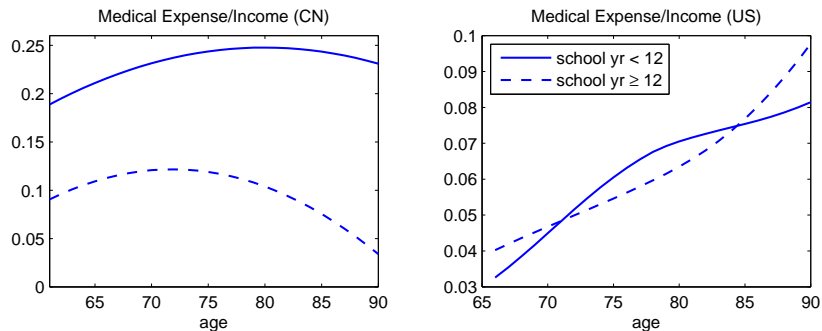
Data on out-of-pocket medical expenses are extracted from The China Health and Retirement Longitudinal Study (CHARLS), available at <http://charls.ccer.edu.cn/en>. We use the 2011 and 2013 waves of the survey to estimate the deterministic and stochastic medical expense process.

For each education group, we calculate the ratio of medical expense to income, then regress the ratio on a quadratic function of age. The left panel of Figure 5 shows the predicted profiles. Clearly, relative to their income, less educated households are subject to higher out-of-pocket medical expenses, which is in sharp contrast with the US profiles shown in the right panel. This is at least partly due to the fact that the more educated Chinese either enjoy free health care if they are in the state sector, or they have better medical insurance coverage if they are in the private sector.

The stochastic process of out-of-pocket medical expense is presented in Table 5. For comparison, we also show the process for the US as estimated in DeNardi, French, and Jones (2006). Apparently Chinese households are subject to larger and more persistent medical expense shocks. The more educated Chinese receive larger shocks, but the shocks tend to be less persistent. However as shown in Figure 5, their deterministic expense relative to income is much smaller, so they are better protected from medical expense shocks overall.

In the estimation of the model, these education specific income, medical expense and mortality processes are exogenous inputs. Moreover, the variance of income innovations varies by education class, and is also taken as exogenous inputs. As noted above, we restrict the variability of medical expenses post-retirement to be the same across education groups.

Figure 5: Post-Retirement Medical Expenditure Relative to Income



The figure shows the average profiles of post-retirement to post-retirement income by education attainment.

Table 5: Stochastic Medical Expense Process

	China			US		
	ρ	$\text{var}(\eta)$	$\text{var}(\epsilon)$	ρ	$\text{var}(\eta)$	$\text{var}(\epsilon)$
Overall	0.978 (0.034)	0.077 (0.053)	1.875 (0.133)	0.922	0.0503	0.665
schooling<12	0.987 (0.029)	0.058 (0.038)	1.904 (0.134)			
schooling \geq 12	0.954 (0.086)	0.107 (0.141)	1.825 (0.281)			

4.3 Returns on Assets

The asset returns reflect observed processes. This includes the returns on stocks, bonds and housing. These processes are inputs into the household optimization problem.

Looking first at the returns after the regime changes in China, we use the real return to Shanghai Stock Exchange Composite Index, including both dividend and capital gain, for the period between March 1994 - March 2016. The stock return is 10.07% on average, with a standard deviation of 0.47. These statistics are used in the baseline analysis.¹⁷ In the robustness check we also estimate the model based on the (i) stock return prior to March 2011 and (ii) stock return process of the US market explained below.

Regarding the real return on housing investment in China, the baseline model uses the housing returns of 11% based on statistics reported in Fang, Gu, Xiong, and Zhou (2015). In the robustness analysis we also consider a lower return of a 6.28% housing return based on statistics reported in Jing Wu and Deng (2012).

Bonds in our model are a composition of housing equity and traditional low-risk assets such as bank deposits, treasury bills and so-called Wealth Management Products (WMPs). We include housing in the composite stock because housing return has a negligible variation compared with the stock return.¹⁸ The bond return is the weighted average of housing return and return to these traditional low-risk assets. The latter has a return of about 1.8% based on data on return to 1-year deposit and 90-day treasury bills. On average housing asset is about 80% of the total assets included in the composite bond, therefore we put a weight of 0.8 on stock and a weight of 0.2 on the traditional low-risk assets, thus the composite bond return is set at 9% in the baseline model. In the robustness analysis it is set to 5.0% based on a housing return of 6.28%.

Prior to the regime change in 1990, there was no active stock market. Further, since there is no active housing market prior to the regime change in 2000, we set the return on composite bond to 1.8%, the return to the traditional low-risk assets.

4.4 Functional Forms

The analysis requires the specification of functional forms, both for the flow utility and the value of bequests. As in Cooper and Zhu (2015), we assume a recursive utility representation following Epstein and Zin (1989) and Weil (1990). The value function is given by:

$$V_t = \left\{ (1 - \beta)c_t^{1-1/\theta} + \beta \left[(1 - \nu_{t+1}) \left(E_t V_{t+1}^{1-\gamma} \right)^{\frac{1}{1-\gamma}} + \nu_{t+1} \left(E_t B_{t+1}^{1-\gamma} \right)^{\frac{1}{1-\gamma}} \right]^{1-1/\theta} \right\}^{\frac{1}{1-1/\theta}}. \quad (16)$$

Here γ captures the attitude of the agent towards risk and θ parameterizes the substitution effects of a change in the real interest rate. With this specification, there two key aspects of household choice are estimated independently.

The bequest function is given by:

¹⁷For the period of 2003-2013, Fang, Gu, Xiong, and Zhou (2015) reports the mean and standard deviation of stock return to be 7.3% and 0.515, respectively.

¹⁸The standard deviation of housing return is only 0.075 for smaller and median-sized cities according to Fang, Gu, Xiong, and Zhou (2015), while in the same sample period the standard deviation of stock return is 0.515.

$$B(Z) = L(\phi + Z). \quad (17)$$

The curvature over the bequests, parameterized by γ , appears through (16). Here $\phi > 0$ allows for $Z = 0$ as $B'(0)^{-\gamma}$ is finite.

4.5 Moments

The moments for China are summarized in Table 6. Here the young and old refer to the 35-45 and 60-70 years old households respectively. The moments are obtained by regressing the elements of household financial decisions on age and education dummies, with the omitted age being those not in either the 35-45 or 60-70 year old category.¹⁹

The model does not include a homeownership choice. Yet, homeownership influences financial decisions. For China, we find that homeownership reduces the participation rate and financial wealth (without housing) to income ratio significantly, while the amount of home equity increases the participation rate and the ratio of financial wealth to income. The effects of housing on stock share are not statistically significant.

To include these effects, as already mentioned, we include housing in the broad category of bonds on the basis that housing return has a standard deviation of only 0.075 for smaller and median-sized cities according to Fang, Gu, Xiong, and Zhou (2015). Accordingly, the share and wealth to income moments are changed. Specifically, the “share” is defined as the ratio of stocks to the sum of financial and housing wealth. This same measure of wealth is used to calculate the wealth to income ratio. Further, as discussed above, the return to bonds includes the return to homeownership. Thus the role of housing as a component of wealth is captured in this analysis.

These coefficients on age and education reported in Table 6 capture the same patterns as the averages by age and education reported in Table 1. In particular, participation increases with education while the share varies relatively little. Further the wealth income ratio is larger for higher education households and rise with age for the high education group.

Table 7 summarizes the moments used in the estimation of the parameters for the US. These moments are obtained by regressing household financial choices on age, age-squared as well as an education dummy.²⁰ The regressions underlie Figure 1 and again make clear that participation, stock share and the adjustment rate are all increasing in education attainment. Further, there are significant life cycle patterns in these choices.

¹⁹Specifically, for participation the regressors are: constant dummies for young-low, young-high, old-low, old-high, controlling for: home ownership dummy, log(house value), and unmarried son; for share and W/I, the regressors are: constant dummies for young-low, young-high, old-low, old-high, controlling for unmarried son. We don't control for housing because housing is included in the dependent variable. For the US analysis, regressors are: constant, age, age² and education dummies (for W/I interaction of age and edu are also included). We use the same treatment of housing as for China.

²⁰The omitted education group is the lowest attainment. Cooper and Zhu (2015) report results for four education groups, both with housing in the moments and conditioning on home ownership status and equity.

Table 6: China: Moments by Education and Age

	const.	Dummies			
age education		Young		Old	
		Low	High	Low	High
Data					
part.	0.120	-0.059	0.206	-0.059	0.100
share	0.124	-0.002	0.009	-0.038	0.048
W/I	12.478	-1.869	4.444	1.967	5.285
Baseline					
part.	0.122	-0.064	0.205	-0.072	0.077
share	0.071	-0.022	-0.034	-0.030	-0.041
W/I	5.318	1.170	2.187	2.039	3.496
Identity Matrix					
part.	0.121	-0.090	0.014	-0.109	0.135
share	0.076	-0.002	0.012	-0.048	-0.0003
W/I	7.258	-0.188	1.920	2.565	6.274
Earlier Stock Return					
part.	0.123	-0.062	0.195	-0.079	0.104
share	0.090	-0.036	-0.035	-0.038	-0.051
W/I	4.713	0.520	1.792	1.342	3.813
Lower Housing Return					
part.	0.080	-0.079	0.207	-0.079	0.071
share	0.105	-0.010	-0.005	-0.029	-0.024
W/I	5.242	-0.714	3.157	-0.449	4.752
US return					
part.	0.081	-0.081	0.062	-0.076	0.035
share	0.225	-0.008	-0.039	-0.071	-0.043
W/I	6.775	1.142	3.290	1.389	4.788

This table reports model moments from various estimations. Housing is included as part of the risk-free assets in data moments.

5 Estimation Results

5.1 Main Results

Table 8 presents parameter estimates for both China and the US. The comparison across countries is useful for a few reasons. First, the issue of how and why household financial decisions differ across the countries is of interest. Second, the cross-country comparison provides a context for evaluating the parameter estimates. The contrast is further enhanced below by looking at estimates for groups within China.

For the Chinese baseline model in the first row, the estimated discount factor of 0.834 for the low education group is considerably lower than the estimate of 0.946 for the high education group. The US parameter estimates are given in the second row of Table 8. For the US the discount factor is also higher for the high education group, though this difference is not statistically significant. Importantly, the discount factor for the Chinese high education group is much higher than that for the US and the Chinese low education group has a much lower discount factor.

The estimated risk aversion, $\gamma = 6.495$, is lower in China than in the US, though the estimate is not very precise.

Table 7: Moments of the US Economy

		const.	age	age^2	edu_2	
part	data	-0.68	0.029	-0.00023	0.412	
	(s.e.)	(0.037)	(0.001)	(0.00001)	(0.011)	
	model	-0.559	0.033	-0.0003	0.401	
share	data	-0.101	0.01	-0.00007	0.121	
	(s.e.)	(0.042)	(0.001)	(0.00001)	(0.015)	
	model	0.233	0.008	-0.0001	0.433	
adj	data	0.189	0.012	-0.00013	0.135	
	(s.e.)	(0.100)	(0.003)	(0.00003)	(0.031)	
	model	-0.226	0.009	-0.0001	0.028	
	(s.e.)	const	age	age^2	$age \times edu_2$	$age^2 \times edu_2$
W/I	data	2.473	-0.173	0.00305	-0.008	0.001
	(s.e.)	(1.152)	(0.04)	(0.00043)	(0.027)	(0.00038)
	model	4.917	-0.247	0.0033	-0.069	0.002

This lower risk aversion is, in part, needed to retain a high stock share in Chinese portfolios given the volatility of stocks in the Shanghai market.

The costs of asset market participation are reported as fractions of average pre-retirement income. The cost is very high, 26% of average income. This is needed to match the relatively low participation rate of Chinese households. Recall that the asset market participation cost for the old cohort when they were young is set to infinity as the asset market opportunities essentially did not exist. This is considerably higher than the US estimate of 0.011. Using average disposable household income of \$51,759 for the US and \$9,313 in China, the participation cost is estimated at \$570 in the US and \$2,421 in China.²¹

The adjustment cost of 1.2% is also significant. Though we do not have any measure of adjustment frequency in the Chinese data, this cost helps to generate the decline in participation for older agents. The estimated cost is about the same for the US in percentage terms and thus about 5.5 times higher in China in levels.

For China there is a large bequest motive, $L > 0$, but there is not evidence that ϕ matters and it was removed from the estimation for China. This bequest motive is much lower for the US.

For both countries there is evidence of a consumption floor. In China, this represents transfers from the government as well as within families and among friends. In the CHFS data, about 5% of the respondents lived in a house that bequeathed or transferred.²² The survey also has questions about two types of financial transfers: government transfer which is mainly needs-based and private transfer from parents, relative friends and others. These transfers are not regular income, and not included in our income measure. The average government transfer is 1582 and the average private transfer is 4298 yuan. The sum of the types of transfer amounts to about 10% of average income. This can be viewed as the lower bound of consumption floor which is estimated at almost 14% in the baseline model.

The consumption floor is about 10 percentage points larger in the US. This, as discussed later, has an effect on

²¹The average household income is calculated our sample of CHFS 2012 which is 58,021 RMB. This is about 9,313 USD using the exchange rate in the end of 2012. For the US, census data shows that in 2012 the median family income is 51,759 US dollar.

²²The survey does not specify where the transfers are from.

the wealth to income ratio through precautionary savings.

Finally, the estimated elasticity of intertemporal substitution is lower in China than in the US. For neither country is θ close to $\frac{1}{\gamma}$ as in the CRRA preference specification.

For this estimation, a borrowing constraint of $A_b = 0$ is imposed. In fact, allowing some borrowing, i.e. $A_b < 0$ did not improve the fit of the model.

Table 8: Parameter Estimates

	β_1	β_2	Γ	F	γ	θ	\underline{c}	L	Fit
China Baseline	0.834 (0.017)	0.946 (0.015)	0.264 (0.068)	0.012 (0.005)	6.495 (1.644)	0.367 (0.075)	0.139 (0.052)	2.479 (0.869)	53.876
US	0.868 (0.012)	0.887 (0.011)	0.011 (0.002)	0.017 (0.004)	8.399 (0.371)	0.580 (0.039)	0.231 (0.035)	0.056 (0.018)	235.842
Identity Matrix	0.856 (0.03)	0.933 (0.024)	0.106 (0.328)	0.047 (0.051)	7.763 (0.524)	0.765 (0.151)	0.064 (0.344)	2.720 (0.546)	4.796
Earlier Stock Return	0.820 (0.009)	0.919 (0.003)	0.339 (0.14)	0.014 (0.005)	6.107 (1.011)	0.441 (0.058)	0.159 (0.083)	1.853 (0.636)	63.42
Lower Housing Return	0.804 (0.013)	0.985 (0.001)	0.478 (0.162)	0.061 (0.019)	6.284 (1.849)	0.349 (0.041)	0.109 (0.025)	2.434 (0.165)	40.01
US return	0.853 (0.006)	0.965 (0.01)	0.464 (0.037)	0.170 (0.044)	8.942 (1.83)	0.459 (0.024)	0.117 (0.081)	3.839 (3.12)	216.389
Rural-urban	0.834 (0.022)	0.970 (0.022)	0.298 (0.158)	0.015 (0.004)	6.681 (1.768)	0.392 (0.169)	0.144 (0.067)	2.677 (2.002)	95.770
Nonstate-state	0.849 (0.013)	0.949 (0.014)	0.234 (0.067)	0.009 (0.005)	6.627 (1.618)	0.351 (0.092)	0.150 (0.1)	2.685 (1.076)	35.395

This table reports parameter values from various estimations. The “US return” estimation imposes US stock return to the Chinese market. The “US Economy” represents the estimation based on the US household finance moments and the US exogenous processes. For the first four cases, β_i for $i = 1, 2$ refers to education groups. For the “Rural-urban”, β_1 refers to rural households. For the “Nonstate-state” case, β_1 refers to households with jobs in the non-state sector.

From Table 6, the estimated model matches the participation moments quite well, capturing both the effects of education and age. The dependence of share on both age and education is relatively small in the data, and in the model. The model is unable to adequately capture the levels of the wealth to income ratio though the model does succeed in matching the increase for both older and more educated households.

For the US, Table 7 presents both the data and baseline model moments. Here, in contrast to China, the moments include the adjustment rate. From this table, the estimated model captures the effects of age and education on the participation, share and adjustment decisions. The estimated model overstates the level of the wealth to income ratio though it does capture the effects of age and the interaction between age and education. More details for the US estimation are provided in Cooper and Zhu (2015).

One important issue is the assumption that houses, like bonds, entail no costs of adjustment. To see if this assumption is important, we compared the fraction of bonds in the total bond plus housing asset. This goes from a low of about 16% for the 46-60 year old group to over 24% for the oldest group in the data. For the simulated model, bonds are about 18.5% of the composite asset. From the 45-75 year olds groups, the changes in bonds in the simulated model were well within these shares so that consumption smoothing through bond changes could be

accommodated without changes in housing stock. This is not always the case though for the 21-45 year olds, as they make sizable adjustments in their composite bond holdings. But for this young group, almost 97% of the adjustment involves the accumulation of assets and thus excluding adjustment costs associated with selling a house is not a problem for this sub-group.²³

5.2 Robustness

This section studies the robustness of our findings for China. There are a number of perturbations of the baseline model with the moments presented in Table 6 and the estimates reported in Table 8.

The first experiment replaces the weighting matrix used in the estimation, the inverse of the variance-covariance matrix, with an identity matrix. With this alternative weighting matrix, matching the moments associated with the wealth to income ratio becomes more important. Both cases, in theory, generate consistent estimates of the structural parameters.

The main features of the baseline model are retained with this alternative weighting matrix. In particular, the large gap between the discount factors of low and high education households are present, though the differences are slightly less. Further, the estimated risk aversions are quite close. However, with the identity matrix, the participation and adjustment costs are much lower and not statistically significant.

Given the short history of stock market in China, it is hard to measure the expected return and volatility of stock market investment. In the baseline estimation, the stock return is calculated based on stocks listed in Shanghai Stock Exchange and Shenzhen Stock Exchange during the period of March 1994 to March 2016. We do two related robustness exercise: (i) assume US return; (ii) calculated stock return based on data in the period up to 2011, the year of the Chinese survey.

The row labeled “Earlier Stock Return” uses the stock return prior to March 2011. In this case, the mean return is 12.57 and the standard deviation is 0.488. For this specification, the estimated values of the discount factor are lower than the baseline, for both education groups. Further, the participation cost is much higher due to the higher mean return.

The row labeled “Lower Housing Return” set the return on housing at 6.28% annually instead of the baseline value of 11% based on a different source detailed in the Appendix. Of course, this reduces the return to bonds, which is treated as a composite asset, to 5.0%. In this case, the stocks are more attractive than bonds. To match the participation and share moments, both the participation and adjustment costs are higher than the baseline. In fact, this specification fits better than the baseline model.

The row labeled “US return” experiment replaces the stock market return in China with the US process. This leads to higher discount factors for both education groups and substantially larger participation and adjustment costs to, again, match the Chinese moments. The fit of the model is almost six times worse than the baseline. Evidently, Chinese households are not equating the stock process in China with that in the US.

²³Of course, the presence of an adjustment cost may influence choices even if it rarely binds. The statement here is just about the *ex post* adjustment in a setting without costs.

5.3 Other sources of Heterogeneity

As noted earlier, there are differences in household choices when comparing urban and rural households as well as when comparing public vs. private sector employment. This sub-section studies the determinants of those differences.

Table 9: China: Moments by Type and Age

	con.	Young		Old	
		Rural	Urban	Rural	Urban
Data					
part.	0.117	-0.081	0.224	-0.085	0.134
share	0.121	-0.016	0.016	0.009	0.052
W/I	13.368	-6.792	4.161	-3.653	6.030
Model					
part.	0.114	-0.108	0.219	-0.110	0.103
share	0.077	-0.002	-0.033	-0.033	-0.045
W/I	5.186	0.884	1.988	1.340	4.242
		Non-state	State	Non-state	State
Data					
part.	0.117	-0.015	0.247	-0.028	0.038
share	0.121	-0.001	0.014	0.008	-0.014
W/I	12.312	1.203	-1.151	2.602	3.755
Model					
part.	0.159	-0.015	0.242	-0.035	0.043
share	0.077	-0.025	-0.049	-0.041	-0.036
W/I	5.908	0.774	3.378	2.005	4.781

This table reports model moments from various estimations. Housing is included as part of the risk-free assets in data moments.

For these cases, the moments were created by including a dummy based either on location of residence or type of employment. Those moments are reported in Table 9.

The first case distinguishes households by location: urban vs. rural. For this treatment, the estimated discount factor was allowed to vary across households. From Table 8, the estimated discount factor is estimated at the same level as the low-education households in the baseline, 0.834. For the urban households, the estimate of 0.97 actually exceeds the point estimate for the high education households. Other parameters are quite close to the baseline.

From Table 9, the estimated model matches both the participation and portfolio shares well. It again fails to match the wealth to income ratio.

Looking at the type of employment, from Table 8, the state sector workers have a much higher discount factor than the non-state workers. Otherwise, again the parameters are close to the baseline. In fact, the fit of this model is better than the baseline.

As for the moments, from Table 9, the age and employment aspects of the participation are matched very well and the portfolio share is similar to that in the data. But again, the wealth to income ratio moments are not matched.

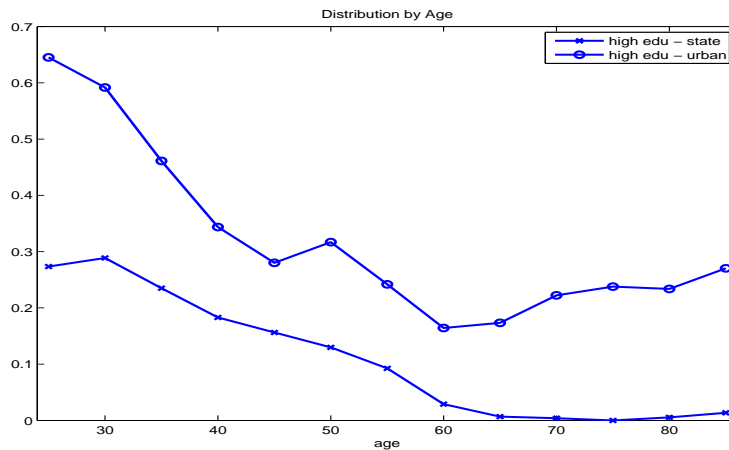


Figure 6:

Of course, these are not independent cuts of the data. Urban residents are more likely to be highly educated. The same is true for the state sector workers. The joint distribution of education type with rural-urban status and with sector of employment is reported in Table 10. To gain understanding of the evolution of joint distributions, we plot the fraction of highly educated urban households and the fraction of highly educated state sector employees against age in Figure 6. The share of highly educated urban employees and highly educated state sector employees are clearly higher among the young.²⁴

Table 10: Joint Distribution of Households

	Low-edu	High-edu		Low-edu	High-edu
Rural	2312	389	Non-state	4311	1714
Urban	2229	2214	State	230	889

This table reports the joint distribution of households by education, location and employment type.

6 Impacts of Regime Change

This section discusses two forms of heterogeneity in China. The first, as captured by the introduction of regime change, creates a difference in the experiences of young and old in our single cross section. Here we evaluate which of the many changes matter across the age groups. Then we study other sources of heterogeneity, including rural vs urban and the nature of employment, private or public.

²⁴The state sector households includes those employed by the governments, the SOEs and the collectively-owned enterprises. In the past 15 years, government jobs have becoming increasing popular among the young. Huawei, the largest telecommunications equipment manufacturer in the world, is classified as a collectively-owned enterprise in China.

6.1 Impact on Household Finance Moments

As noted earlier, a key dimension of the analysis is the introduction, through the model's simulation, of a regime change. That is, the old agents in the single cross section of data began their economic lives in a very different environment than the current young agents. Those differences appeared both in the exogenous processes for income, medical expenses and the participation cost.

Table 11: Counterfactual Experiments

Age	Pre-retirement		Post-retirement		Distance
Education	Low	High	Low	High	
Baseline					
part	0.070	0.362	0.017	0.078	
share	0.063	0.095	0.038	0.020	
W/I	6.088	7.182	3.571	4.951	
Old Housing Return=1.8%					
part	0.146	0.682	0.015	0.088	8.142
share	0.104	0.159	0.056	0.057	
W/I	4.157	5.453	1.927	2.681	
New Housing Return =11%					
part	0.039	0.173	0.023	0.094	2.111
share	0.062	0.070	0.021	0.019	
W/I	6.446	7.578	4.073	5.520	
Old Income Process					
part	0.062	0.219	0.018	0.052	2.900
share	0.061	0.076	0.029	0.013	
W/I	5.127	5.998	3.767	5.297	
New Income Process					
part	0.109	0.694	0.027	0.201	3.127
share	0.059	0.100	0.040	0.021	
W/I	6.151	8.754	3.447	5.805	
Stock Market Always Accessible					
part	0.070	0.362	0.012	0.047	0.084
share	0.063	0.095	0.038	0.026	
W/I	6.088	7.182	3.560	4.919	
Completely New Regime					
part	0.051	0.276	0.000	0.000	3.687
share	0.066	0.082	0.000	0.000	
W/I	6.574	9.276	2.937	5.148	

This table presents counterfactual exercises to determine which elements of the regime change are more important.

In this section, based upon these estimates we determine which differences across age groups are most important. In principle, the change in regime which occurred when the 60-70 year old group was around 40 years old should matter insofar as the financial state variables at that time influenced their subsequent financial choices.

The results are shown in Table 11. The different blocks refer to treatments that evaluate the impact of different elements of the regime change. The distance measures how far the simulated moments are from the baseline. Here

the metric is the simple sum of absolute differences.

The moments are reported by education group and for pre- and post-retirement. Though the estimation focused on two particular age brackets, here we look more generally at the influence of age, allowing a comparison with the motivating moments in Table 1.

The second and third blocks change the housing return. Recall that in the baseline model, the housing return is changed from 1.8% to 11% in 2000 unexpectedly, thus influencing the decision rules of various age groups differently. For these two treatments, the housing return either stays at its original value throughout the optimization and simulation, “Old Housing Return” row, or is at its new value throughout, the “New Housing Return” case.

Keeping the housing return at its original value matters a lot for the moments. The distance of 8.142 to the baseline is the largest difference. Put differently, the change in the housing return across cohorts is the most important element of the regime change. Relative to the baseline, the wealth to income ratio is much lower with the reduced return on housing while the participation rate, particularly for the young agents is much higher than the baseline. This response reflects the fact that the lower return on housing and thus on bonds induced agents to participate in the stock market. This has a strong impact on the young agents who, under this treatment, forecast a lifetime of low housing return.

The fourth and fifth blocks alter the income processes. This includes the pre- and post-2000 stochastic components reported in Table 4 as well as the deterministic income shown in Figure 4. It also includes the changes in the college premium shown in Figure 3. The “Old Income” treatment gives the income process of the old regime throughout the lifetime of both cohorts. In other words it assumes that structural change of income never happens. The treatment labeled “New Income” does the opposite, assuming the new income regime has always been in place.

From these two blocks, the differences in the income processes influence the wealth income ratio, particularly that of the more educated because they are the households benefited from higher education premium in the new regime. Income uncertainty is much lower in the old regime, therefore in the “Old Income” treatment the wealth-income ratio is lower. Correspondingly participation rate is lower. Stock share is not affected much. On the one hand stock share should be higher due to less income uncertainty, but on the other hand it should be higher because the participants are more selectively wealthier. When “New Income” is imposed, income is riskier, leading to higher wealth-income ratio and higher participation rate.

In the block labelled “Stock Market always Accessible”, we experiment with the case where both old and young cohorts have access to stock market throughout their lifetime, as if the market has always existed. This treatment does not affect the decision of the young cohorts because they enter the economy after stock market re-opens in the baseline model. The old cohort is affected only slightly – with higher participation rate and wealth-income ratio.

In the last experiment, we assume both cohorts have been living in the new regime all the time, with higher income uncertainty, higher education premium and access to stock market. Similar to the case of “New Income” we see significantly higher wealth-income ratio and participation rates. These results show that it is important to take structural changes explicitly into analysis when one studies an economy like in China.

6.2 Impacts on Wealth Distribution

Table 12: Wealth Distribution

	c.v. of wealth	top 5% <i>bottom5%</i>	top 10% <i>bottom10%</i>	top 20% <i>bottom20%</i>	prob. (%) of hitting \underline{c}
<i>data</i>	<i>2.00</i>	<i>4117</i>	<i>974</i>	<i>176</i>	<i>n.a.</i>
Baseline	1.21	4060	522	91	5.9
Old Income	0.98	1732	388	79	5.4
New Income	1.08	7817	616	93	6.0
Old Housing Return	1.69	∞	956	227	11.7
New Housing Return	1.05	2513	494	73	5.6
Stock Market Always Accessible	1.21	4064	523	91	5.9
Completely New Regime	0.98	3707	555	76	5.7

This table reports statistics for the wealth distribution from the data, the baseline model and with some counterfactuals.

It is interesting to see how the structural changes impact the wealth distribution in China. Five measures of wealth distribution are considered. The first one is the coefficient of variation of total wealth. This measure mainly captures the overall wealth distribution of households, but it is less informative about the changes of distribution in tails. Therefore three alternatives are used: the mean wealth levels of top 5, 10, 20 percentiles over the corresponding bottom 5, 10 and 20 percentiles. The last one is the probability of hitting consumption floor in the model. A higher probability implies more households with low income and low wealth.

Our goal is to understand the factors that influence the wealth distribution. Table 12 reports the results. The first row reports moments of the wealth distribution from the data except the probability of hitting the consumption floor which is not available in the data. The distribution from the baseline model, shown in the second row, is less dispersed than in the data. But the ratio of top-bottom 5% matches the data almost exactly. Both in the model and the data, the richest 5 percentile has an average level of wealth over 4000 times larger than the poorest 5 percentile.

If the income process prior to year 2000 has never been changed, then the wealth distribution would have been much less dispersed compared with the baseline results based on each of the five measures. This is shown in the row of “Old Income”. Intuitively, income is much less dispersed in the old income regime, with smaller and less persistent shocks. This is translated into less dispersed wealth distribution. On the other hand, imposing the new income process to years prior to 2000, the wealth distribution becomes more dispersed except that coefficient of variation is lowered slightly, implying fatter tails in the distribution.

With the old housing return imposed to each year in the model, the wealth dispersion increases tremendously compared with the baseline results. The bottom five percentile has zero wealth and about 12% of household live on the consumption floor. Conversely, if the new and higher housing return is applied to each year, then the wealth distribution becomes less dispersed. Mechanically, a higher housing return induces a higher saving rate and attenuates the precautionary motive of saving, hence heterogeneity in income shocks becomes less relevant for wealth accumulation. Notice that we assume every household participates in the housing market. If the housing

market is accessible to only a fraction of households, the implication on wealth distribution should be different.

Accessibility to stock market does little change to the wealth distribution, which is consistent with the fact that stock return has an extremely high volatility, but the mean return is not much higher than the composite bond that includes housing asset. Also note that the stock market participation rate is low – about 5% (20%) for less (more) educated households.

This exercise is important for the evaluation of policy measures that might reduce the cost of accessing capital markets. Evidently those policies will have little impact on the wealth distribution. Overall, in the completely new regime, the wealth distribution is less dispersed.

7 China vs the US: Why do they Differ?

This section returns to one of the central questions of this paper: what are the sources of the observed differences in household finance patterns between the US and China. The approach here is to impose parameter estimates for the US as reported in Table 8 and examine how they cause changes to household finance moments. In addition, we impose the stock return process in the US to the Chinese economy and examine the impacts on household finance moments in China. For this part of the analysis, there is no re-estimation, just simulations based on changes to the baseline parameter estimates.

The results of counterfactuals are reported in Tables 13 and 14. There are two experiments. In the first, reported in Table 13, we take the Chinese baseline and then put in US parameters or stock return process. This would influence both the young and old cohort. In Table 14 we do this same exercise but assuming that all agents are in the new regime, as if the parameter changes influenced a “post-2000 China”.

The main finding, reflected in these tables, is that differences in discount factors are the most important source of difference across households in the two countries. The second largest impact comes from the different estimates of the EIS. Other differences, such as the lower consumption floor in China and the higher participation and adjustment costs in China matter much less for the moments we focus on in the estimation. These findings hold for both the experiments with cohort effects, Table 13, and without, Table 14.

For the first exercise, the estimated discount factors for the US households with different education attainment were used to solve the optimization problem of the Chinese households, given education. We find the difference in discount factors matters substantially. The increase in the discount factor increases the wealth income ratio for the low education households in all age groups. The lower discount factor for the high education group decreases the wealth to income ratio. Further, the participation rate almost doubles for the low education groups and falls for the high education group, particularly the young households. The sum of squared differences in the moments is 7.118, considerably larger than any of the cohort effects or the differences in their parameters.

The other substantial change in the moments comes from changing the estimated EIS in China, of $\theta = 0.367$ to the US estimate of $\theta = 0.580$. From Table 13, this increase in the EIS increases the wealth to income ratio for the high education group and also increases the participation rate of this group. For the low education group the higher EIS causes lower wealth to income ratio. These changes are related to the different timing of income of

Table 13: US parameters for Chinese Households (with cohort effect)

		Pre-retirement		Post-retirement		Distance
		Low	High	Low	High	
Benchmark	part	0.070	0.362	0.017	0.078	
	share	0.063	0.095	0.038	0.020	
	W/I	6.088	7.182	3.571	4.951	
US β	part	0.138	0.048	0.038	0.006	7.118
	share	0.067	0.063	0.039	0.021	
	W/I	7.382	4.933	4.658	2.977	
US γ	part	0.046	0.359	0.013	0.059	2.015
	share	0.053	0.077	0.019	0.018	
	W/I	6.740	7.668	4.026	5.274	
US Γ	part	0.432	0.636	0.126	0.271	1.559
	share	0.066	0.109	0.081	0.031	
	W/I	6.217	7.367	3.679	5.077	
US F	part	0.044	0.258	0.008	0.035	0.263
	share	0.070	0.103	0.039	0.020	
	W/I	6.075	7.156	3.565	4.930	
US θ	part	0.023	0.465	0.003	0.182	6.596
	share	0.064	0.117	0.019	0.029	
	W/I	5.184	8.444	3.366	8.857	
US \underline{c}	part	0.064	0.340	0.008	0.065	1.930
	share	0.063	0.098	0.036	0.025	
	W/I	5.536	7.014	2.674	4.698	
US stock return	part	0.104	0.331	0.119	0.271	1.598
	share	0.197	0.262	0.192	0.184	
	W/I	6.173	7.338	3.719	5.179	

This table reports counterfactuals using US parameters instead of the estimated parameters for Chinese households. In this case, there are cohort effects for Chinese households.

these two education groups. As shown in figure 4, the income of low education group comes earlier than the higher education group. Hence the low education group have a strong incentive to save for the future if the EIS is low, so that consumption is smoothed over time. When the EIS is higher, this motive is weakened, resulting in lower wealth to income ratio. On the other hand, the high education group have some incentive to dis-save in order to smooth consumption over time because income is higher in later stage (of course they still save out of precautionary motives). Now with lower EIS, the incentive to dis-save is lowered, so they actually have higher wealth to income ratio with higher EIS.

In addition, reducing the entry cost from the Chinese to the US levels leads to a substantial increase in the participation rate, even more than the increased discount factor. Accordingly, the wealth/income ratios increase for all education and age groups as households enjoy higher returns on their savings.

Another substantial effect comes from increasing the estimated risk aversion in China to the higher level in the US. Given the risk in stock ownership, at the higher risk aversion the participation rate falls to zero for the low education groups, as does their stock share.

The last counterfactual analysis imposes the US stock return process on China. This is interesting because the Sharpe ratios between the two countries are very different. For the US stock market over the 1947-2007, the average return is 6.33% and the standard deviation is 0.155.²⁵ As discussed in Cooper and Zhu (2015), in the US the return on composite bond that includes traditional low-risk asset and housing is 4.08%. Therefore the Sharpe ratio (based on our definition of riskfree asset) is 0.145. For the Chinese market, the Sharpe ratio is 0.023 and 0.108 using the composite bond return of 9% and 5%, respectively. Therefore the risk-adjusted return is much higher in the US stock market, which should partly explain the different household finance patterns between these two countries.

²⁵As in Cooper and Zhu (2015), these are taken from Robert Shiller's online data of *S&P500* for the period 1947-2007.

Table 14: US Parameters for Chinese Households (without cohort effect)

	Pre-retirement		Post-retirement		Distance
	Low	High	Low	High	
benchmark	0.051	0.276	0.000	0.000	
	0.066	0.082	0.000	0.000	
	6.574	9.276	2.937	5.148	
US β					7.752
part	0.115	0.061	0.000	0.000	
share	0.070	0.059	0.000	0.000	
W/I	8.096	6.296	4.005	3.273	
US γ					2.220
part	0.052	0.315	0.000	0.000	
share	0.056	0.080	0.000	0.000	
W/I	7.347	9.994	3.302	5.458	
US Γ					1.393
part	0.309	0.605	0.090	0.239	
share	0.044	0.053	0.027	0.028	
W/I	6.660	9.472	2.965	5.209	
US F					0.038
part	0.041	0.268	0.000	0.000	
share	0.074	0.083	0.000	0.000	
W/I	6.568	9.270	2.937	5.148	
US θ					5.856
part	0.020	0.395	0.000	0.000	
share	0.067	0.099	0.000	0.000	
W/I	5.774	11.023	2.609	7.961	
US \underline{c}					1.364
part	0.047	0.270	0.000	0.000	
share	0.067	0.082	0.000	0.000	
W/I	6.125	9.154	2.338	4.964	
US stock return					0.371
part	0.049	0.279	0.0001	0.000	
share	0.102	0.114	0.125	0.000	
W/I	6.590	9.434	2.936	5.148	

This table reports counterfactuals using US parameters instead of the estimated parameters for Chinese households. In this case, there are **no** cohort effects for Chinese households.

8 Conclusions

This paper studied household financial decisions for different education groups for the US and China. Patterns of household finance, including participation in asset markets, portfolio shares, stock adjustment rates and wealth to income ratios, differ across education groups. These patterns are studied jointly in this paper. This broadens the analysis beyond the dimension of differences in savings rates between the two countries.

The point of the analysis is to uncover the key determinants of the different household financial behavior. We find significant differences in driving process. Households in China have (i) more variable income, (ii) are exposed to more medical risk and (iii) receive less income support from the government. In addition, high education households in China discount the future less than high education US households. The pattern is reversed for low education households.

As it stands, the study excludes a couple of other key factors influencing savings and housing demand. One, emphasized in Wei and Zhang (2011), invokes the importance of housing in attracting a spouse. The second is significance of family size in determining savings, particularly with a binding constraint on family size, as in Choukhmane, Coeurdacier, and Jin (2013). Both of these influences on savings and portfolios deserve further attention.

9 Appendix

The key data set for this study is the China Household Financial Survey. Information on the data is available at <http://www.chfsdata.org/>.²⁶ The moments used for the estimation were computed from these data.

9.1 China: Exogenous Processes

Returns Stock return is calculated based on Shanghai Stock Exchange Composite Index, available from WIND data base (<http://www.wind.com.cn/en/Default.aspx>). The real return includes dividends and capital gains weighted by their market values, controlled for inflation using CPI. First we calculate the real returns based on quarterly data, then compounded them into annual data. Using the period of March 1994 - March 2016, the annualized mean return is 10.07% on average with a standard deviation of 0.47. These statistics are used in the baseline model. For robustness, real stock return between March 1994 - March 2011 is also calculated. The resulting annualized mean return is 12.57% with a standard deviation of 0.488. The mean return is higher than from the longer sample period, partly reflecting the stock market crash since June 2015. Since the CHFS survey is done in 2011, we also estimated the model based on the shorter sample. As a cross check, we also calculated the value weighted average return of all the stocks listed in Shanghai Stock Exchange and Shenzhen Stock Exchange during the period of 1994-2013, from GTA data base (<http://us.gtarsc.com/>). The annualized real return is 12.43%

²⁶The China Household Finance Survey (CHFS) is provided by the Survey and Research Center of China Household Finance, Southwestern University of Finance and Economics, Chengdu, China. For more detail about the dataset, please see Gan, Yin, Jia, Xu, Ma, and Zheng (2013).

with a standard deviation of 0.492. These are extremely close to the returns based on Shanghai Stock Exchange Composite Index. Compared with the US data, both the return and volatility are significantly higher. Consistent with findings in the literature, we cannot reject the hypothesis that stock return follows an i.i.d. process.

A prominent trait in China household finance is the dominance of housing asset in the portfolio. Among the three major categories of asset (bond, stock, housing equity), the share housing equity is 80% on average based on the 2012 CHFS. The housing market started to be marketized since the end of 1990s. House price then started to take off after 2000, leading to a high average rate of growth. On the other hand, the standard deviation of housing return is only 0.075 for smaller and median-sized cities according to Fang, Gu, Xiong, and Zhou (2015). Thus we categorize housing as a low-risk asset, and combine it with other traditional low-risk assets, including cash, current deposits (checking account), fixed deposits (CDs), WMPs, treasury bills, corporate bonds, investment trust, nonRMB asset, and cash lent to friends and relatives. Collectively these assets are named bond in this paper.

Consistent with our definition of bond, bond return should be the weighted average of housing return and return to traditional low-risk assets. The average annual return to bank deposits are available on the website of People's Bank of China (<http://www.pbc.gov.cn/zhengcehuobisi/125207/125213/125440/125838/125888/index.html>). Between 1990-2014, after inflation adjustment using CPI, one-year bank deposit has an average annual return of 1.87%. During the same period of time, 90-day treasury-bill in China has a real annual return of 1.75%.²⁷ Thus the real return to these traditional safe assets is about 1.8% per year.

There are huge controversies over what the average housing is. This is mainly due to the discrepancies among the house price indices compiled by different agents. We consider two sources of housing return. The first source is Fang, Gu, Xiong, and Zhou (2015) which reports that, between 2003-2013, annual housing returns are 15.7%, 13.5% and 11% respectively among the first-, second- and third-tier cities in China. We take the housing return from the third-tier cities because the majority of the CHFS sample are from third-tier cities (and rural area). Combining this 11% return with the return to traditional low-risk assets, we have the annual real return of bond at the level of 9%. This return is used in the baseline analysis. Another source of housing return is Jing Wu and Deng (2012) which shows that nationwide real house has grown 240% between the first quarters of 2000 and 2010, amounting to an annual growth rate of about 3.42%. Jing Wu and Deng (2012) also shows that price-to-rent ratio has a mean value of about 35 implying a rental return of 2.86%. Therefore the overall housing return is $3.42\% + 2.86\% = 6.28\%$. Again we combine this with the return of traditional low-risk assets and calculate the bond return as 5.0%.

We include in the traditional low-risk assets the so-called wealth management products (WMPs). These are mutual funds issued by state-owned commercial banks. They are typically considered low-risk products. About 26% of them have returns guaranteed explicitly by the issuing bank. The remaining do not have guaranteed returns, but banks tend to choose to repay investors even if the products fail to meet the expected performance set forth by the banks. On average the real return of WMPs is between 2-4%. Not all the households have access to WMPs because each fund requires a minimum level of fund. Perry and Weltewitz (2015) provides a nice description of WMPs in China.

²⁷Data available at <https://research.stlouisfed.org/fred2>.

Income and Medical The sources for these processes and their representations are presented in the text.

9.2 US: Exogenous Processes

Details on the US processes are provided in Cooper and Zhu (2015).

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